

Deburring & Finishing Gears with Power Brushes

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Why Brushes?

In this age of hi-tech, robots, automatic machines, machining cells, etc., is there a niche somewhere for power brushes? Let me answer by asking another question. What tool does the gear manufacturer have in his arsenal that allows him to deburr green gears, hardened gears, hobbled gears, ground gears and shaved gears? What tool allows him to deburr powder metal gears — green and sintered — brass gears, bronze gears, stainless gears made of exotic materials such as inconel, waspaloy, or hastaloy, and fiber and plastic gears? How about spur gears, helical gears, sprockets, both internal and external splines, clutch teeth and pump gears? What tool allows the finishing of pump gear journals to a one to three micro-inch finish without changing concentricity or size? What tool has the flexibility to reach into a confined area and actually round off a tooth edge or root area without creating another burr or two? What tool is so adaptable that it can be used on power tools, bench motors, semi-automatic machines, fully automatic machines and robots? What robot-programmable tool is so compliant that it will not ruin even an improperly fixtured gear? The answer to all of these questions is power brushes.

This is not to say that power brushes are the answer to every finishing and deburring problem, but they are a potential solution that should be considered when these problems arise. Power brushes will fit in with most production and budget requirements. Most of the time, cycles for gear deburring with power brushes are measured in seconds. Equipment costs begin under \$1,000, and systems can be upgraded as much as budget considerations allow. The power brush is a throw-away item which means no regrinding or reworking. For most applications, even if there are angles or convex or concave forms, the power brush will conform and eventually wear into the shape or form so that no pre-dressing is required. A power brush will also stress-relieve a gear, thereby strengthening heat treated gears, because power brushes will break and round all sharp edges and fillets, reducing gear tooth breakage.

Sometimes power brushing is used to remove burrs and break edges for assembly purposes only. The brushing before assembly makes the gears easier to handle, and part-to-part fit is much improved. This brushing can help to solve many assembly problems.

Types of Brushes

Power brushes can be made with wire,

natural fibers or synthetic materials. All these materials have their uses in gear deburring and finishing.

Wire Brushes: Wire brushes come in two types: crimped, where each strand of wire has crimps or bends in it, and straight wire, where the wire is used as is. Two distinct styles are involved here. The crimped wire brushes are made in solid wheel types, while the straight wire brushes are in twists or knots. The reason for these differences is the manufacturing process. Both styles are actually wires bent like hair pins. When the wires in the crimped brushes are doubled back, the crimps interlock and are secured inside the face plates. The straight wire brushes, however, will not interlock, so in order to lock the wire in the face plates, the wires must be twisted and knotted in individual clumps.

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The straight wire brush is most commonly used in gear deburring because of its very aggressive nature. The reason the straight wire brush is more aggressive is that being straight, all wire points are on the O.D. where they belong. The crimped wire brush, on the other hand, has areas around the periphery that are dull because the bends of the wire are exposed. This cuts down considerably on the amount of work performed. The hardness of the wire approaches hardened tool steel so that most gear materials can be deburred or edge-broken with wire brushes. Wire brushes are used where finish is not critical, where burrs are heavy and where time cycles must be short. Most of the work performed by a wire brush takes place in the initial revolution of the gear past the brush.

A wire brush works by lifting the burrs and bending them back against the parent metal of the gear. It then attacks the burr at this juncture and wears it away. The brush will be aggressive on all edges, but will do little work on the solid areas of the gear. This is one of the reasons brushes work well on automated equipment, such as robots. Spur gears are ideal candidates for wire brush treatment, as the heavy burrs are removed quickly, and an even edge break is generated around the tooth profile. The result is a rounded edge (not quite a true radius) and a stronger gear because all sharp edges are rounded. Brushing has reduced gear failures by 90% in some heavy duty transmissions.

Helical gears do present a problem for wire brushes if the gears are not shaved. A wire brush will roll some of the parent gear material into the tooth on the acute side only. The obtuse side is never a problem, so all attention should be directed to the acute side. If the gears are first hobbed, then brushed so that a large break is generated, and then shaved for the precision needed, the rollover will be gone. Since there is already a break on the edge, it will be burr-free when finished.

Wire brushes are also made with stainless steel wire in both crimped and straight styles. Stainless wire brushes

should be used only where contamination is a problem or on some aluminum parts. Stainless wire is not as hard as carbon wire, so it doesn't cut as well. Stainless wire work hardens quickly, so it does not have the life of carbon wire. Because of less life and higher initial cost, stainless brushes should be used only where necessary.

Natural Fiber Brushes: Two natural fiber-brushes have application value in gear deburring and finishing. Tampico, either treated or untreated, is one of them. It is a form of sisal plant grown only in Mexico. When made into a brush with the material as is, the bristles are very flexible with little cutting power. When either liquid or solid abrasive compounds are added, it becomes a very good brush for polishing worms or other such difficult parts. This type of brush will give color or cut or both if desired. The variations come with the various compounds selected. The abrasive compounds can be applied by hand or automatically with compound applicators.

Treated tampico brushes have a solution added to their fibers which permanently keeps them stiff and tacky. This brush is always used with an abrasive compound. The tacky substance holds the compound in the brush and makes the brush either cut or polish, depending on the compound applied. The treated tampico is excellent for blending and deburring exotic materials and is, therefore, used quite heavily in the jet engine industry. Finish as well as cut is excellent, and the smooth polished finish makes for strong gear teeth. The treated tampico will round off gear teeth as long as pressure and compound is applied. Gear teeth can actually be crowned with this method.

Synthetic Brushes: Many of the tampico and compound applications have been taken over by the newest in brush materials, abrasive filaments. The base material, nylon, is impregnated with silicon carbide, aluminum oxide, pumice or other abrasive materials. This material has the compound built in, saving the trouble of applying another additive. The strands, being made of nylon, are tough and durable, giving long wear. Cut is

limited in terms of size, but the silicon carbide will break the edges on the hardest of materials, even carbide inserts used in various machining operations.

The abrasive brush performs best on ground gears. They are not aggressive enough to remove heavy hobbing burrs. If some type of skiver is used to break down the heavy burrs, then the abrasive brush would break the edges on the gear teeth. The abrasive brushes work extremely well on exotic materials, so are widely accepted in the jet engine industry. The abrasive material is an excellent tool for robots, as it has good compliance, will remove burrs and leave smooth edges with no rollover.

Unlike wire brushes, which roll burrs into the acute angle on helical gears, the abrasive brush will round the edges without rolling the burr, so these brushes can be used after shaving. Abrasive brushes are also good for removing the sharp edges from powdered metal gears after sintering. There are times when powdered metal gears in the green state can be brushed also. Splines are good deburring prospects for this material, as the material is removed from the spline teeth and the assembly of the mating part is made easier. Hardened pump gears are another good application. Abrasive brushes produce the light, well-rounded edge break required for these gears.

Bufcut Brushes: While talking about pump gears, the Bufcut brushes should be mentioned. The material used in them is a type of sisal that grows only in Italy. When used with the proper compound, a finish of one to three micro-inches can be obtained on hardened pump gear journals. To obtain this finish, a grind of 10-12 micro-inches is necessary. The Bufcut brush will not change the concentricity of the journal, nor will it effect size; however, it will not correct a concentricity problem either. This brush must be used with an abrasive compound, as it will do nothing when used by itself.

Cup and End Brushes: The cup brush, where it can be used, generally gives excellent brush life and is used on tough rugged jobs such as sprockets. The cup type brush will take off most heavy

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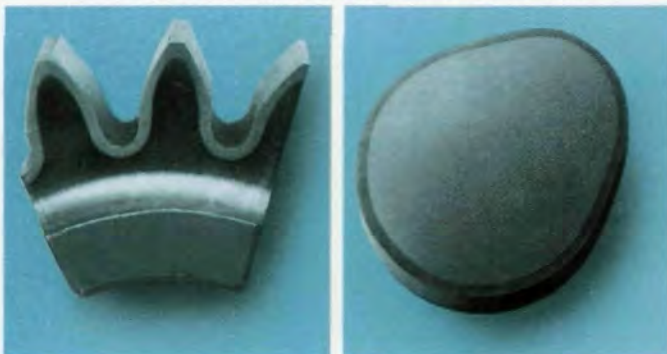
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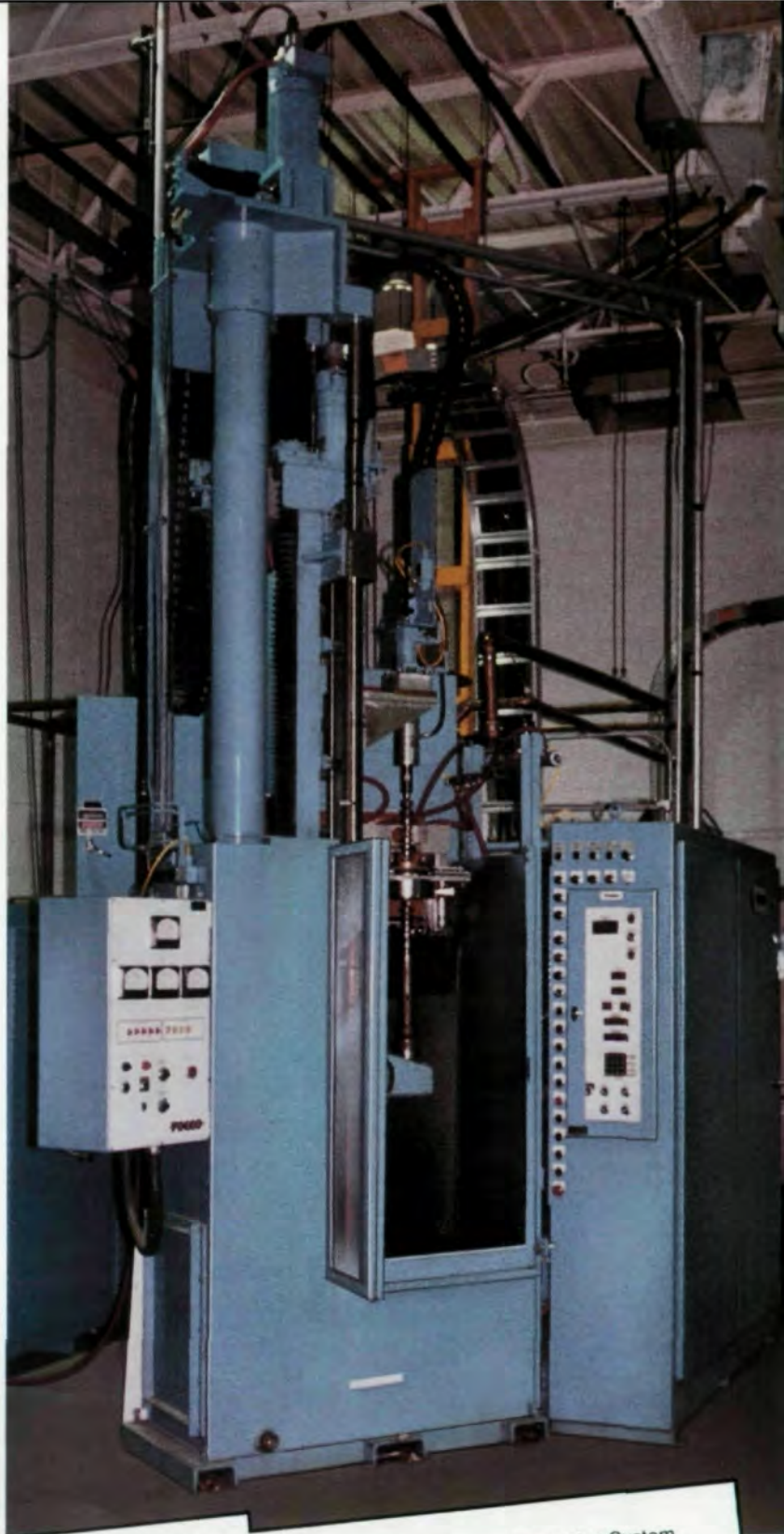
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burrs. Cup brushes are filled with wire and abrasive filament materials. An even break may be generated with only one cup brush, but using two is desirable to achieve faster time cycles. On many applications cup brushes can be more cost-effective than radial brushes. The cup brush generally requires a vertical spindle, while radial brushes require a horizontal one. Some thought should be given to this when purchasing or designing a new machine.

End brushes are desirable for some applications. This type of brush can be fixtured to form odd sizes and get into areas such as internal splines, that cannot be reached by any other type brush.

Power Brush Set-up

The setting-up of power brushes to deburr and finish gears is frequently thought to be a very simple matter, or, because of the variety of gears and brushes, quite complicated. Actually, both are misconceptions. If approached in an orderly manner, set-up is neither so simple nor as complicated as it may have at first appeared. The proper set-up is important, however, and most brushing failure is due to improper set-ups.

Almost all gear deburring involves at least two brushes being used at the same time. The brushes are spaced apart so that an even edge break is generated around the tooth profile. The spacing will vary, depending on the size of the gear being processed. The spacing is determined by visualizing the gear as the face of a clock. One brush should be placed in the five o'clock position, and one brush in the seven o'clock position. With the two brushes rotating towards the center of the gear and the gear itself rotating, an even edge break will be generated. If more break is desired on the sides of the teeth, move the brushes to the four and eight o'clock positions. On the other hand, if a larger break is desired in the root section, bring the brushes closer together. By setting the brushes in this manner, it is not necessary to reverse them. The five o'clock brush gets the left side of the tooth and half of the root area. The seven o'clock brush gets the right side of the tooth and the other half of the root area. When only one brush is used, the brush must be reversed in order to get both sides of the tooth, and the edge break will not be even.

Costs

Costs per part can vary greatly. They can run anywhere from pennies to several dollars. If costs are high, the choice of brush and improper set-up may be at fault. Efforts should be made to find the best possible combination for a particular application. The proper brush for the application must be chosen and then used to its best advantage. A brush must physically be able to come across and through the gear teeth and not be hampered in any way. If the brush

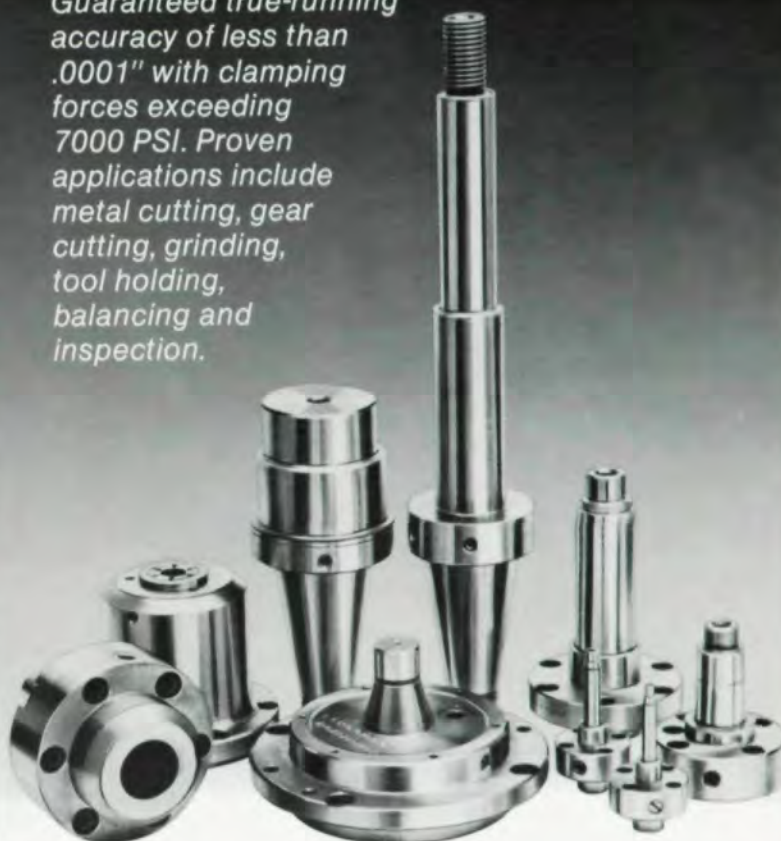
material must be forced to reach these areas, poor brush life will result. Use the largest diameter brush available. While it is much easier to design "in" a small brush, a large brush will give better performance and life. Common sense and a little knowledge gained from brush manufacturers will keep costs down and give the best brush use for dollars spent.

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