Which Brush Should You Choose?

The right choice could boost deburring productivity as high as 800%

At least it did for one maker of steel pinion gears when it replaced a hand deburring tool with an automatic skiving and brushing system. To remove large burrs that a broaching operation shaved onto the gear faces, an operator originally pencil-ground the profile of each tooth with the hand tool at 50 gears per hour. The automatic machine, which includes two 12" (305 mm) knot-type steel-wire brushes on a rotary turret, now deburrs 400 gears per hour.

Power brushes offer many advantages that manufacturing engineers should consider for both automated and manual jobs. They remove surface contaminants from metal without disturbing the base material and are durable. In edge blending, they produce one smooth edge instead of two secondary sharp edges and do not load up when working soft material. A power brush can remove burrs and tool marks yet maintain the surface finishes and tight tolerances required in automatic machining.

Advances in power brush materials, design, and construction are continuing as vendors enhance brush life and increase operator productivity. Top-performing wire brushes, for instance, now have solid steel rings to lock the wires in place. Knot-style brushes have exact strand counts for perfect balance.

On the other hand, brushes are not the best tool for every application. For instance, abrasives or tools like rotary burrs are better at removing extremely heavy burrs caused by dull cutting tools that displace large amounts of metal. Deburring and finishing many small parts are better suited to mass finishing techniques such as vibratory finishing. So choose your brush applications carefully.

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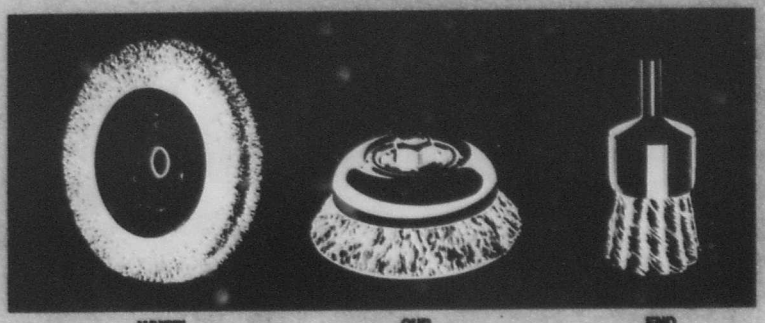
When to Brush

Wire brushes are good for cleaning welds because they dislodge slag without removing the weld metal and clean the surface for painting or another welding pass. They also work well in removing large burrs. Each strand is like a dull tool bit in that its tip strikes the work surface, knocks off burrs, and slightly work-hardens the part.

Bristles for most wire brushes are either medium-carbon heat-treated steel or 302 stainless. Tempered high-tensile carbon steel is best for most carbon steel parts. It lasts up to 10 times longer than other nonheat-treated materials. Never use a carbon steel brush on stainless and nonferrous-metal parts, however. As the brush rubs the workpiece, small pieces of carbon steel embed on the part surface and will rust. Instead, use stainless steel wire.

Stainless steel brushes can also contaminate the workpiece because they can attract carbon steel particles from the air or workbenches. To

Here Are Your Choices



WHEEL CUP END

Wheel brushes are circular, generally no wider than 2" (51 mm), and range from 5/8 to 15" (16–380 mm) in diameter. Bristles can be steel, stainless steel, brass, bronze, and nickel silver wires; natural fibers such as tampico and animal hair; or synthetics such as abrasive-filled nylon and polypropylene. Wheel brushes use both crimped and twisted-knot wire forms.

Cup brushes come in three basic types: stem-mounted miniature (3/8–1" [9.5–25.4 mm] diam), crimped wire (1¾–6" [44.4–152 mm] diam) for lighter jobs, and knot (2½–6" [63.5–152.4 mm] diam) for heavy-duty jobs requiring aggressive action. Cups work on portable power tools.

End brushes are for portable air and electric tools for light to heavy-duty work where space is limited. Diameters range from 5/32 to 1⅛" (4.0–28.6 mm). Tube brushes are twisted-in-wire (or bottle-brush) types for portable tools and drill presses to clean and finish holes and internal threads. A typical range for diameters is 3/16 to 1¼" (4.8–31.7 mm).

Wide-face brushes have faces that are greater than their diameters. Other than buying a factory-assembled integral unit, you can create this type of brush by stacking a number of wheel brushes on a common arbor. Wide-face unit brushes are usually custom designed.

Miniature brushes are small versions of end, wheel, and cup types for brushing miniature components. Sizes range from 5/32 to 1½" (4.0–38.1 mm) diam and fill materials may be animal hair, synthetics, or wire. These brushes mount on a 3/32 or ⅛" (2.4–3.2 mm) shank.

A new composite hub for abrasive-nylon brushes replaces the conventional metal hub, which works best for wire brushes. An advantage is that the one-piece molded hub exposes all the filament material during the brush's life. Conventional hubs can waste up to 20% of the nylon fill material in the metal mounting. The composite one-piece construction also does not damage the filaments, which can happen with metal hub components.

prevent this, wash the brushes in a degreaser and keep them wrapped in plastic. Nonferrous wires are also available for nonsparking and other special needs.

Crimped and twisted-knot styles are the two most popular wire forms. The waveform shape of crimped wires allows the strands to interact to reduce vibration damage to themselves as they strike the workpiece. This configuration also allows many wire tips to touch the work surface. Crimped wire works well on light to medium-duty jobs, such as removing burrs from grooves of castellated automotive nuts and cleaning connections before lead-dipping resistors.

Knot forms are best for heavy-duty applications like gear deburring and for uniformly removing heavy scale and surface contamination. They use bundles of straight wire twisted into individual knots or short cables that can deliver extremely high impact forces. A special "stringer bead" style is especially good at cleaning welds.

Elastomer-bonded, or encapsulated, wire brushes are similar to densely filled crimped-wire brushes. The bristles can move and are still somewhat flexible, but cut more aggressively. Encapsulated brushes work well in applications demanding brush control, such as stripping insulation from copper wire and deburring key slots and other difficult-to-reach areas.

Another way power brushes are similar to cutting tools is that they have a most efficient speed and pressure (down force) for a job. The highest speed and lightest pressure possible usually cut the fastest and offer the longest brush life. High speeds increase the face hardness and cutting action, so a fine wire brush rotating fast will often produce the same results as a coarser wire brush rotating slower. Using the finest wire possible usually lengthens brush life.

Excessive pressure between brush and workpiece overbends and heats the filaments. Rather than increasing pressure, first try a brush that cuts more aggressively, and then boost speed by increasing either spindle speed or brush diameter. If your job requires high pressure, switch to a shorter-trim brush because its wires will deflect less and, therefore, last longer.

Also, periodically reverse a wire brush's direction of rotation to exploit its self-sharpening ability. Do so by removing the brush from the spindle, turning it side for side, and remounting it.

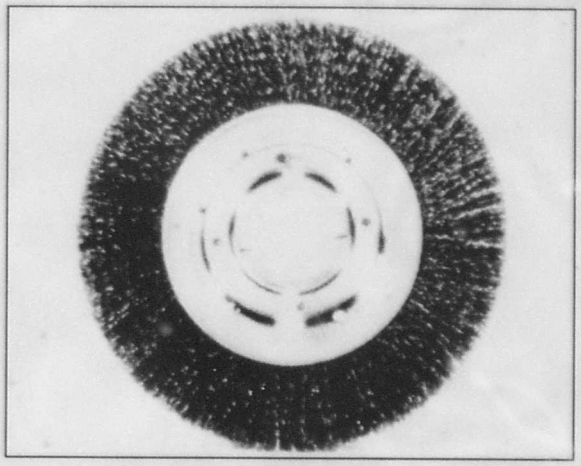
When working on a recessed area or the inside of a tube, end brushes depend on centripetal force to apply pressure on the wire tips when they flare outward. Because a rotating end brush is larger than the hole, it can be difficult to force into it. To avoid damaging the part or brush, insert the brush before rotating it and turn off the power before removal.

Consider Abrasive Nylon

Even though abrasive-filled nylon filaments are a recent development, brushes of this material are popular in industries like aerospace that demand fine deburring, finishing, and edge blending. These brushes can follow complex or deeply machined parts and are often the best way to smooth their rough surfaces.

Most filaments contain 600–46-grit silicon carbide or aluminum oxide abrasive and offer the flexibility of a brush and the cutting ability of an abrasive tool. They can deburr and finish in one step instead of three or four, furnish a microfinish of 9 or 10

Wire Configurations



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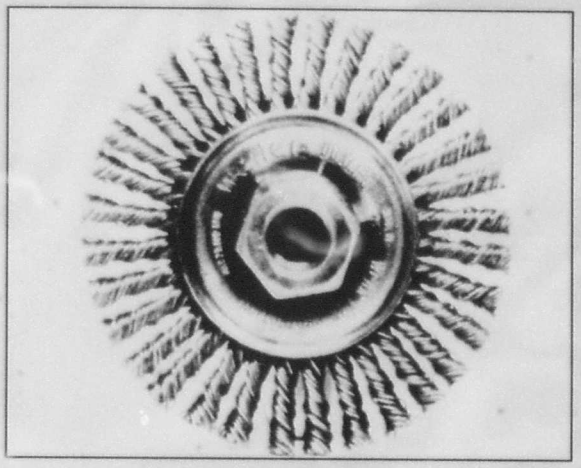


TWISTED KNOT (OR STRAIGHT)

rms, and last longer than other tools because they run cooler without absorbing too much heat.

Filaments are usually crimped to keep them separated and give the brush a full, even face. With this design, the sides do most of the work, acting like flexible files. Use rectangular filaments for more contact and impact with the workpiece in applications like carbide edge honing, deburring injector nozzle cutouts, and finishing decorative hinges. Use round uncrimped filaments for applications such as deburring the slots in cast-magnesium computer cage backs and putting a uniform scratch-finish on aluminum chair bases.

Silicon carbide grit offers the best combination of hardness, sharpness, and toughness. It has harder and sharper grains than aluminum oxide, is more friable, and does a better job at finishing metal. Use it for most nylon brushing jobs. Aluminum oxide grit is less likely to fracture and is generally for finishing soft metals. Because aluminum oxide prevents carbon contamination, the aerospace industry usually prefers it for jet engine blades and other parts.

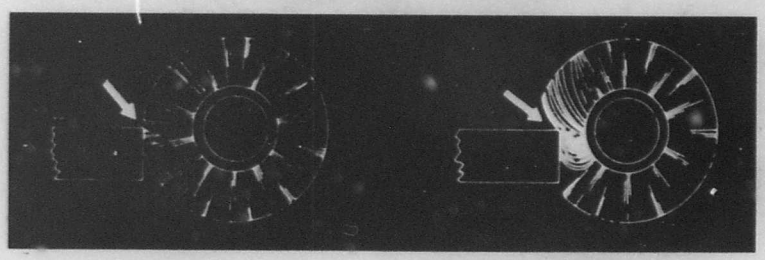
The abrasive is sparsely distributed in the nylon, so more nylon rubs the part surface than exposed abrasive, which generates heat. On poor heat conductors like stainless steel, smearing (embedding small brush particles into the work material) occurs readily. Spraying a lubricant onto the brush surface when the tool is stopped or barely moving reduces friction between the nylon bristle and part and stops smearing. The brush can then accept twice the work load.

Lubricant is not always necessary, however. Metals like aluminum disperse heat faster and can tolerate much higher speeds and forces before smearing occurs. Maintain the nylon filaments' temperature below 150°F (65.6°C) to maximize brush life. Hydrocarbons, oils, and most organic solvents have no lasting effects on the filaments.

Like wire brushes, applying less pressure to abrasive-nylon brushes increases life. Unlike wire, they run at low speeds with enough pressure to force the sides, as well as tips, of the filaments to cut. Optimum cutting results when the workpiece penetrates, or "mushes," into the brush face.

New configurations and fill materials are only part of the reason brushes continue enjoying widespread use. Machines like robots are using brushes to finish surfaces, deburr, and blend edges with consistent results. As long as brushes and automation can increase productivity 800%, using power brushes should continue to increase well into the next century. ■

Use Wire Brushes Properly



CORRECT

WIRE TIPS DO THE WORK

INCORRECT

EXCESSIVE PRESSURE CAUSES A WIPING ACTION AND CAN BREAK THE WIRE

Want More Information?

SME offers three publications on deburring: *Robotic Deburring Handbook*, *Deburring Technology for Improved Manufacturing*, and the *Deburring & Surface Conditioning '91* technical paper set. Another source is the finishing and deburring installment of the video series *Manufacturing Materials and Processes*. You may want to attend the Buff, Brush, and Polish Techniques clinic in St. Paul October 2–3. Call 1-800-733-4SME.

For more from Weiler Brush, **Circle 420.**