Grinding Wheel Primer

Choosing the best wheel for your steel

by Jerry Glaser

Good results on a bench grinder depend on having the proper grinding wheel for tool steel, which is almost certainly not the all-purpose wheel that came with your grinder. Also, you'll need some means of keeping the wheel dressed, which means sharp, clean and round. Without both of these, you'll have to grind painfully slowly to avoid burning the tool and you'll still not have the edge you want.

About 25 years ago, I was really frustrated with grinding. The wheel on my power grinder seemed as likely to burn the steel as sharpen it. The wet sandstone wheel I had bought as a cure was almost worthless. Then one day at work I happened to notice that the guys in the tool room were grinding with white wheels, not gray, and I started asking questions. (The company I work for uses half-a-million dollars worth of abrasives a year, for grinding everything from turbocharger parts to bronze bushings. The wheels range anywhere from 3 in. on up to monsters 30 in. in diameter and 6 in. wide.)

Notice the chart on the facing page. All American-made grinding wheels are marked, on the paper washer at the side of the wheel, with a series of letters and numbers that tell you the wheel's characteristics. This code covers the type and coarseness of the abrasive (the hard grains in the wheel that actually do the grinding) and the type and concentration of the material used to hold the grit together, called the bond. There isn't room in a magazine article to cover all the grinding wheel variations (and I admit that in some places I'll be simplifying things), but here's what you should know about choosing a wheel for grinding woodworking tools.

Let's cover the simplest thing first, the bond type, which can be V, S, R, B, E, or O. For our purposes, you can forget any bond type but V, or vitrified, which means that the abrasive particles are held together by ceramic material fused in a furnace—the other bonds are mostly for high-speed cutoff wheels and other industrial applications far removed from tool grinding. A vitrified wheel is similar to glass or china, which makes it waterproof (and oil proof), allowing it to be cooled if you are so inclined. It is perfectly safe to use a misting or spraying system when grinding, but don't allow a wheel to sit with one edge in water; enough may soak in to leave the wheel dangerously unbalanced the next time it's turned on.

The next symbol to consider is the type of abrasive. Diamond and the new cubic boron nitride are out of this discussion because of their cost, at least five to ten times more than the standard abrasives, namely silicon carbide and aluminum oxide. Silicon-carbide (C) wheels may be green or black in color. They are used for grinding cast iron, brass and aluminum, and the green ones can sharpen carbide tools. They are not a good choice for tool steel, however, because the individual grain particles lose their sharp edges in use, and the dull grit generates heat without removing steel. In contrast, aluminum-oxide (A) wheels remain sharp because the individual grit particles fracture and chip in use, constantly exposing new cutting edges.

There are a few different kinds of aluminum oxide, distinguished by color. The familiar gray wheel, the one that comes with the grinder, is not a bad choice for all-purpose grinding. But the other aluminum oxides, which are white, off-white, or pink are a better choice for tool grinding because the grains fracture more easily—the wheel grinds cooler, stays sharper and requires less frequent dressing to keep it clean of embedded steel particles.

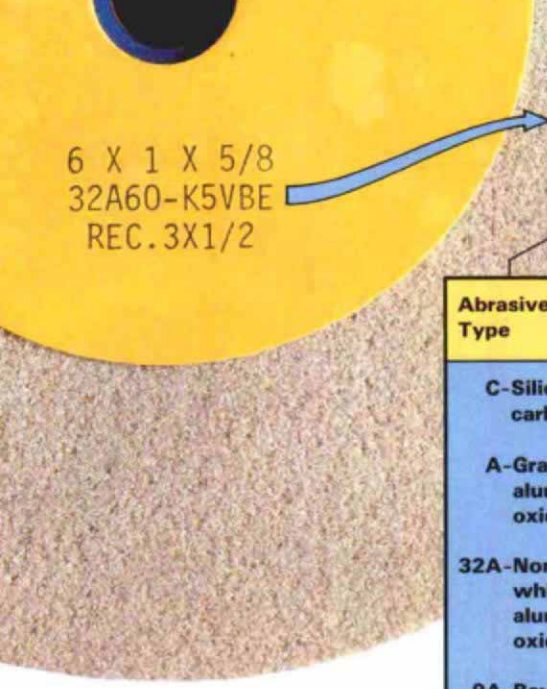
If you're looking at wheels on the shelf, you can see the color. If ordering sight-unseen from a catalog, look for a qualifying number ahead of the A in the code—Norton's white wheels (off-white, actually) are called 32A, for example, and Bay State's are called 9A. Any of these pink or white wheels is an excellent choice for both carbon steel and high-speed steel.

The remaining part of the code—the grain size, the structure and the bond grade—is more complicated because each is interrelated with the others.

The ***grain size,*** ranging from 10 up to 600, refers to the size of each particle, and is the same grading used for sandpaper: Grain particles are sorted by passing them through a series of screens with larger or finer openings. Other things being equal, the large grains in a 36-grit wheel remove steel more quickly and with less heat than the finer grains of a 100-grit wheel, but the tool's surface will be rougher and require more honing before it can be used.

The ***structure*** of a wheel refers to how much open space there is between grit particles, and is designated by a number ranging from 1 to 15. The higher the number, the more space between particles. Wheels in the 5-to-8 range are all good for grinding tools. Generally speaking, if two wheels are the same grit size, 60 let's say, an 8 structure will grind faster than a 5, and will run a little cooler. But the denser 5 wheel will grind a smoother surface. Thus, structure tends to "modify" grit size—a dense 60-grit wheel acts like it has finer grit, and an open one acts coarser.

The ***bond grade*** of a wheel, ranging from A to Z, tells you how much bonding material is in the wheel. The less bonding material, the faster the wheel will shed grains from the surface during grinding, and the more self-cleaning and self-sharpening the wheel will be. Harder wheels hold each grit particle longer, and thus have a longer life. Wheels in the H to M range are all good for grinding tools. The H (softer) wheel will wear out faster, but



32A60-K5VBE

Abrasive Type	Grain Size	Bond Grade	Structure	Bond Type	Manufacturer's Record Symbol
C-Silicon carbide	10	A-Soft	1-Dense	V-Vitrified	Example: VBE is a vitrified bond, with Norton modifications.
	12	B	2		
	14	C	3	S-Silicate	
A-Gray aluminum oxide	16	D	4		
	18	E	5 Smoother, long lasting, hotter	R-Rubber	
	20	F Grinds cooler	6		
	24	G	7	B-Resinoid	
32A-Norton's white aluminum oxide	56	H	8		
	60	I	9 Faster cutting, cooler, more self-cleaning	E-Shellac (virtually obsolete)	
	80	J	10		
	100	K	11		
		L	12		
9A-Bay State's white aluminum oxide		M	13	O-Oxy-chloride	
		N Grinds hotter	14		
	600		15-Open		Indicates range recommended for steel tool sharpening.
Various 'A' numbers for white and pink aluminum oxides		Z-Hard			

The Norton wheel above is the author's first choice for grinding high-carbon tool steel and high-speed steel. Chart at right interprets code numbers used by all U.S. manufacturers.

it won't clog as quickly and will grind cooler than the M wheel. Bond grade modifies grit size in the same way structure does—a hard, 60-grit wheel cuts finer, and hotter, than a soft one.

So, what's the best wheel for you? As a woodturner, I do a lot of grinding of both carbon steel and alloy steel, and I use a Norton 32A60K5VBE grinding wheel. Disregarding the 32A (Norton's white aluminum oxide) and the VBE (vitrified, the BE is a Norton code and pretty much immaterial to us), the important part is 60K5. Because I spend a lot of time at the grinder, I like a 60-grit wheel. It removes metal quickly and coolly, yet leaves the tool smooth enough to hone easily. I could probably get used to a 54-grit wheel just as well, but wouldn't want to go much coarser and still hone by hand.

I also like a dense wheel (the 5) because it lasts. If you want a wheel like mine, your best bet is to shop at your local industrial-hardware or machine-shop supplier (larger Yellow Pages often have a separate listing under "Abrasives"). Specify the wheel diameter and arbor size to fit your grinder.

I find my wheel ideal for lathe tools, but someone with less practice grinding might prefer a softer, more open wheel that would be less likely to overheat the tool. If so, you don't have to look far. Woodcraft Supply (P.O. Box 4000, Woburn, Mass. 01888) sells a 9A60J8V5 wheel in 6 in. and 7 in. diameters. The wheel is made by Bay State, and 9A is their code for white aluminum oxide. Woodcraft also sells 6-in. and 7-in. wheels of 9A100I8V, which should be good for very fine grinding of small carving tools and the like. Prices range from $23.50 to $33.50 (depending on the size), which is about what I'd expect to pay for a well-made wheel. But you might consider shopping around locally to see if you can get a better bargain—now that you understand the code, you might find a very usable wheel on sale for half what it's really worth.

I advise against buying an inexpensive imported wheel, which is likely to contain a percentage of low-cost, low-performance abrasive, such as flint.

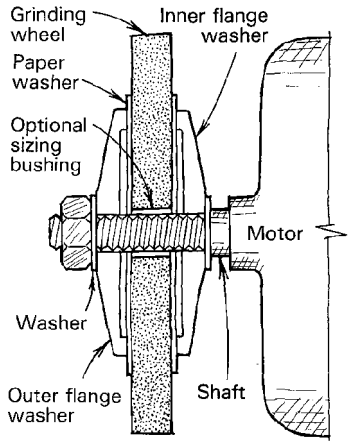
Mounting and dressing a wheel—As mentioned earlier, a vitrified wheel is glass-like, and a new one should always be tested for cracks. Put a dowel through the hole to suspend the wheel, then tap the side with a small piece of hardwood. A good wheel will ring. A cracked wheel will sound dull, like a cracked baseball bat. The drawing below shows how to mount the wheel.

All grinding wheels are labeled with the maximum safe speed, but this is not likely to be a factor unless you're working with a shopmade grinder that has been set up with an unsuitable pulley combination or fitted with a too-large grinding wheel. The usual commercial grinder has protective shrouds that limit wheel size, and the motor speed is chosen accordingly.

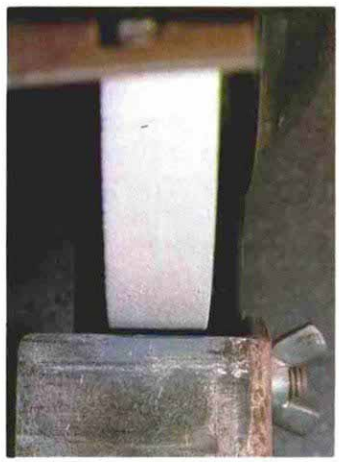
The first order of business when you turn a grinder on is to stand to the side for a minute or so, to be sure that the wheel is not going to fly apart. Obviously, any guards and side shrouds should be in place before running the machine.

Once the wheel is mounted, it will have to be dressed true to the arbor. A wheel running out-of-round will cause the tool to bounce around and make smooth grinding impossible. Dressing, which means scraping or chipping away the high spots while the wheel is turning, is the cure. Dressing is also used to rejuvenate a wheel that has become dull or clogged with metal particles; it trues the surface of a wheel that has become rounded or grooved, and can also shape the profile of a wheel for special jobs, like regrinding the flute of a gouge.

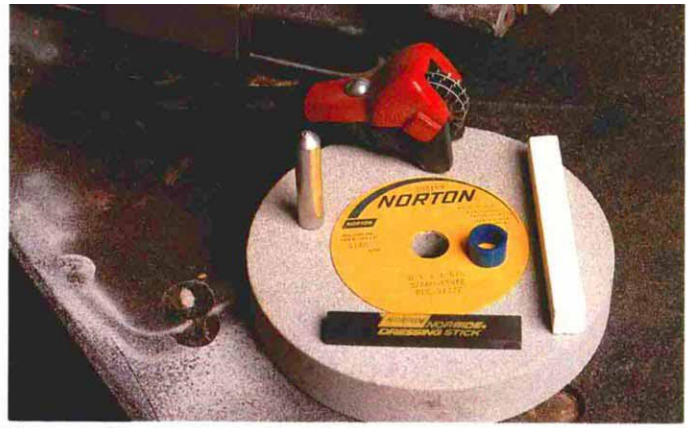
There are basically four dif-



When mounting a new wheel, clean the shaft of grit and remove any paper-washer residue from the flange washers. Do not overtighten nut.



Bottom photos show Bay State's 100-grit wheel before and after dressing. At left, after much grinding of lathe tools, the wheel is worn concave with some embedded steel particles, which cause excess heat. Top photo shows the initial coarse dressing with a star wheel; center photo shows final truing with a Norbide stick.



Norton's 60-grit wheel, off-white in color, with a variety of wheel dressers (shown counterclockwise from top): a star wheel, a single-point diamond, a Norbide stick and a plain abrasive stick.

ferent tools that can be used to dress a wheel. The simplest and least satisfactory is nothing more than an old piece of coarse grindstone or the coarse abrasive sticks sold for the purpose. The second type is the star-wheel dresser, which chips away at the surface of the wheel removing large quantities of grit quickly. Then there are diamond dressers and finally boron-carbide sticks (Norton calls theirs Norbide), both of which are hard enough to wear the wheel down. All of these dressers should be available at the nearest industrial hardware supply house.

The star-wheel dresser is the best tool for the initial dressing for the simple reason that its mass, width and fierce chipping action make it easy to get the wheel true. The usual diamond dresser, in contrast, cuts at a single point, and must be rigidly controlled in a straight, square path across the wheel to work effectively. If your grinder has a tool-holding setup that will accomplish this, then a single-point diamond dresser will work fine, but otherwise, a diamond dresser may leave a wheel grooved and more out-of-round than it was to start with. You can buy multi-point diamond dressers, which are easier to use, but these are expensive and a star wheel costs less than $10.

To dress a wheel, support the star-wheel dresser against the tool rest and bring the star wheels into full contact with the rotating grinding wheel. Then sweep the dresser across the face of the grinding wheel using only a light force to push the two together. After a couple of passes the wheel should be running true. Wear safety glasses and a face mask during the operation. The peripheral speed of a grinding wheel can approach 60 MPH, and dressed-off grit particles will be traveling at this speed.

A star-wheel dresser tends to open up a wheel, leaving the surface rougher than it will be after you've ground a few tools on it. This is because some of the freshly exposed grit has higher cutting edges than the other particles. The effect can be a good thing because the wheel will run cool, but the wheel will also cut a little coarser. For a finer grind, re-dress the wheel very lightly with a diamond or a carbide stick.

As a last note, most wheels are marked "Do Not Grind on Side." There are a few reasons for this: First, it's less efficient to grind on the side of a wheel because the surface speed is less than on the face. Also, when the side of a wheel becomes glazed and clogged it is much more difficult to dress. Another problem is the danger of grooving or undercutting the wheel, which might weaken it to the point where it could shatter. Occasional light grinding on the side of a wheel shouldn't cause problems, but my general advice is to avoid it unless there is no other choice. □

Jerry Glaser is manager of manufacturing engineering at Garrett Automotive Products Co., in Torrance, Calif.