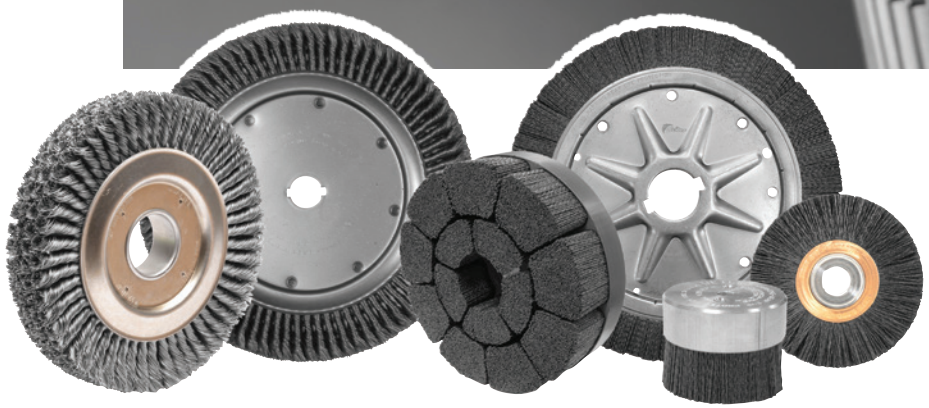
GEAR DEBURRING
WITH BRUSHES



An Introduction to Automating Brush Deburring of Power Transmission Components

QUALITY & PERFORMANCE

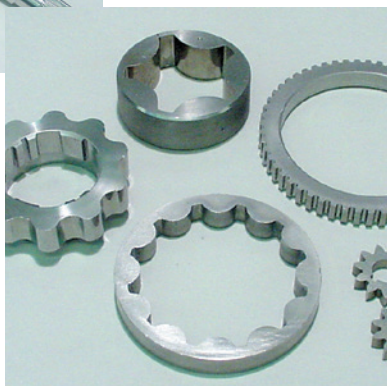
WHY DO GEARS NEED TO BE DEBURRED?

All cutting and shaping operations produce some type of burr or leave a sharp edge. On power transmission components such as gears, these undesirable by-products are especially troublesome.

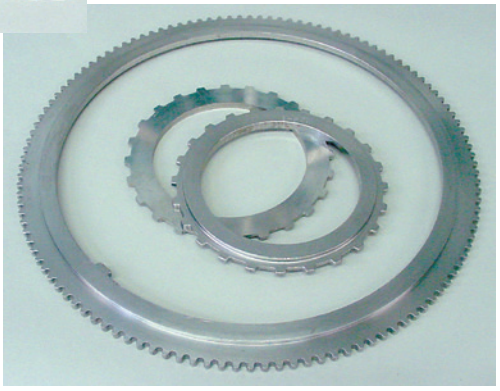
Even well-attached, heavy burrs can loosen from the parent edge, either during assembly or in actual operation. These chips are then free to travel through the power transmission system and damage components.

Under operating conditions, sharp edges become areas where internal stresses concentrate and failures become more likely. Radiusing eliminates edge defects, minimizes stress risers and contributes to better mesh and lower operating noise between individual components in a drivetrain.

In summary, removing burrs and sharp edges improves the quality, performance and reliability of power transmission components.



Although power transmission components are available in a wide variety of configurations, in-service performance is often determined by edge quality.



WHY ARE BRUSHES IDEAL TOOLS FOR DEBURRING GEARS?

BRUSHES DO NOT ALTER PART GEOMETRY

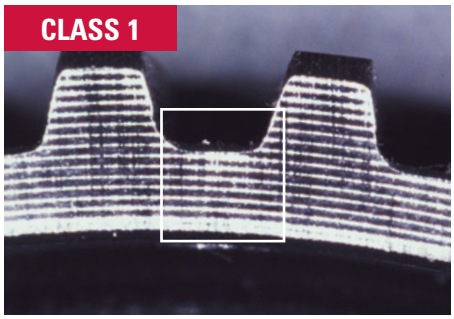
Power-driven brushing tools have been used for removing burrs and sharp edges for over half of a century. The moving filaments of a brush concentrate their collective kinetic energy on the edges of a part. Couple this characteristic with the compliance that is inherent in a brush and the result is a product that is able to remove undesirable edge defects without altering the geometry of a part. This ability makes them ideal for deburring complex power transmission components that are manufactured to close tolerances and tight specifications.

BRUSHES ARE IDEAL FOR AUTOMATION

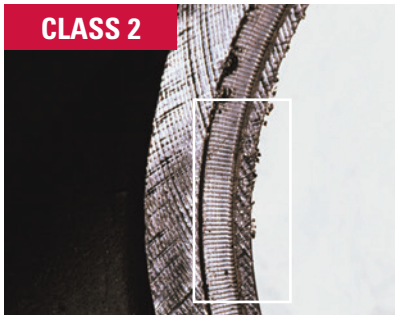
Although brushes are traditionally viewed as great tools for off-hand applications, their use in automated applications has also proven to be effective and economical. Their durability and flexibility complement the efficiency and consistency of semi-automatic or fully automatic equipment. A properly designed automated brush deburring process usually costs only a few cents per part while having the ability to meet other production requirements. Although gear and sprocket manufacturers were among the first to adopt the use of automated brush deburring processes, there is still a great deal of confusion about equipment design, machine set-up, and media selection even within the power transmission industry.

BURR CLASSIFICATION

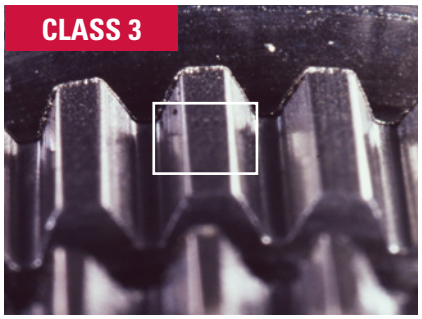
Burr size, shape and orientation are critical in the selection of brush fill material. These photos show a variety of burrs with different characteristics. They are classified in a way which describes the difficulty of removal in qualitative terms.



Often called “micro-burrs” because they can only be observed under magnification, Class One burrs appear as sharp edges to the unaided eye. Grinding operations are a common source for this burr formation.



Feather burrs are readily visible without magnification; typically small in size and characterized by thin roots. Class Two burrs can usually be removed by a pencil tip.



Burrs in this group are relatively small in size, but are well-attached to the parent edge. Because of this, a significant amount of mechanical energy must be applied to remove Class Three burrs.

Like Class Three burrs, the burrs in this class are well-attached. The primary difference is that Class Four burrs are larger with slightly thicker roots.

Burrs in this class are very large with extremely thick, rigid roots. Class Five burrs differ from the conventional definition of a burr because they consist of displaced base material that is still fully attached to the parent edge.

FILAMENT SELECTION

NYLON ABRASIVE FILAMENT BRUSHES

are best understood by thinking of them as a collection of flexible files. Each nylon filament contains thousands of abrasive grains. Although these filaments contain the same size grains as other abrasive products, the flexible nylon carrier does not forcefully apply them to flat surfaces. However, when they encounter an edge, these abrasive grains act like the teeth on a file, removing burrs and generating small edge radii. Due to the flexibility of the nylon bristles, the ultimate aggression of abrasive filament brushes can be somewhat limited. Traditional Nylox brushes featuring filaments with silicon-carbide abrasive grains are capable of removing Class One and most Class Two burrs. Burr-Rx brushes featuring filaments containing an engineered ceramic abrasive grain are more cost-effective tools capable of removing large Class Two and Class Three burrs as well as many Class Four burrs. In addition to different abrasive grains and grit sizes, brush media featuring different filament sizes, fill densities, and trim lengths are available to tailor the brushing action to the requirements of a particular application.

CRIMPED AND KNOT WIRE BRUSHES

work through an impact-driven process similar to sand blasting. The focused velocity of millions of sharp wire tips striking an edge within a short period of time strips away burrs and peens sharp edges. Brushes with crimped wire offer a more compliant brushing action than knot wire brushes which maximize the impact of the wire tips on the work. Because wire brushes can focus a great deal of mechanical energy on an edge, they are best suited for removing large Class Three and Class Four burrs. Although Class Five burrs can sometimes be removed with particularly aggressive brushes, cutting tools or abrasive products are often better suited for removing these heavy burrs.

ORIENTATION

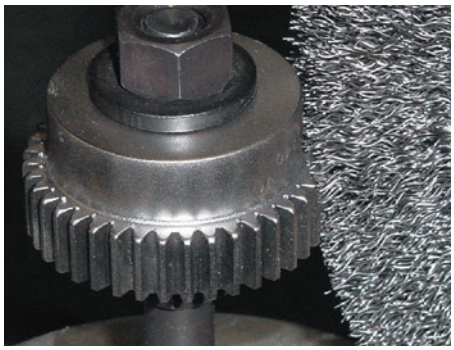
BURR LOCATION AND BRUSH PRESENTATION

Burr location determines the proper orientation of the brush to the part. The brush filaments must have direct access to the burr, and the parent edge must be oriented properly, relative to the direction of filament movement. Brush orientation also affects production economics. Product life expectancy is directly dependent on the amount of penetration into the face. Minimizing brushing pressure reduces filament fatigue in wire-filled brushes and filament wear in Nylox brushes.

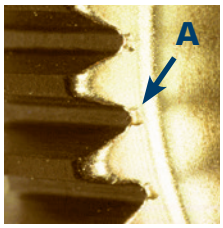
The following photos depict two approaches for deburring a small spur gear. Set-up I is not desirable for several reasons. First, the brush does not detach all of the burrs. Rather, it peens them against the face of the gear (see A). Secondly, the variation in penetration into the brush face produces excessive radii on the tips of the gear teeth and performs inadequate work on the roots. Finally, the penetration that is required to place the wire tips on the root diameter of the gear decreases the brush life due to excessive wire fatigue.

In contrast, Set-up II produces more desirable results. Using this technique, the wire tips strike each tooth edge as the part rotates. The burrs are easily removed because the direction of filament movement attacks them at the root and bends them away from the parent edge. The amount of penetration into the brush face is minimized and does not vary. Thus, brush life is maximized while a more consistent radius is generated on the teeth.

SET-UP I - NOT RECOMMENDED

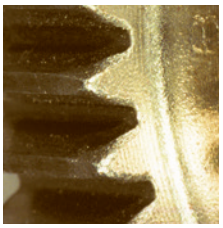


Result I



SET-UP II - RECOMMENDED

Result II

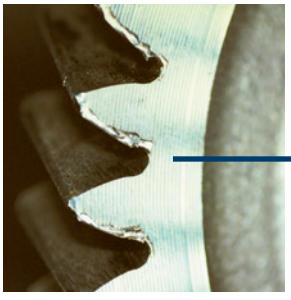


Brushes are most effective at deburring edges that are perpendicular to the direction of filament movement.

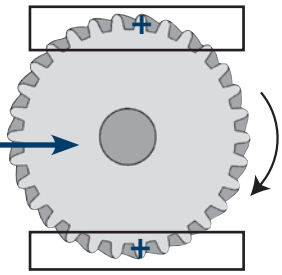
The following photos illustrate this point using a helical gear with two common burr configurations. In Case I, the primary burr is on the side of the tooth. Based on this position, brush heads should be located as shown in Orientation I. This brush position focuses maximum deburring action on the sides of the gear teeth since they are perpendicular to filament movement.

The primary burrs in Case II are near the roots of the teeth. To remove burrs in this location, the brushes need to be moved to the orientation shown in Orientation II. By repositioning the brushes, the contact point between the brush and the part is changed and more energy is applied to the roots of the gear teeth.

CASE I

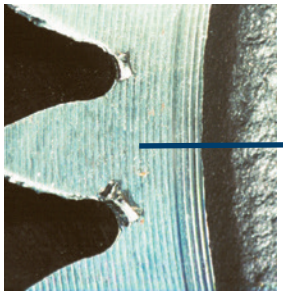


Orientation I

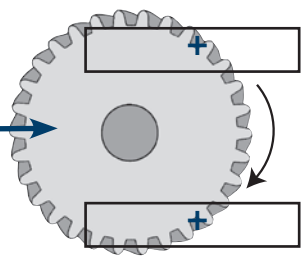


+ Brush Contact Point

CASE II



Orientation II



+ Brush Contact Point

PARAMETERS

Prior to selecting the operating parameters for a particular deburring application, brush size must be determined. This is because the velocity at which the filaments strike the work is a function of both spindle speed and product diameter. In general, larger diameter brushes are preferred, even when dealing with small parts, because they lower consumable-cost-per-part and increase production stability. The only exception to this rule occurs when a small diameter brush is required to access an edge due to the part geometry.

Although power-driven brushes are available in other configurations such as disc, cup, and end brushes, these product types are not frequently used in gear deburring applications because of their rotary, multidirectional nature. The unidirectional nature of wheel brushes allows them to focus a larger amount of mechanical energy on a target edge within a relatively short time. The following table lists the recommended operating parameters for wheel brushes based on diameter and fill material.

WHEEL BRUSHES AND OPERATING PARAMETERS

Brush Size	Wire Brush Speed	Wire Brush DOI	Nylox Brush Speed	Nylox Brush DOI	*Power	Minimum Spindle Dia.
1"-2"	20,000	.030"	5,000	10% of trim	1/4 hp	1/4"
3"-4"	15,000	.030"	3,000	10% of trim	1/3 hp	3/8"
6"	5,000	.030"	1,750	10% of trim	1/2 hp	1/2"
8"	3,450	.030"	1,400	10% of trim	3/4 hp	5/8"
10"	2,500	.030"	1,200	10% of trim	1 hp	3/4"
12"	2,000	.030"	1,000	10% of trim	1-1/4 hp	1"
14"	1,750	.030"	800	10% of trim	1-1/2 hp	1-1/4"

*Note: Power recommendations are stated per one inch of engaged brush face.

Because wire-filled brushes work through an impact-driven mechanism, they should be used at higher speeds and with a minimum amount of penetration. Excessive penetration into the face not only reduces brush life, it also decreases the contact between the wire tips and the work. Nylox brushes, on the other hand, require lower speeds and greater amounts of penetration. This allows the filaments to smoothly file across the target edges.

TROUBLESHOOTING

The table in the ***preceding*** section provides general guidelines for the majority of applications. If they are not effective in a particular application, the following table contains recommendations for increasing and decreasing aggression.

Problem	Wire Brush Recommendations	Nylox Brush Recommendations
Brush not aggressive enough	Select a brush with larger diameter wire fill	Select a brush containing a more aggressive filament
	Select a brush with shorter trim and higher fill density	Select a brush with shorter trim and higher fill density
	Select a brush with knot wire versus crimped wire	Increase brushing pressure and depth of interference
	Increase operating speed	Increase brushing time
Brush is too aggressive	Select a brush with smaller diameter wire fill	Select a brush containing a less aggressive filament
	Select a brush with longer trim and lower fill density	Select a brush with longer trim and lower fill density
	Select a brush with crimped wire versus knot wire	Decrease brushing pressure and depth of interference
	Decrease operating speed	Decrease brushing time

USE QUALITY MEDIA FOR THE LOWEST COST

Weiler offers the most complete line of power brushes in the industry as well as the technical expertise to aid with your selection of the best product and process to meet your needs. The following is a condensed selection of Weiler brushes available for your deburring applications. For additional product selection or assistance with your gear deburring problem, call our Applications Hotline toll-free at 888-299-APPS (2777).

00214

08004

09790

86135

BRUSHES FOR CHAMFERMATIC AND REDIN GEAR DEBURRING MACHINES

3" Crimped Wire Wheels

Wire Size	Arbor Hole	Item Number
.008	1/2"-3/8"	00214
.014	1/2"-3/8"	00274

4" Crimped Wire Wheels

Wire Size	Arbor Hole	Item Number
.0095	1/2"-3/8"	00124
.014	1/2"-3/8"	00144

3" Knot Wire Wheels

Wire Size	Arbor Hole	Item Number
.0118	1/2"-3/8"	08004
.020	1/2"-3/8"	08024

4" Knot Wire Wheels

Wire Size	Arbor Hole	Item Number
.0118	1/2"-3/8"	08034
.020	1/2"-3/8"	08064

3" Abrasive Nylon Wheels

Filament Dia./Grit	Arbor Hole	Item Number
.035/180SC	1/2"-3/8"	31084
.026/120CG*	1/2"-3/8"	86164
.043/120CG*	1/2"-3/8"	31101

*Burr-Rx ceramic-abrasive filament

4" Abrasive Nylon Wheels

Filament Dia./Grit	Arbor Hole	Item Number
.035/180SC	1/2"-3/8"	31104
.026/120CG*	1/2"-3/8"	86165
.043/120CG*	1/2"-3/8"	31100

*Burr-Rx ceramic-abrasive filament

BRUSHES FOR DEDICATED GEAR DEBURRING MACHINES

14" Knot Wire Wheels

Wire Size	Arbor Hole	Item Number
.014	2" w/ Keyways	08310
.020	2" w/ Keyways	08330
.016	2" w/ Keyways	09790*
.020	2" w/ Keyways	09800*

*Heavy-duty 90-knot construction

14" Abrasive Nylon Wheels

Filament Dia./Grit	Arbor Hole	Item Number
.026/120CG*	2" w/ Keyways	86135
.043/120CG*	2" w/ Keyways	86136
.035/80CG*	2" w/ Keyways	86108
.055/80CG*	2" w/ Keyways	86137

*Burr-Rx ceramic-abrasive filament

RECOMMENDED BRUSHES FOR NEW APPLICATIONS

12" Knot Wire Wheels

Wire Size	Arbor Hole	Item Number
.014	1-1/4" w/ Keyways	09709
.020	1-1/4" w/ Keyways	09719
.023	2" w/ Keyways	09870*

*Heavy-duty 66-knot construction

12" Crimped Wire Wheels

Wire Size	Arbor Hole	Item Number
.0104	1-1/4" w/ Keyways	01309
.0118	1-1/4" w/ Keyways	01319
.014	1-1/4" w/ Keyways	01329

12" Crimped Nylox Wheels

Filament Dia./Grit	Arbor Hole	Item Number
.035/180SC	2" w/ Keyways	83716
.040/120SC	2" w/ Keyways	83717
.040/80SC	2" w/ Keyways	83718
.026/120CG*	2" w/ Keyways	86132
.043/120CG*	2" w/ Keyways	86133
.055/80CG*	2" w/ Keyways	86134

*Burr-Rx ceramic-abrasive filament

APPLICATION SOLUTIONS: CALL 888-299-APPS

or complete the electronic Application Assistance form on our website.

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