fives

Gardner Superabrasives

Diamond & cBN grinding wheels



Custom engineered superabrasive products for maximized production

Index

Gardner Abrasives diamond & cBN grinding wheels	1
Gardner superabrasive wheel identification	2 - 6
Abrasive markings	6
Use of diamond & cBN wheels	7 - 11
Guidelines for using superabrasive wheels	12



Gardner Abrasives diamond & cBN grinding wheels

“Fives utilizes bond systems & materials that are custom engineered around each operation to maximize part quality & reduce total grinding costs”

CUSTOM ENGINEERED SOLUTIONS:

Fives offers both diamond and cBN abrasives in a wide variety of bond types, crystal sizes and styles including ring, button, segment, and ANSI standard configurations to fit virtually any superabrasive-capable disc grinding system.

The hardness and longevity of superabrasive crystals provide extremely long wheel life and the ability to hold tight tolerances with minimal down-time for dressing and wheel changes. Gardner superabrasive wheels deliver consistently better productivity, resiliency, and surface finishes than conventional abrasive wheels across a broad range of applications.

Fives’ high performance cBN button wheels provide consistent finishes & minimize heat damage compared to single-layer, electroplated cBN wheels, while delivering long wheel life.

AVAILABLE BONDS:

- Resinoid
- Vitrified
- Plated
- Polyimide
- Metal
- Hybrid

CRYSTAL SIZES:

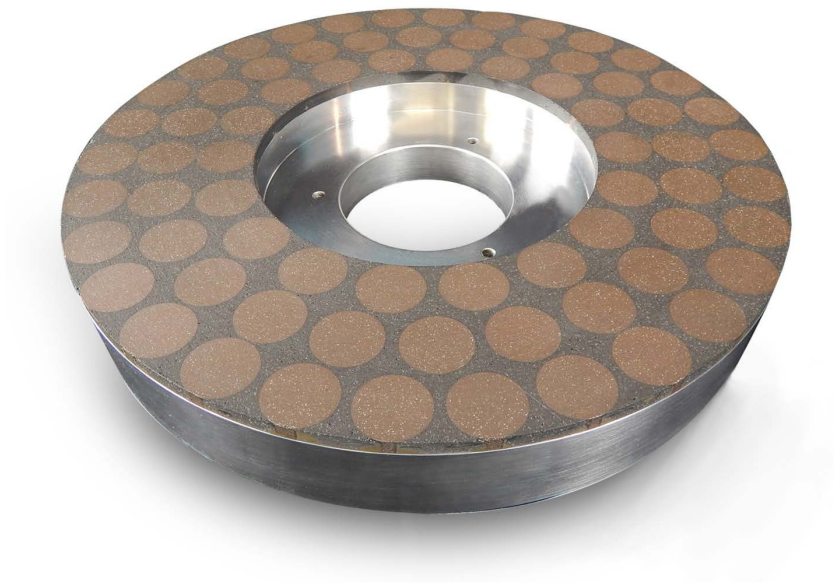
- Range from 20 to 3,000 grit

WORKPIECE MATERIALS:

- Various steels
- Magnetic material
- Ceramics
- Powdered metal
- Carbide

WHEEL CONFIGURATIONS:

- Ring
- Segment
- Button
- ANSI standard



Gardner superabrasive wheel identification

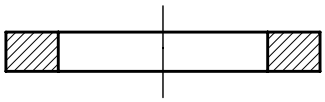
SHAPES & STYLES:

Fives utilizes shape and specification designation and markings for diamond and cBN wheels that are in conformance with ANSI and FEPA guidelines. Gardner Abrasives are identified by a code that is based on (3) or (4) designators listed in the following sequence:

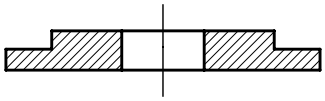
- Standard core shape
- Section shape
- Section location
- Modifier (may or may not be required)

CORE SHAPES:

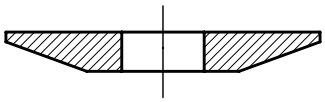
Shape 1 & 2.



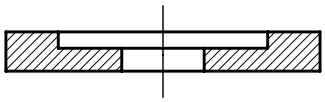
Shape 3.



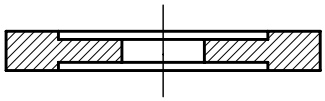
Shape 4.



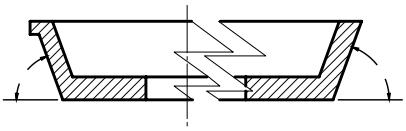
Shape 6.



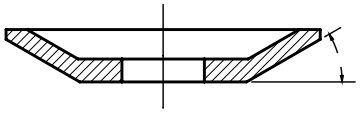
Shape 9.



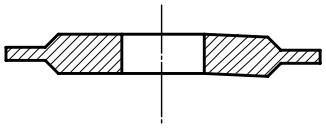
Shape 11.



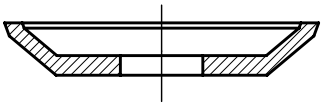
Shape 12.



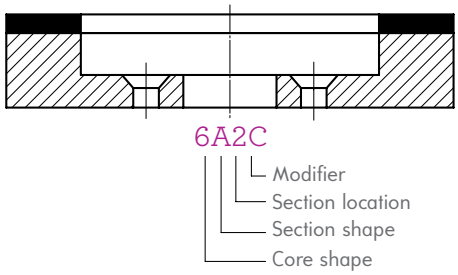
Shape 14.



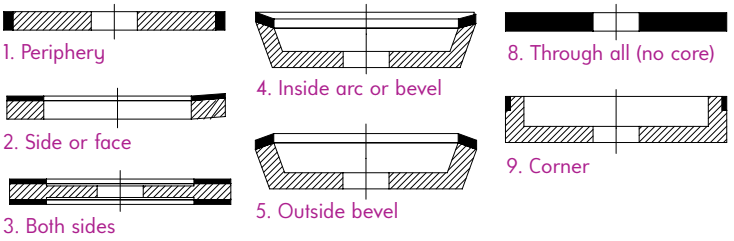
Shape 15.



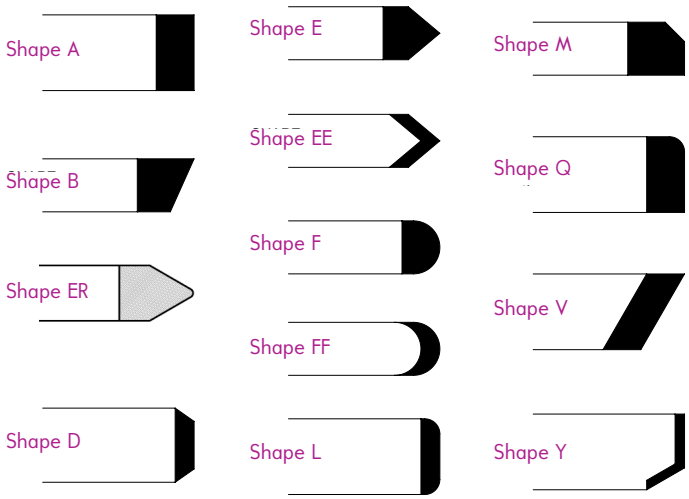
TYPICAL WHEEL TYPES:



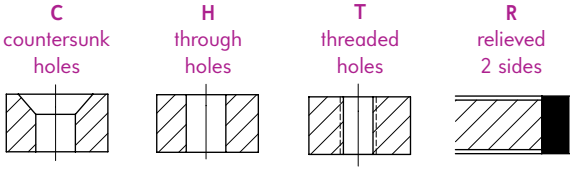
SECTION LOCATIONS:



SECTION SHAPES:



COMMON MODIFIERS:

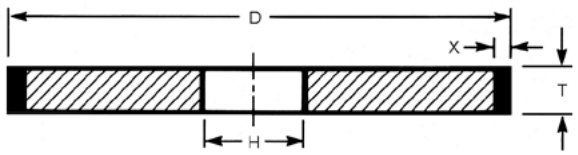


Gardner Superabrasive wheel shapes & sizes

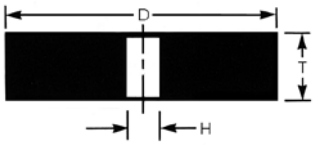
KEY TO WHEEL DESIGNATIONS:

- D Outside diameter
- E Back thickness
- H Arbor hole diameter
- J Back flat diameter
- K Inside flat diameter
- R Radius size
- S Outside angle
- T Thickness
- U Diamond length
- V Included angle
- W Diamond width
- Z Back thickness at rim
- X Diamond depth
- BC Bolt circle diameter

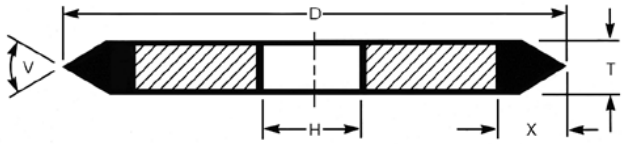
1A1



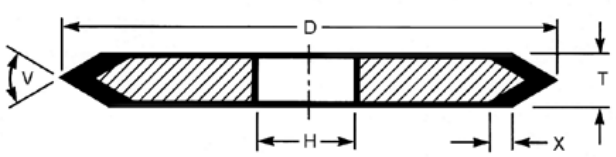
1A8



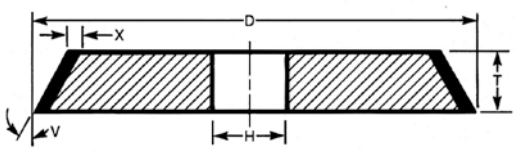
1E1



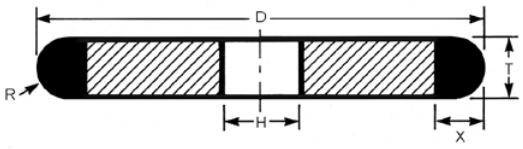
1EE1



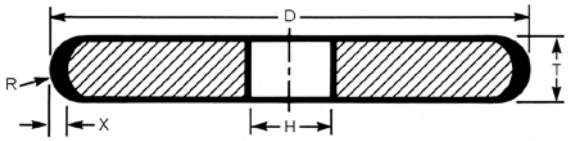
1V1



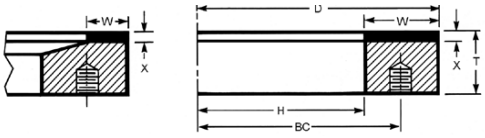
1F1



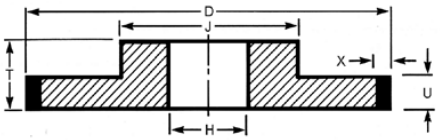
1FF1



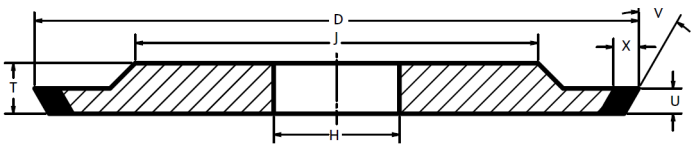
2A2T



3A1

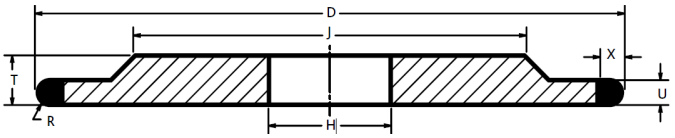


3V1

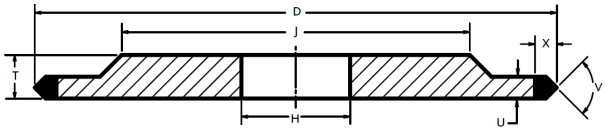


Gardner Superabrasive wheel shapes & sizes

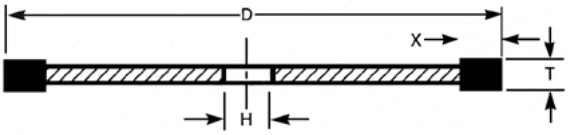
3F1



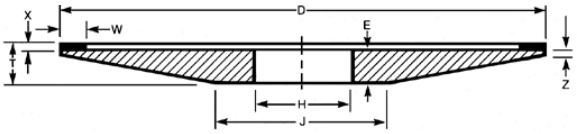
3E1



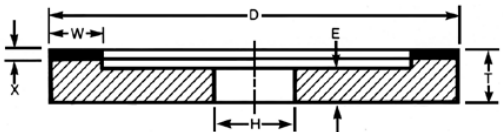
1A1R



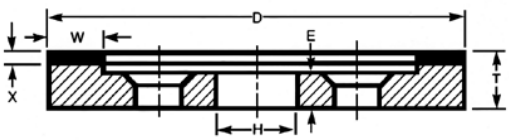
4A2P



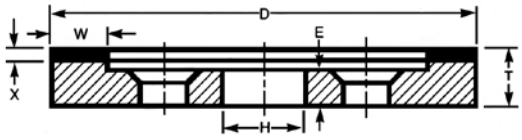
6A2



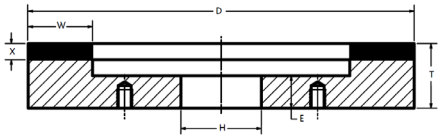
6A2C



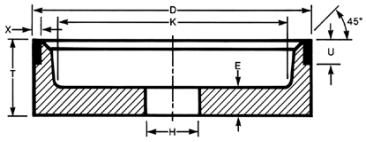
6A2H



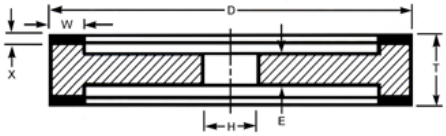
6A2T



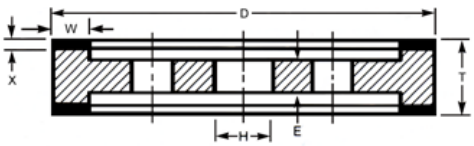
6A9



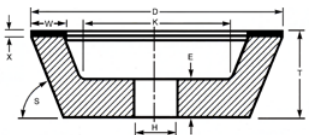
9A3



9A3H

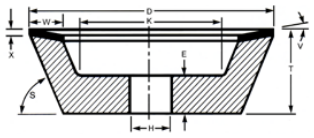


11A2

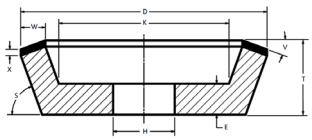


Gardner Superabrasive wheel shapes & sizes

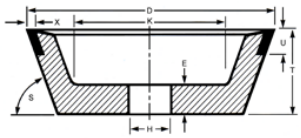
11V4



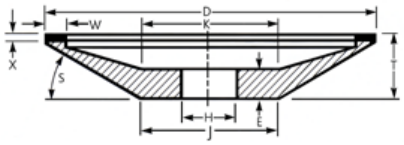
11V5



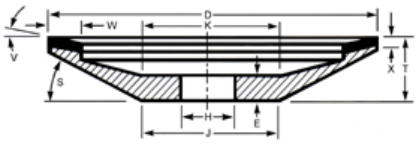
11V9



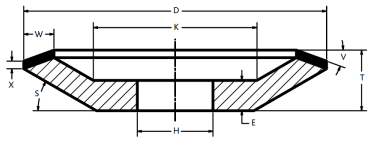
12A2



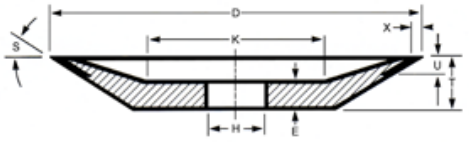
12V4



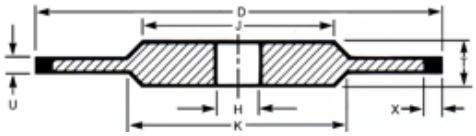
12V5



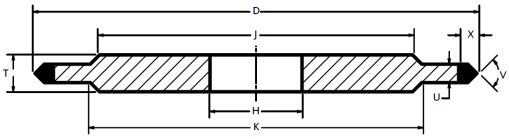
12V9



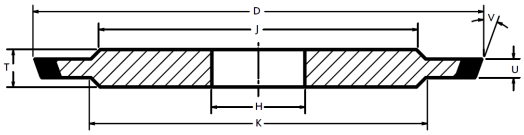
14A1



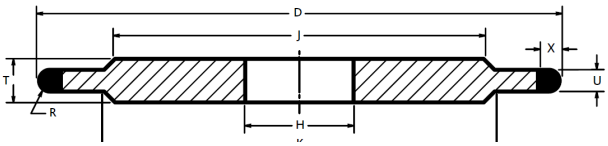
14E1



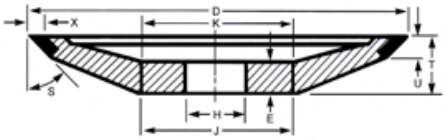
14V1



14F1

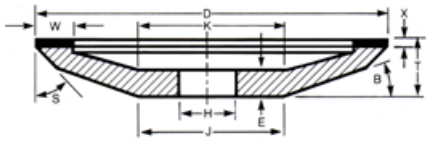


15V9

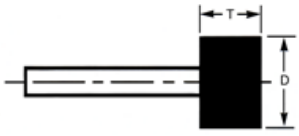


Gardner Superabrasive wheel shapes, sizes & abrasive markings

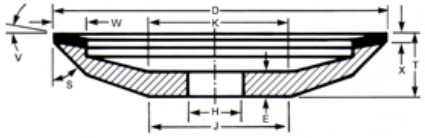
15A2



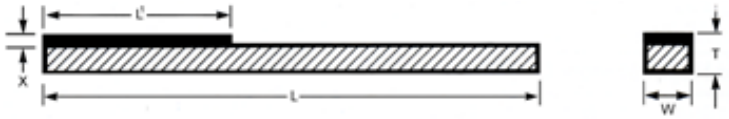
DW



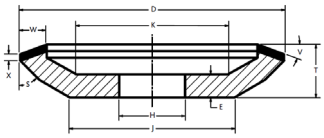
15V4



HAND HONES



15V5



Specific abrasive D or B - size - hardness - concentration - bond type - specific bond	
Specific abrasive	— Number and/or letter combination that designates a specific type
D or B	— D = diamond, B = cBN (Cubic Boron Nitride)
Size	— U.S. mesh size or equivalent (the smaller the number the bigger the diamond or cBN crystal)
Hardness	— Normally a letter: A being the softest, Z being the hardest grade. — Hardness grades are relative with the manufacturer's bond systems only.
Concentration	— The best concentration for an application is determined by bond, abrasive type, and size in conjunction with the mode of grind. — Concentrations typically run from 25 to 200.
Bond type	— Normal designations are B = Resin, V = Vitrified, M = Metal and P =Polyimide.
Specific bond	— May be a combination of letters and/or numbers that are specific to the manufacturer.

Use of diamond & cBN grinding wheels

WHEEL SPEEDS:

Never exceed the maximum safe operating speed specified in the Safety Code ANSI-B 7.1, or marked on the wheel.
The specified limits are:

— 6,500 SFPM for vitrified diamond and cBN wheels with vitreous core

— 9,500 SFPM for polyimide, resin, and vitrified bond wheels without a vitreous core

— 12,000 SFPM for plated and metal bond wheels

— 16,000 SFPM for metal bond and resin wheels (1A1R). The optimal speed for the diamond wheels is lower in most applications than the above maximum safe operating speed.

— Higher speeds than 7,500 SFPM up to the maximum safe limit is justifiable for cutting off and also for grinding with cBN wheels. Wheels may be operated above ANSI B 7.1, but these wheels must be speed tested accordingly.

FEED RATES:

— It is not a sufficient description of the feed rate to state just the stock removed per pass (downfeed). The work speed, table speed, cross feed and/or the size of the surface ground should all be stated to allow the calculation of cubic inches of material removed per minute or per hour.

— The specific feed rates are stated as cubic inches per hour of contact time, per inch of the width of the wheel face.

— The cost advantage of grinding at high feed rates is the time saved in producing a unit. The disadvantage is that when using a diamond wheel in this fashion the wear of the wheel is increased and the diamond cost per unit of production is greater. Each application must be judged within these parameters.

— If the feed rates cannot be achieved, grinding at constant power, closer to the permissible maximum is the best practice.

— Gardner resin bonded wheels were developed to require low power consumption and grind with less heat to permit higher feed rates and still maintain wheel life.

GRINDING RATIO:

— Wheel life is measured with the grinding ratio. This is calculated by dividing the cubic inches of material removed by the cubic inches of wear of the grinding wheel. This ratio is also decreased if the feed rate is increased.

— The grinding ratio may also be used to measure the grindability of the work material. These differences can range. The same wheel may have a few hundred grinding ratio on carbide, several thousand on dense aluminum oxide ceramics and several hundred thousand on glass.

— Within each class of material, differences of hardness have very little effect on the grinding ratio, but the microstructure of the piece to be ground dœs. Fine microstructures are more difficult to grind than coarser ones.

— With cemented carbides the chemistry of the metal binder affects grindability.

— Cobalt binder is quite easy to grind, nevertheless, with increasing cobalt content a decrease of grinding ratio is often observed.

— A content free tungsten metal (not combined with carbon to form carbides) decreases the grindability very substantially. Other metals which form stable carbides with carbon of the diamond also incease wear of the diamonds, by dissolving carbon from the diamond.

— This absorption of carbon element by these types of metal is also the chemical interaction that limits the use of diamonds for grinding steels, except on those steels that already have a high carbon content. On these alloys of iron, cobalt or nickel in the 50 Rockwell “C” scale of above, cBN should be used.

— cBN should never be used on carbide, ceramics or glass or any combination of these materials. If grinding a combination of materials, diamond should be used and the loss of grinding ratio should be accepted.

Evaluation of grinding tests

When testing diamond wheels for efficiency three errors are often committed. These pitfalls should be avoided:

1. TOO SHORT TEST

— The test should be long enough to generate significant wheel wear. If the test is so short that less than one grain diameter is lost from the surface of the wheel one cannot make conclusions on the durability of the bond.

— Short tests evaluate only whether the wheel was correctly dressed. A much too hard wheel may appear acceptable if properly dressed. A good wheel may appear too soft if excessively dressed, or too hard if it was trued and not sufficiently dressed.

— It is recommended that after dressing at least one layer of diamonds be used in a conditioning run. The measurements should start after conditioning, and extend for accurate results until the wear of the surface is greater than four times the diameter of the diamond grit. The following table lists the recommended minimum wear of the surface. When testing a peripheral (Type 1A1) diamond wheel twice the listed amount should be worn off the diameter.

Grit size U.S. mesh	Minimum wear inches
400	0.007
220	0.012
150	0.017
100	0.029
46	0.067

2. ACCELERATED TESTS

— Do not accelerate the test by running it under abusive conditions. Failure under abusive conditions is not related to wear under normal operating conditions.

3. MEASURE WEAR CORRECTLY

— It is wrong to calculate the wear by measuring the diameter of warm test wheels. The thermal expansion may be more than the wheel wear. Metal bond wheels could be measured after overnight storage at standard temperature. (Resin bond wheels of poor composition might suffer permanent expansion during wet storage.)

— Instead of measuring the wear of peripheral wheels by subtracting the diameter after the test from the diameter before the test, one should measure the change in thickness of the diamond layer more directly. It is recommended for Type 1A1 and similar peripheral wheels to scratch reference marks into the core of the wheel, close to the inner edge of the diamond section. Measure from the mark to the outer edge of the diamond layer. It is recommended that the marks be made on both sides of the wheel. Three marks on each side approximately 120° apart. The results of the six measurements should be averaged.

— Thinner wheels such as Type 2A2 and flat dish shape wheels may be measured back to front. The error over a short distance will be negligible, if the wheels are approximately at room temperature. Four measurements, approximately 90° apart are recommended for side grinding wheels.

Use of diamond & cBN wheels

CORE MATERIALS:

Material	
Resin	— Aluminum: very strong, moisture resistant, easily machined — Most popular core material for resin bond
Bakelite	— Resin bond
Abrasive	— Resin bond
Steel	— Resin, metal, or vitrified bond
Copper filled	— Resin or polyimide bond
Bronze	— Metal bond

WHEEL SIZE & DIAMOND DEPTH:

— Wheels of larger diameter and greater width, yield higher grinding ratios and cost less per usable cubic inch than smaller wheels. This results in double benefits if using as large and as wide a wheel as possible.

— High pressure is needed to feed wider wheels into the work and, if lack of machine rigidity or deflection of slender work pieces places a limit on the allowable pressure, narrower wheels should be used.

— A wheel with 1/8" deep diamond layer will normally last longer than two wheels with 1/16" diamond depth and costs less than the two wheels. It is because of these economics that the largest diamond depth suitable for the application should be utilized.

— It is because of these economics that 1/8" diamond depth is the most popular and advantageous in most precision grinding applications. The 1/4" diamond layer provides further economies, though the further savings are not quite as substantial.

— The two prime factors that lend justification to thinner diamond sections are:

A) If the wheel is rarely used or is intended to perform on occasional special application.

B) If the wheels are very roughly used or abused and are not likely to be fully utilized before they are damaged.

DIRECTION OF WHEEL ROTATION:

— The quality of the edges is better is the direction of rotation of the wheel is "down" away from the edges. When the infeed per pass is deep, slightly higher grinding ratios are obtained in "up" grinding.

— When simultaneously grinding steel shanks and carbide tips, the grinding ratio will be substantially higher and power consumption lower if grinding is done from the steel towards the carbide.

ARC OF CONTACT & AREA OF CONTACT:

— The length of the path each active abrasive grain scratches at each contact is the "arc of contact." It is a very important consideration when selecting the formulation of the grinding wheel.

— When the arc of contact is very long, for instance, the spiral scratched in Blanchard grinding of large work pieces, the grinding debris or swarf has to travel along an extended path before it is removed. It will cause wear of the wheel while traveling because this abraided material will erode the bonding agent.

— Another detrimental aspect is that during the time of contact, the coolant cannot be applied very efficiently and the heat may penetrate the bond of the wheel. For this type of application, Fives has developed heat and wear resistant bonds.

— In dry grinding, better heat resistance and less mechanical wear resistance are required for superior performance.

— When the arc of the contact is short, such as when centerless grinding or surface grinding at high table speeds and light infeeds, both the heat and the debris can be easily removed by the coolant. However, with a short of contact, the area of contact is also small and the grinding forces are concentrated on a small area of the wheel. High mechanical strength and tight anchoring of the diamonds are more important than heat and wear resistance.

Use of diamond & cBN wheels

DIAMOND QUALITY & CHARACTERISTICS:

— Diamonds are selected according to the application for best performance. They range from gem-like perfect shaped crystals to the mosaic structured friable diamonds which are designed to breakdown gradually and present new sharp corners during their life time.

— The mosaic structured diamonds used in resin bonds for carbide grinding are almost always metal clad. Protective nickel, silver, and copper coatings approximately double the grinding ratios.

— Copper clad diamonds are used for dry grinding of carbide, and also for wet grinding with very long arc of contact. The copper acts as a heat sink and lubricant to minimize thermal damage to the wheel. When any steel is ground with carbide - either in combination as in brazed tipped tool - or as occasional high speed steel tools ground alternating with carbide tools - nickel clad diamonds should be used in dry grinding as well as wet grinding.

— Always use coolant where possible. Turn it on before starting to dress, NEVER during. Turning on the coolant while the tool is in contact with the wheel could cause the diamond to shatter. It is better to finish the dress dry and correct it on the next pass than during the grinding process.

— Most hardened tool steels are better ground with cBN than with diamonds. Exceptions to this rule are high carbon die steels which are better ground by diamonds.

COOLANTS:

— Dry grinding considerably shortens the life of the diamonds wheels. Whenever feasible, ample flow of coolant should be used. Even bonds designed for dry grinding perform better wet. A light mist spray can improve the life of resin bonded wheels substantially. Normally, when only a light spray is used, it is best to select a “dry” grinding bond formulation.

— Despite the fact that grinding ratios are less in dry grinding, most manually controlled precision grinding of carbides is conducted dry, using resin bond diamond wheels, because of the desired visibility on the work piece. Dry grinding is also used when ultimate cleanliness is required, or to avoid the coolant from soaking into porous work materials.

— Resin bonded cBN wheels are also affected in life by coolants, although the type of coolant is very important. Water, with only a rust inhibitor added, will not improve the wheels performance over dry grinding. Water soluble oils or synthetic oils are normally used with the “heavy duty” soluble oils being preferred. Ideally straight oil is best, but the oil mist generated when grinding under straight oil requires expensive precautions to prevent fire hazards and contamination of the environment.

NOTE: in all instances, the recirculated coolant should be well filtered, because recirculated swarf shortens the life of the diamond and cBN wheels and also generates heat.

VIBRATIONS

— Vibrations adversely affect the finish especially of the edges and shortens the life of the diamond and cBN wheels. Therefore, the spindles and bearings of the machines should be well maintained. Precision grinders should also be insulated from soil vibrations and have good rigidity. The load on the tables should be such as not to cause any bouncing of the diamond wheel. For instance, the work pieces on the table of a Blanchard grinder should be set close enough to keep the diamond wheel in contact during the complete cycle.



Use of diamond & cBN wheels

TRUEING OF SUPERABRASIVE WHEELS:

— Although superabrasive wheels are accurately concentric at the time of manufacture, they need to be trued to the machine they are to be mounted on. Trueing generates a wheel surface that is concentric with the machine spindle axis. The wheel should be centered on the spindle by tapping a wooden block held against the wheel periphery. This action, in conjunction with an indicator, will enable the wheel to be accurately centered on the spindle. Accurately centering the wheel conserves both time and abrasive material during trueing.

— Superabrasive wheels must be sharpened after trueing to expose the superabrasive crystals by eliminating the glazed, closed surface resulting from the trueing operation.

SHARPENING SUPERABRASIVE WHEELS WITH CITCO TOOLS ALUMINUM OXIDE DRESSING STICKS

Catalog number	Size	Grit
WLDS150	3/8" x 3/4" x 4"	150
WLDS220	3/8" x 3/4" x 4"	220
WLDS500	3/8" x 3/4" x 4"	500
WLDSL150	1" x 1" x 6"	150
WLDSL220	1" x 1" x 6"	220
WLDSL500	1" x 1" x 6"	500

Frequent dressing is expensive in time and abrasive consumption. Frequent need for dressing usually indicates a need for a grinding process modification or a change in superabrasive wheel specification.

* Other sizes and/or grits can be special ordered by request

SUGGESTED WHEEL SPEEDS FOR BEST PERFORMANCE ON POLYIMIDE WHEELS:

Gardner Abrasives diamond polyimide tool and cutter grinding wheels for CARBIDE grinding applications with use of:

Suggested wheel speeds for best perforamnce
RPM x diameter x 0.2618 = SFPM

WATER SOLUBLE COOLANT	
Wheel diameter	**RPM**
3"	7,894
4"	5,921
5"	4,736
6"	3,947
7"	3,383
8"	2,962

OIL COOLANT	
Wheel diameter	**RPM**
3"	7,894
4"	5,921
5"	4,736
6"	3,947
7"	3,383
8"	2,962

* For cBN wheel SFPM is always over 6,000

Guidelines for using superabrasive wheels

OPERATING TIPS:

1. Be sure wheel is properly trued and dressed.
2. Use individual wheel mountings for each wheel to avoid re-trueing and dressing after wheel changeover.
3. When grinding wet, make sure a large amount of coolant reaches workpiece/wheel interface.
4. When "deep-grinding" slots or grooves, "climb-grind" so that the wheel and workpiece are traveling in the same direction.
5. With a large wheel or when running at high speeds, proper wheel balance and spindle bearing quality are very important.
6. Use finer mesh wheel and/or higher wheel speeds to achieve better surface finish.
7. The quality of the edges is better if the direction of rotation of the wheel is "down" away from the edges. When the infeed per pass is deep, slightly higher grinding ratios are obtained in "up" grinding.
8. When simultaneously grinding steel shanks and carbide tips, the grinding ratio will be substantially higher and power consumption lower if grinding is done from the steel towards the carbide.

IMPORTANT: Safety Do's & Don'ts:

DO'S

1. Always handle and store wheels in a careful manner.
2. Visually inspect all wheels before mounting for possible damage in transit.
3. Check maximum operating speed established for wheels against machine speed.
4. Check mounting flanges for equal and correct diameter (Should be at least 1/3 diameter of the wheel and relieved around hole.)
5. Be sure work rest is properly adjusted. (Center of wheel or above; no more than 1/8" away from wheel.)
6. Always use a guard covering at least one-half of the grinding wheel.
7. Allow newly mounted wheels to run at operating speed, with guard in place, for at least one minute before grinding.
8. Always wear safety glasses or some type of eye protection when grinding.

DON'TS

1. Don't use a wheel that has been dropped.
2. Don't force a wheel onto the machine or alter the size of the mount hole – if wheel won't fit the machine, get one that will.
3. Don't ever exceed maximum operating speed established for the wheel.
4. Don't use mounting flanges on which the bearing surfaces are not clean and flat.
5. Don't tighten the mounting nut excessively.
6. Don't grind on the side of the wheel unless wheel is specifically designed for that purpose.
7. Don't start the machine until the wheel guard is in place.
8. Don't jam work into the wheel.
9. Don't stand directly in front of a grinding wheel whenever a grinder is started.
10. Don't grind material for which the wheel is not designed.

fives ultimate machines ultimate factory

CONTACT US:

Fives Landis Corp. - (CITCO Tools)
7605 Discovery Lane - Concord Twp., OH 44077 - USA
Tel: +1 440 709 0700 - Fax: +1 440 709 0710
Email: citcoinfo@fivesgroup.com

Fives Landis Corp. - (Gardner Abrasives)
481 Gardner Street - South Beloit, IL 61080 - USA
Tel: +1 815 389 2251 - Fax: +1 815 389 5024
Email: gardnerinfo@fivesgroup.com

www.fivesgroup.com

Copyright © 2018 - Fives Landis Corp. - All rights reserved. Rev. 1 Print Reference: **DTSC-101**