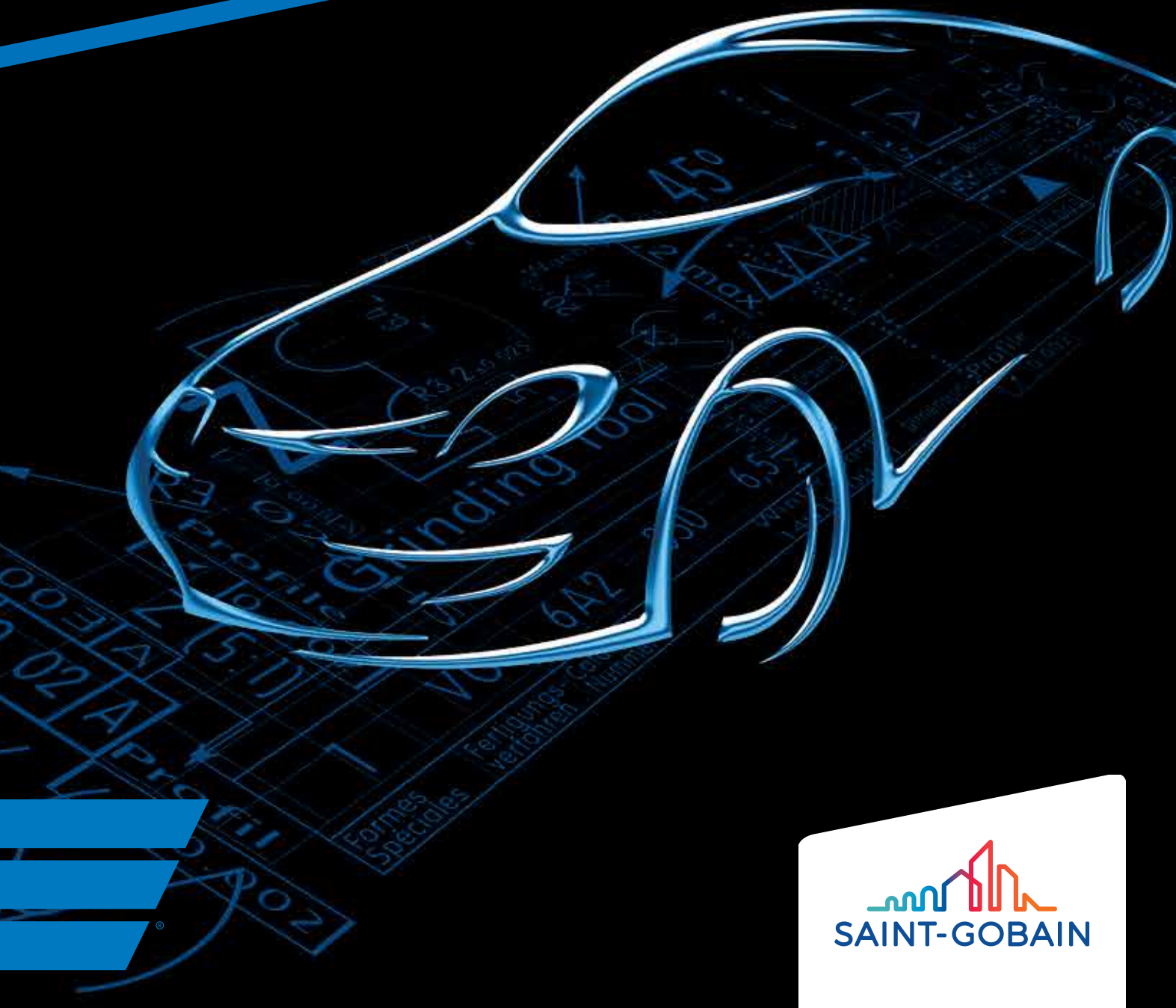
NORTON

SAINT-GOBAIN

Transforming surfaces ...and beyond

ABRASIVE SOLUTIONS FOR AUTOMOTIVE INDUSTRY



SAINT-GOBAIN

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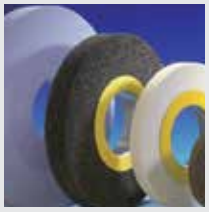
BRIEF
INTRODUCTION

Saint-Gobain

Founded in 1665 in France, Saint-Gobain Group is a global or European leader in each of its four core sectors: Innovative Materials, Packaging, Construction Products and Building Distribution.

Saint-Gobain at a glance
- € 39 billion turnover
- >1000 consolidated companies in 67 countries
- Over 170,000 employees
- 8 research centres and 101 development units
- Top 100 global innovators

A world leader in Glass, Housing Products & Innovative Materials with the mission to be No.1 or 2 in each of its industries.



1st Bonded Abrasives in the world

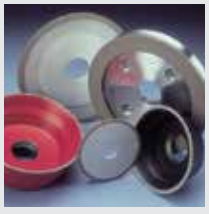
2nd Coated Abrasives in the world

Saint-Gobain Abrasives

As a world leader in Abrasives, Saint-Gobain designs, manufactures and markets all abrasives products (Bonded Abrasives, Coated Abrasives, Superabrasives, Thin-Wheels and CP) under its master brands, Norton, Winter and Flexovit. It's also the only global producer which can manufacture all 5 types of abrasives. Saint-Gobain is dedicated to enhancing their customers' productivity and performance in all industrial manufacturing sectors.

Grindwell Norton, a Saint-Gobain Company, made first grinding wheel in India in 1941 and is today India's leading manufacturer of Abrasives, Ceramics and Performance Plastics. Head-quartered in Mumbai, it has state-of-the-art manufacturing plants at 6 locations. Saint-Gobain's cross-functional global R&D Centre - SGRI - based at Chennai, supports innovation and new product development. Grindwell Norton also has a Grinding Technology Centre and an Automotive Research & Training Centre at Bangalore.

1st Super-abrasives in the world



1st Thin Wheels in the world

3rd CP in the world

Automotive

Mercedes-Benz

BMW

Audi

Volvo

Volkswagen

GM

Ford

Peugeot

Honda

Toyota

Mazda

SUZUKI

Hyundai

NISSAN

Maruti

Tata Motors

Skoda

Fiat

Saint-Gobain:

Your trustworthy global partner in automotive and auto parts manufacturing industry

Auto Parts

DELPHI
DENSO
MAHLE
ZF
CUMMINS
Rane TRW
EATON
SCHAEFFLER
NSK
NTN
SKF
TIMKEN
Koyo
NACHI
BOSCH
BorgWarner
AISIN
GETRAG
GKN
LINAMAR
MOBIS
JTEKT
TENNECO
Honeywell
Thyssen Krupp
Fast Auto Drive
LYC
Gabriel
Rane EVL
Bharat Forge
Tata Bearings
NRB
Toyota Kirloskar
Endurance
Sekurit

AUTOMOTIVE
INDUSTRY PARTNERS

Saint-Gobain has forged long-term partnerships with well-known automotive and parts manufacturers. With belief to provide the advanced grinding solutions for customers, we cooperate with prominent grinder manufacturers and provide professional technical support.

Saint-Gobain Abrasives has plants and sales offices in over 100 countries around the world, ready to respond to your needs at any time.

Grinder

JUNKER
United Grinding
EMAG
LANDIS
Hi-Life
TOYODA
KENT
RELSHAUER
Gleason
DANOBAT
CHEVALIER
MECCANODORA
TACCHELLA
HARDINGE
Precision Machine Tools
BESTEK
Micromatic
Solitaire Machine Tools

RESEARCH & INNOVATION

Research and Innovation are at the heart of Saint-Gobain's strategy. The Group's research focuses both on breakthrough innovations and on continuously improving its products, processes and services in a spirit of openness and attentiveness to customer needs.

R&D objectives are aligned with the Group's needs and ambitions to ensure that Saint-Gobain can compete successfully, explore new horizons and recruit top talent.

The Group has eight major cross-business research centers that serve all Activities, thus optimizing synergies between them. These research centers maintain and develop the highest level of skills and key technologies for the Group. Their size and multi-disciplinary focus facilitate effective interaction with the academic world, early notice of scientific advances, and the recruiting of talents. The Group also has approximately one hundred development units around the world, facilitating research into new products more closely tailored to customer needs and local market requirements.

Saint Gobain invested 430 million euros in research and development at its main R&D centres and the one hundred or more development units established throughout the world, which employ 3,700 research workers, in 2013.

- 4 Specialist Grinding Technology Centres located in USA, Germany, China, India where highly skilled engineering technologists test, train, and develop, replicating real-life customer conditions & applications
- 8 Centres of Excellence located across 4 continents (India, Luxembourg, France, Netherlands, Germany, Poland, Brazil, USA)
- Many of our 64 manufacturing plants have local R&D and Centres of Excellence dedicated to serving customers' requirements
- ~50 patent applications p/a
- 3.0% of sales invested in R&D
- Nearly 35% of sales from products <5 years old

Saint-Gobain Research India (SGRI)

A unique industry-institute collaboration between Saint-Gobain and IIT-Madras

Saint-Gobain Research India (SGRI) is the 7th cross-functional R&D center for the Saint-Gobain Group. SGRI supports and develops existing and new businesses in India and provides and nurtures future talent for the Group in India. SGRI works on improving manufacturing processes, from raw materials to adding new functions to our end product through collaborative work and project management. Our researchers are quickly integrated into multidisciplinary teams and they take part in research programs in collaboration with marketing and production.

Support existing businesses
- 31 new product launches
- 20 patent applications
- 12 competencies across 6 Business Units

External collaborations
- 31 academic collaborations
- Co-innovations with customers & various partners

New business opportunities
- Application innovations

Saint-Gobain Abrasives research and development teams are continually upgrading our product offering based on market needs and new technologies to solve cutting, grinding, and finishing problems, increase productivity, and provide the best option for the application in performance and/or total cost.

Mission

The primary mission is to provide active and forward-looking support for the Group's various businesses, leading to developments and innovations in terms of both products and processes, to serve our current markets and enhance our businesses' competitive edge.

The second mission is to contribute to the Group's technological innovation and enable it to penetrate new markets. In line with the Group's development and leadership strategy on housing and construction markets, the center supports the development of technologies to meet the challenges of growth, energy and the environment.

Creating Values for You

• Field Instrumentation System (FIS)

Field Instrumentation System (FIS) is a portable testing tool to record, analyse and compare process information to optimize the grinding process. Developed by Saint-Gobain, FIS is used in all grinding areas, helping customers achieve top notch grinding process, shortened grinding cycle, extended service life and improved production performance.

• Process Solutions Program (PSP)

A unique, bespoke service for your manufacturing operation

To maintain competitive advantage in tough economic times you have to be leaner and more productive than ever before.

Through the Saint-Gobain Process Solutions Program (PSP) we can analyse your grinding operation to significantly reduce rejection and scrap rates. Assessing cost, quality, safety and service PSP will show you how to produce parts faster with fewer rejections; substantially driving down costs to make your operation more profitable.

With a PSP trained sales force, experienced application engineers and a range of specially designed PSP diagnostic tools, as well as training in Kaizen techniques, Lean Manufacturing and Six Sigma, we are fully qualified to review your entire manufacturing operation.

• Free Testing Service

Customers who have interests to know about Saint-Gobain Abrasives can enjoy our free testing service. Our technicians will recommend suitable grinding solutions to meet y our ever changing grinding needs.

• Grinding Technology Centre & Automotive Research & Training Centre

Saint-Gobain grinding technology centre and Automotive Research & Training Centres based at Bangalore in India offer professional training to customers, and cooperates with them in visionary research on grinding technology.

Saint-Gobain is constantly striving for innovation. We are commited to help our customers upgrade and optimize grinding and manufacturing process with comprehensive and tailor-made grinding solutions.

Environment, Health & Safety (EHS)

Environment, health and safety play a key role at Saint-Gobain Abrasives. Every day we are actively committed to carrying out programs to implement these values throughout our organization.

**“Zero occupational injuries,
Zero occupational diseases and
Zero cost for waste treatment”**

——— are the company’s long-term goals.

World Class Manufacturing (WCM)

World Class Manufacturing is a widely recognized management model. In 2008, Saint-Gobain Abrasives successfully introduced it to facilitate the rapid industrial development in China.

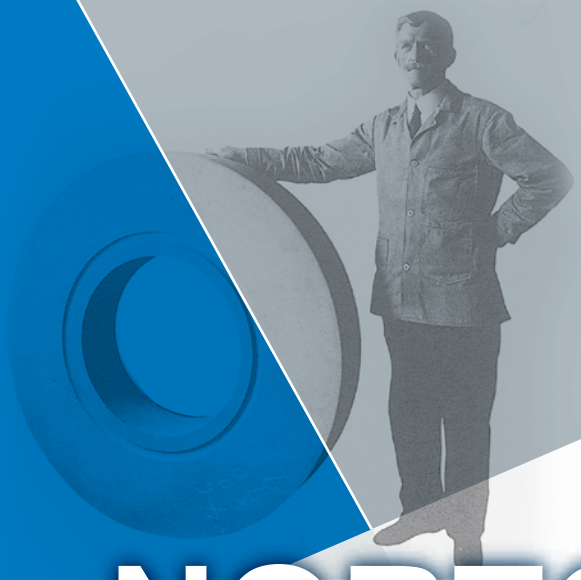
Through the World Class Manufacturing program, operations of Saint-Gobain Abrasives has been escalated to a new level, with reduced loss and waste, better operational efficiency and product quality.

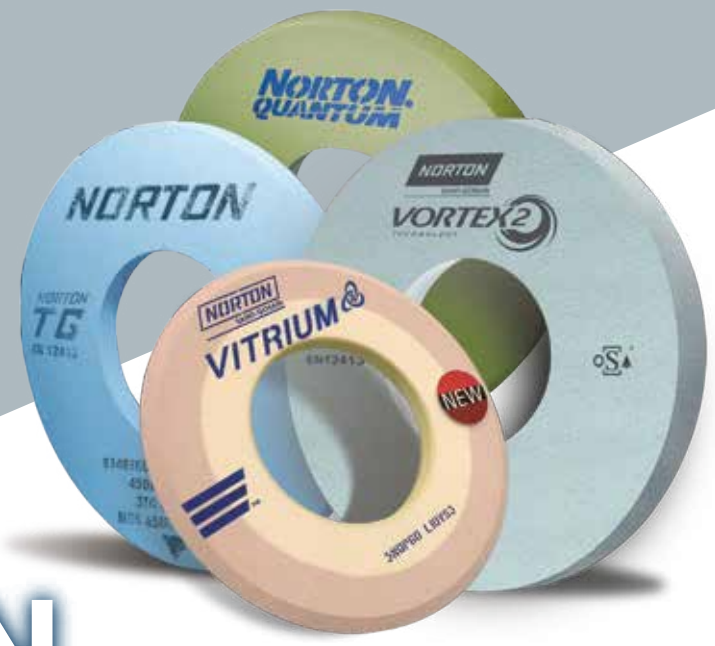
Quality & Safety

Customers are always our priority and this is reflected in our products. Products are designed and produced to the most stringent quality standards to guarantee optimum personal safety and user comfort.

Saint-Gobain Abrasives also plays an active role to promote the values of and conforms to all world-wide quality, safety & environmental federations.

- FEPA (Federation of European Producers of Abrasive Products)
- ISO9001 (International Quality Management System)
- ISO14001 (International Environment Management System)
- EN12413 / EN13743 / EN13236 (European Product Safety Standards)
- OHSAS 18001 (Occupational Health and Safety Management System)
- oSa (The Organization for the Safety of Abrasives)





NORTON
BRAND STORY

NORTON
SAINT-GOBAIN

In the middle of 19th Century, a group of ceramists and entrepreneurs in Worcester, Massachusetts, USA, set out with a goal: meet the growing need of the burgeoning U.S. manufacturing industry, which needed an ever increasing supply of grinding wheels to build and maintain machinery.

By 1950 Norton had established itself as the leading world-wide abrasives brand. This steady growth, based upon innovation, technology and responsiveness to customers, has continued and Norton now has a presence in 28 countries around the world.

For over 128 years, Norton has provided innovative solutions to fight against challenges faced by industries. By 1876 Norton was manufacturing grinding wheels, and had acquired a patent for vitrified wheels. In 1885 the Norton Emery Wheel Co. was founded to manufacture the first grinding wheel that could be precision made and mass-produced. In 1901, Norton invented the first synthetic alundum abrasive. In 1906, Norton had possessed 100 important patents. In 1958, Norton introduced zirconia corundum abrasives, the most important break-through in abrasives field after the Second World War. At the beginning of the 21 Century, Norton has continued to lead the technical trend with a series of innovative offerings, including the patented new Vortex 2 technology, revolutionary bond Vitrium^3, Quantum and TG ceramic abrasives. In 1990, Norton was acquired by Saint-Gobain.

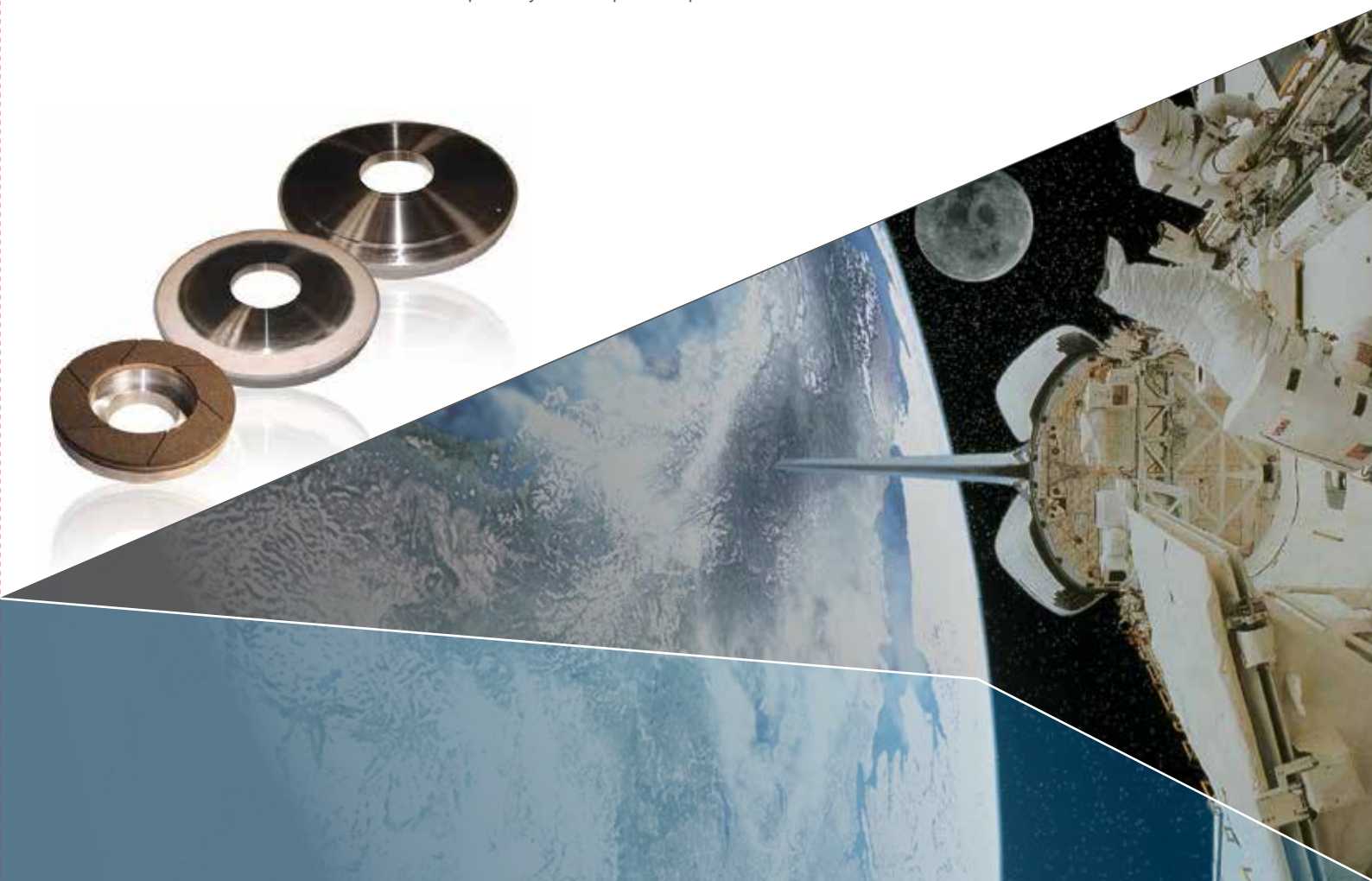
WINTER
BRAND STORY

NORTON SAINT-GOBAIN WINTER

WINTER was established in 1847 by Ernst Winter as a family-owned company. It adheres to the original goal of developing ultra-hard crystal tools of the highest quality. In diverse applications for diamond and CBN grinding tools WINTER has been pioneers, and today it still follows this way as the trend-setter and the technology leader.

Since the foundation of the company, WINTER has stood for quality at the highest level. In 1954, WINTER further developed the special resin bond to first produce synthetic diamonds. As the first grinding tool manufacturer worldwide, WINTER presented CBN grinding tools with a special resin bond (KSS) for HSS tool grinding in 1969. WINTER SG-CNC rotary dressers conquered the market in 1993. It has made dressing of vitrified CBN grinding wheels possible. In 2006, N^7 as a glass-ceramic bond system was introduced to the market. This bond could be precisely engineered to meet individual customer application requirements. WINTER was acquired by Saint-Gobain in 1996.

In Superabrasives, WINTER is No. 1 in Europe. Over 75% of all WINTER products are developed in close cooperation with our customers, thus developing solutions that perfectly fit their special requirements.



Innovative Grinding Technology

Innovative Grinding Technology

NORTON
SAINT-GOBAIN
QUANTUM™

Norton Quantum uses a new generation of alumina grain chemistry and shape developed from the Norton's patented Seeded-Gel Technology. With innovative organic and vitrified bonds specially developed to enhance grain performance, Norton Quantum Wheels provide the fastest and finest grinding in the industry.

This revolutionary ceramic grain multiplies the cutting efficiency by controlling the grain breakdown at the micrometric level. Norton Quantum is a versatile technology that is ideal for low, medium and high force applications on materials ranging from cast iron to stainless steel as well as hard to grind inconel and titanium.

Microstructure of Quantum grinding wheel

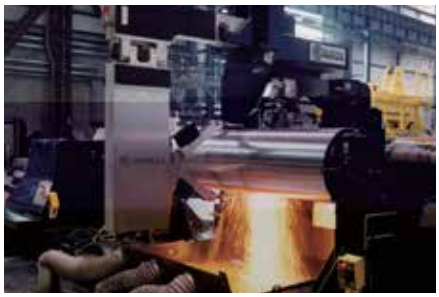
Features

- Patented ceramic grain
- Engineered grain boundaries
- Specific bond formulations

Benefits

- 30% to 100% higher metal removal rate
- 33% to 100% longer life v/s competitive ceramic products
- 15%+ lower threshold power
- Versatile in all low, medium, and high force applications
- Superior results in both vitrified and organic applications

Application Fields



Steel roller grinding

Auto parts grinding

Bearing internal and race grinding

TG ceramic sinter alumina grain has the rectangular structure with high length-width ratio. Compared with other abrasives, TG grain has sharper cutting edge and better removal capability, making it ideal for high-efficiency, high-precision grinding.

Microstructure of TG grinding wheel

TG ceramic grain with high aspect ratio: L/D = 3 to 4 (Normal grain is 0.8 to 1)

Features

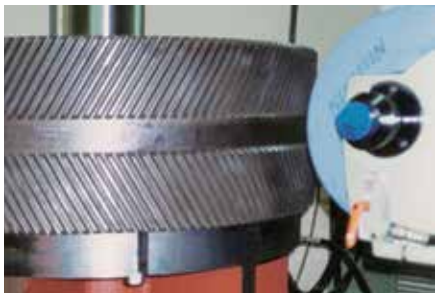
- High performance engineered ceramic grain
- Highly porous and permeable for maximizing coolant diffusion in the grinding zone
- Optimum grain shape for improved chip clearance and reduced friction from "spot contact"

Benefits

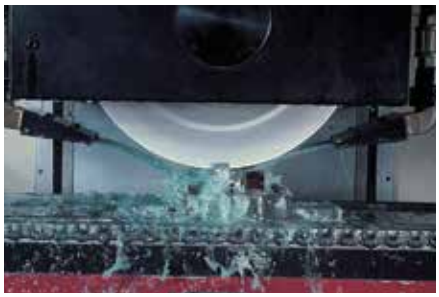
- Very high metal removal rates giving dramatically reduced cycle times up to 50% lower.
- Very long wheel life through dramatically reduced wheel dressing up to 3 times of normal products
- Extreme permeability produces coolest grinding wheel for heat-sensitive applications
- Reduced residual stress after grinding

Application Fields

Bearing internal and race grinding



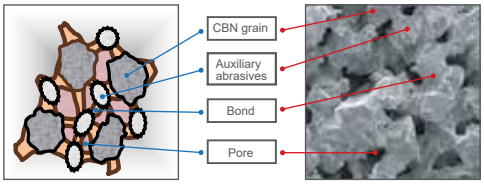
Gear form grinding



Engine blade creep-feed grinding

Innovative Grinding Technology

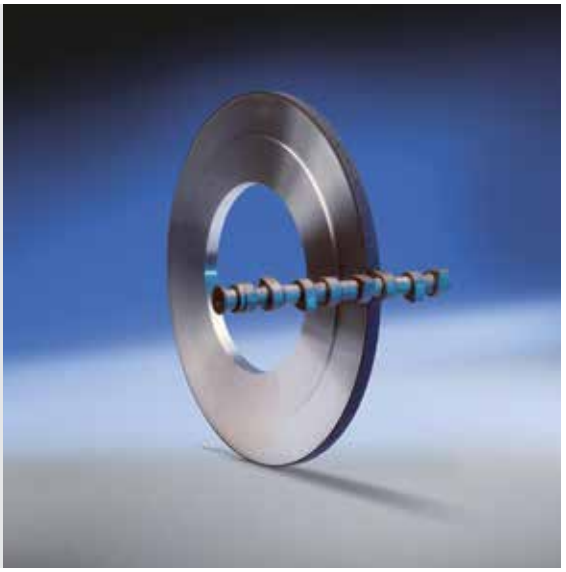
The vitrified bond system N^7 is one of the latest innovations from WINTER based on “Glass-Ceramic bond systems”. It is a vitrified Superabrasive bond system that achieves excellent bond bridge formation with optimal grit wetting and encapsulation properties. Specially designed for high efficiency deep grinding processes, N^7 bond technology offers a cooler cutting grinding tool which is particularly suitable when high specific removal rates, best surface finish and tight surface tolerances must be achieved.



Microstructure of N^7 grinding wheel

Features
- Very high bond hardness with increased wear resistance
- Optimal abrasive grain wetting
- Excellent shaping of the bond bridges
- Highest porosities for cool grinding

Benefits
- Improved part quality with significantly reduced burns
- High precision grinding
- Precise profile and extended wheel life
- Very high metal removal rates for significant cycle time reduction



Application Fields


Cage window grinding


Auto shaft parts grinding

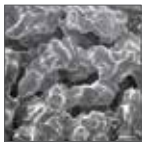

Ultra-precision bore grinding

NORTON
SAINT-GOBAIN

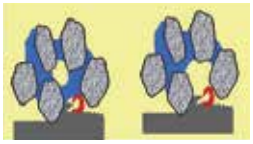
VORTEX2 TECHNOLOGY

Innovative Grinding Technology

Vortex 2 is the combination of engineered 3D grain spacing and a new technology bond created by Saint-Gobain Abrasives. The result is a cool cutting abrasives which provides a 40% increase in wheel life and profile holding, thus significantly increasing metal removal rates and productivity to a new level.



Microstructure of Vortex 2



Vortex 2 provides higher porosity to allow more coolant into the grinding zone

Features

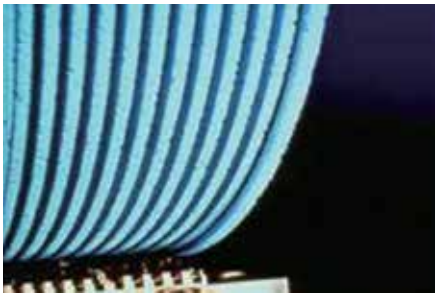
- New bond formula
- High performance engineered fused alumina grain
- Highly porous & permeable for maximizing coolant diffusion in the grinding zone
- Optimum grain spacing for improved chip clearance and reduced friction from‘spot contact’

Benefits

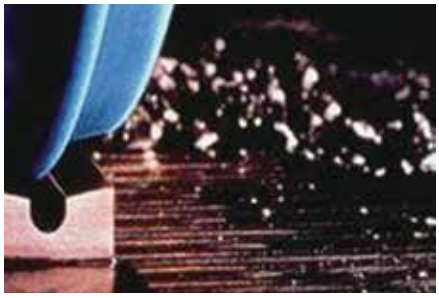
- High profile holding for extended wheel life and improved productivity
- Improved total cost versus performance ratio
- Very long wheel life though dramatically reduced wheel dressing
- Gentle on the dressing tool, very easy to profile
- Ultimate degree of burn reduction through extreme permeability
- Reduced residual stress after grinding

Application Fields

Turbine blade creep-feed grinding



Steering rack grinding



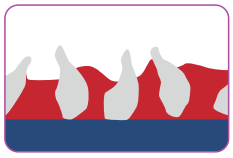
Auto parts grinding

Innovative Grinding Technology

NORaX Engineered Abrasives work like a grinding wheel on a coated backing. As the belt wears, dull abrasive particles are lifted out of the belt and a new layer of sharp abrasive is exposed to the work surface.

The innovation lies in the abrasive layer: a multi-layer coating of abrasive is engineered into a 3-D pattern. These patterns give a controlled contact surface between the abrasive and part that optimizes belt performance.

To add to the performance advantage of NORaX Engineered Abrasives, a surface powder grinding aid is incorporated into all NORaX belts. The surface powder increases initial belt aggressiveness and decreases grinding temperature.



Conventional
(Mono-layer structure)

NORaX engineered abrasives
(Multi-layer, controlled contact area)

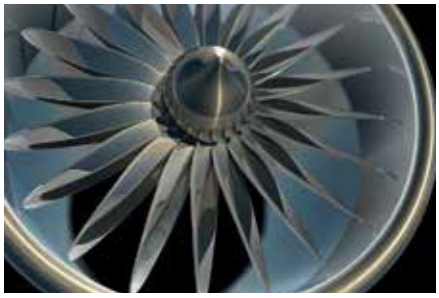
Features

- Specially treated engineered grain using multi-layer technology
- Water proof backing
- Highly flexible

Benefits

- Higher cut rates at lower pressures
- Longer product life
- Superior and consistent finishes
- Cooler operating temperatures
- Lower specific grinding energies

Application Fields



Turbine blade polishing

Paint refinishing

Metalworking processing

NORTON
SAINT-GOBAIN

VITRIUM³™

Vitrium³ is a revolutionary vitrified bond that will reshape the world of precision grinding. This new generation bond features an exclusive chemistry that promotes grain adhesion and allows for increased porosity resulting in improved product versatility across a wide range of high precision applications. Performance improvements with Norton Vitrium³ span all abrasive grains from proprietary Quantum ceramic alumina to conventional aluminium oxide.

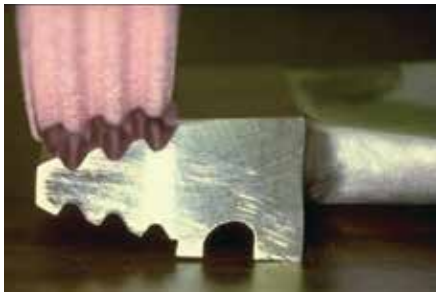
Features

- Cool cutting
- Precise profile
- High speed

Benefits

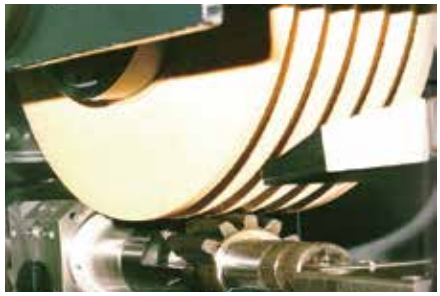
- Significantly reduced burn
- Increased cutting efficiency and cut rate
- Improved coolant flow , reducing heat build -up and wheel loading
- Ultra radius accuracy and extended wheel life
- Reduced dressing frequency and cost
- Improved cycle and process time
- Work at higher machine speed /pressure
- Leverage existing equipment and optimizd machine efficiency

Application Fields



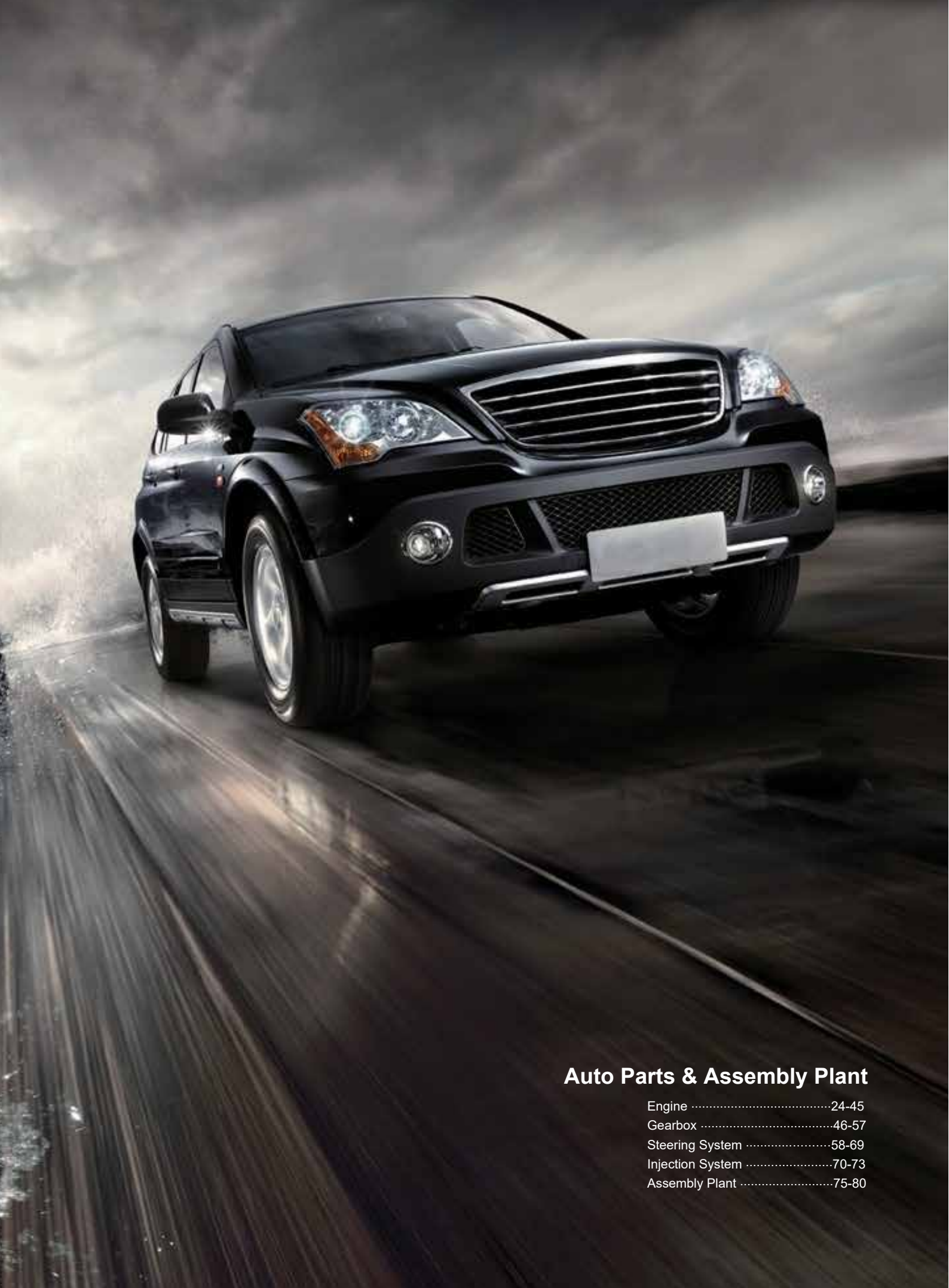
Turbine blade creep-feed grinding

Wind-power gear form grinding



Gear worm grinding

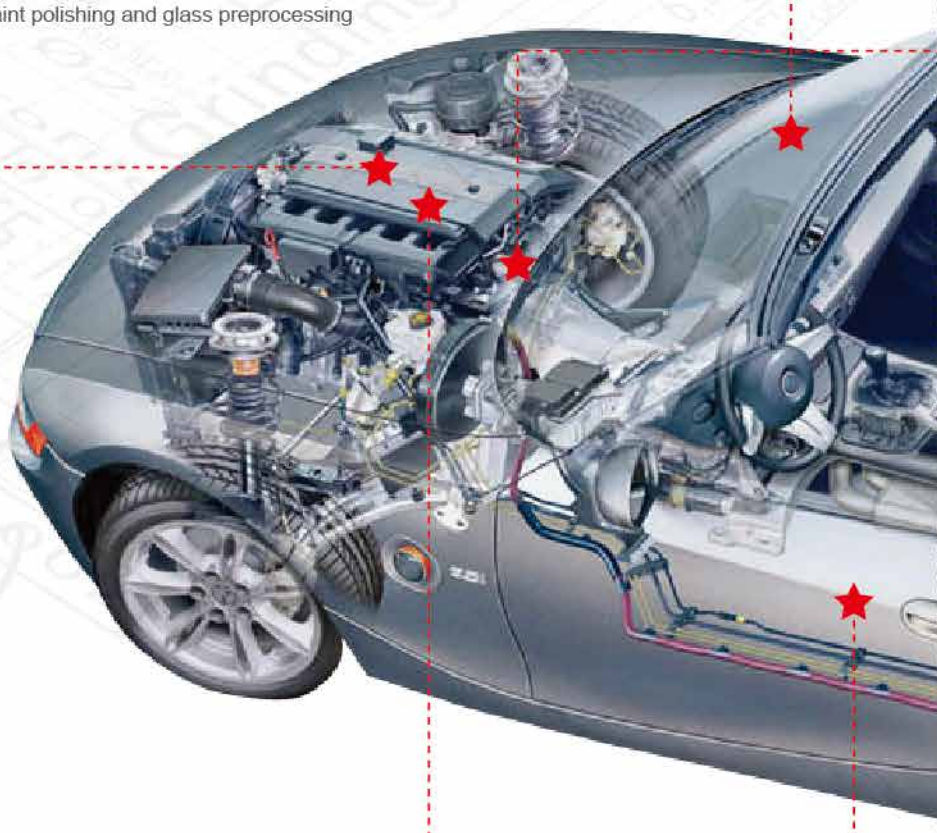
Notes



Auto Parts & Assembly Plant

Saint-Gobain Abrasives
--Total Grinding Solutions for Automotive Industry

Saint-Gobain Abrasives boasts a full line of products ranging from roughing, and refined grinding to finishing and polishing. The tailored system solutions facilitate automotive and parts manufacturers to improve productivity and product quality with even lower cost. Our products are widely used for grinding of auto engines, transmissions, driving devices and steering systems. In addition, auto body sanding, paint polishing and glass preprocessing can't do without our abrasives.



(P24–45)

Engine

Crankshaft, camshaft, valve,spring, connecting rod, piston ring, cylinder block, cylinder head etc.

(P70–73)

Other auxiliary precision parts (Injection system)

Fuel injection system

Automotive glass preprocessing

Edge rounding, beveling, drilling on side and rear window shield etc.

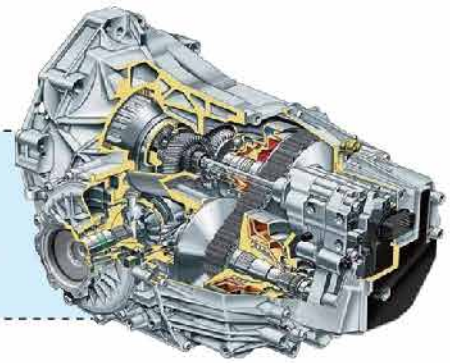
AAM (car care & repair)

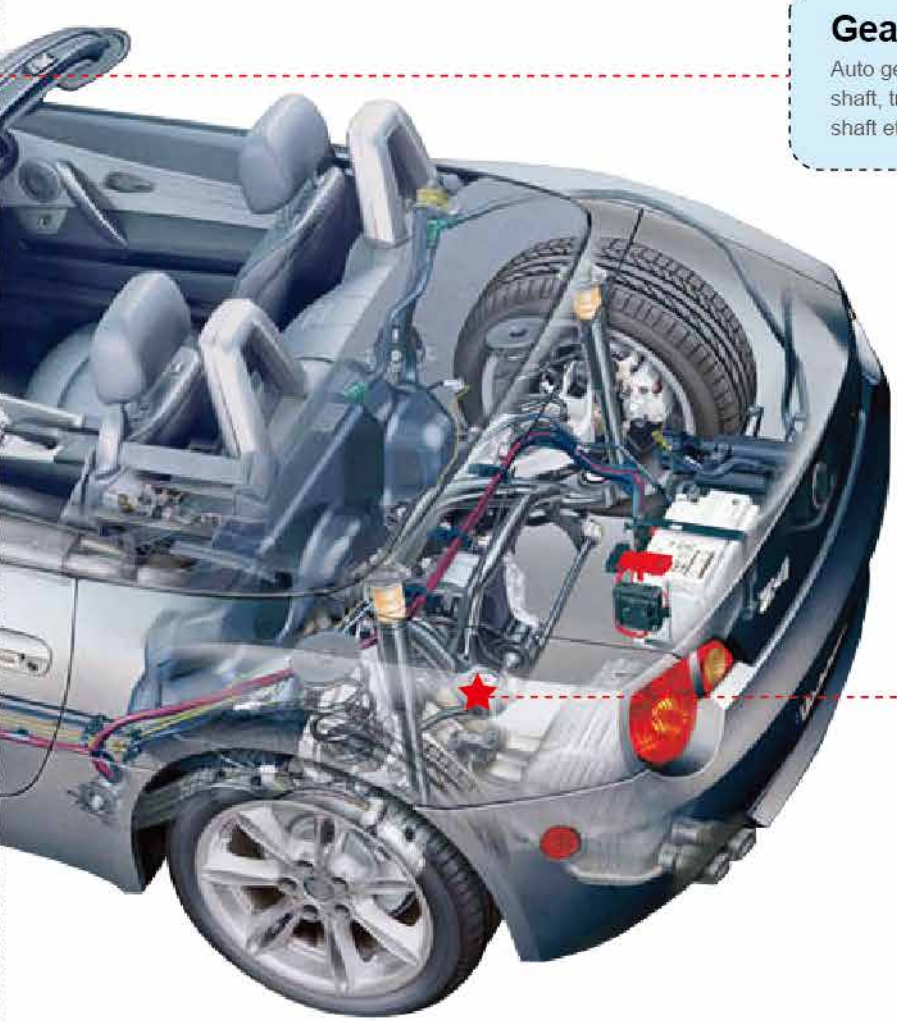
Metal plate repairing, paint surface polishing, gloss recovery and waxing & coating.
(For details, please visit our website)

(P46–57)

Gearbox

Auto gear, gear shaft, transmission shaft etc.

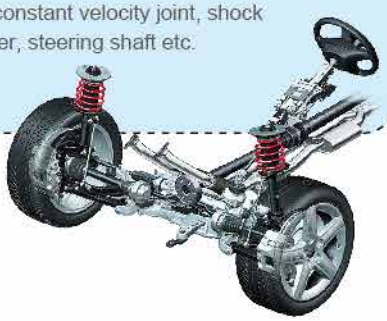




(P58–69)

Steering system

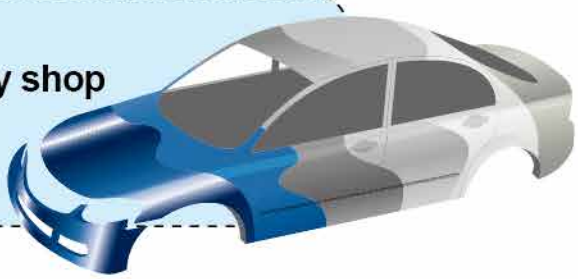
Rack, constant velocity joint, shock absorber, steering shaft etc.



(P75–80)

Press shop, body shop, paint shop and assembly shop

Metal plate repairing, welding line and slag grinding, putty grinding, paint refinishing and polishing etc.



Engine manufacturing underpins auto industry production and development while quality and precision of engine parts have a direct influence on automotive performance. These results in stringent standards on engine parts processing.

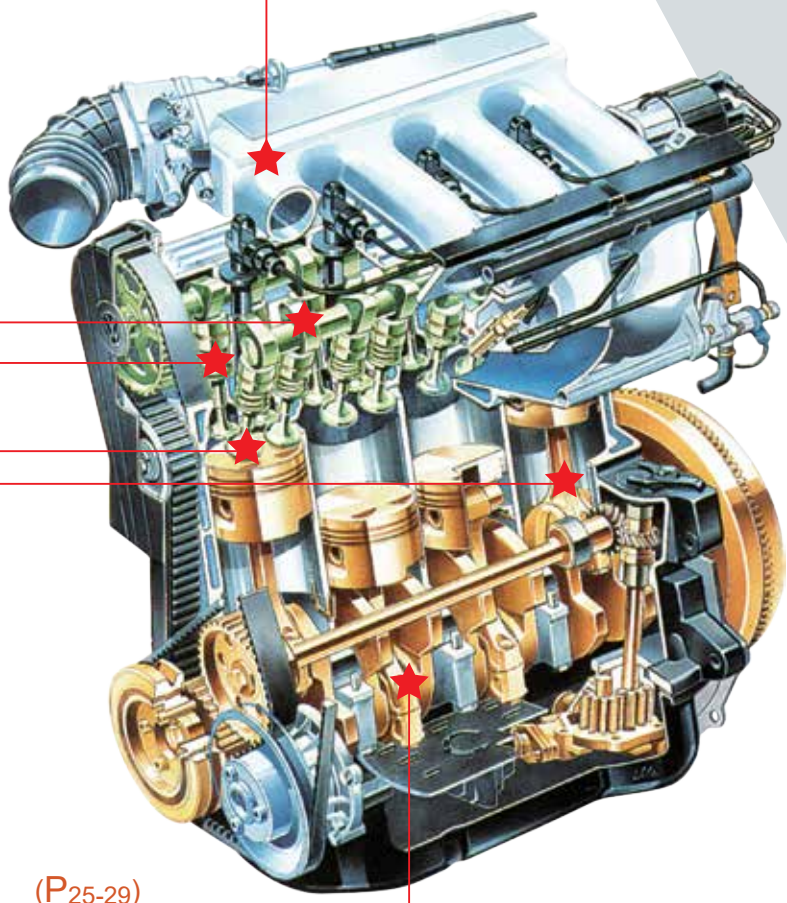
Engine

Auto Parts

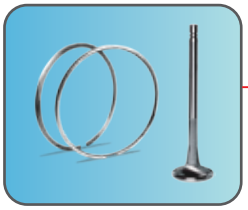
(P31-35)
Camshaft

(P41-42)
Cylinder Block & Head

(P39)
Spring



(P39-40/43-45)
Piston Ring / Valve

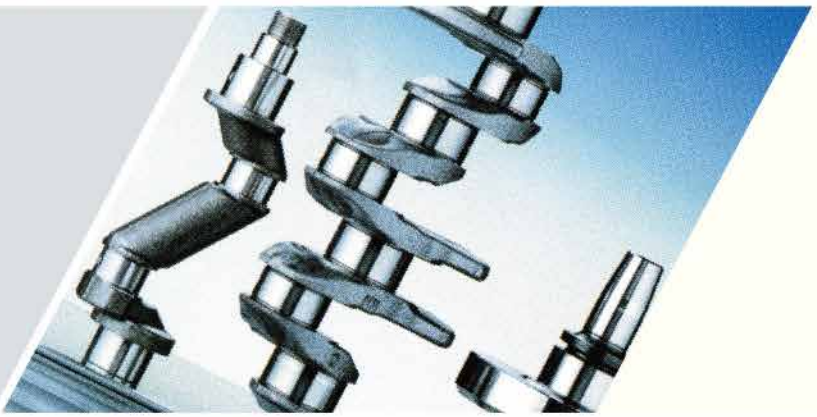


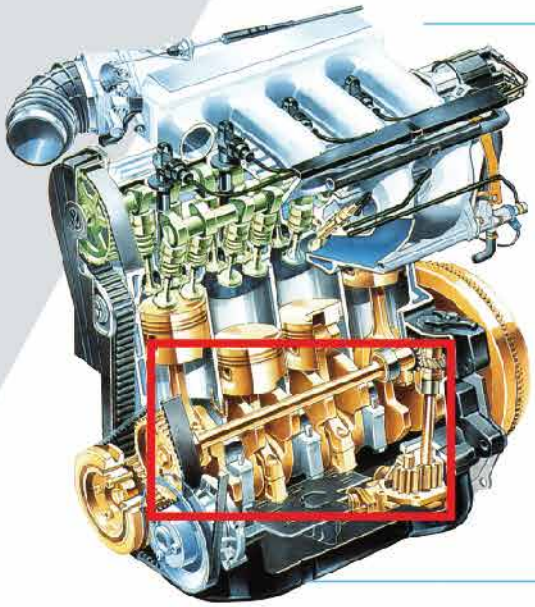
(P37-38)
Connecting Rod

(P25-29)
Crankshaft

Crankshaft

Engine





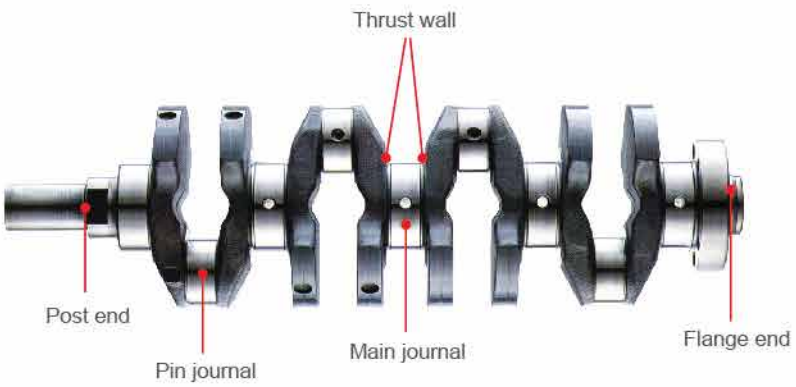
Crankshaft is the power source of engine, an important part transmitting the combustion-generated energy to the transmission system under high heat and mechanical loads. Surface quality and precision are critical for the performance of crankshaft and the engine.

The latest trend

Crankshaft is expected to stand increasingly tough working conditions because of demand for higher dynamic performance and engine compactness; accordingly crankshaft manufacturers have to improve wear resistance, quality and stability of their products. Such improvements call for better steelmaking process, adoption of new materials with higher strength and entirely new quenching and grinding techniques.

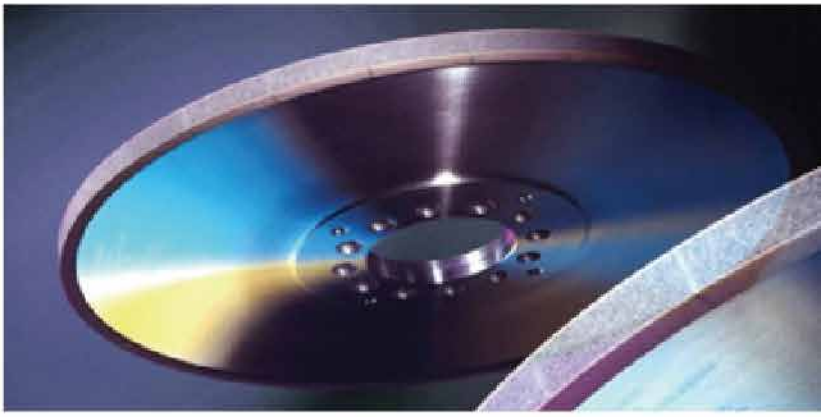
Grinding position

Post end, main journal, flange end, thrust wall and pin journal.



Solutions to mass production of crankshaft

With more automotive and parts manufacturers adopting numerical-control CNC grinding machines, speed, efficiency and life of grinding wheels face much severer requirements. Vitrified CBN grinding wheels can live up to such high standards with considerable material removal, less burns and cracks. They are especially suitable for ultra-high cylindrical grinding (crankshaft, camshaft etc).

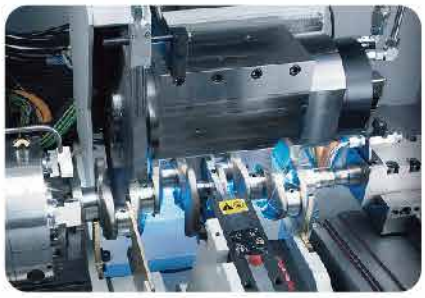


WINTER N7 CRANK

Availability

Vitrified Bond CBN Grinding Wheel

- Grain: CBN
- Diameter: 500~700mm
- Grit: FEPA B126-B181
- Hardness: H~J
- Bond: VSS, N7



Main Journal (Diesel Engine)

Application	
Workpiece	Crankshaft(Diesel engine): side wall Ø 90.4 mm /journal diameter Ø 74 mm
Material	42CrMoA, HRC 52-58
Machine	NAXOS UNION
Grinding portion	Side wall, radii and diameter
Grinding method	Plunge grinding
Coolant	Oil
Grinding wheel	WINTER N7 1VG1L1 650-39.6-6-3.5 B151
Dresser	CNC plated diamond roller dresserr SG 71P – 150 – 1.2
Grinding parameters	Grinding speed (m/s) v_c = 95 Stock removal (mm): diameter a_e= Ø 1.2 thrust wall: a_e= Ø 0.5 Max. infeed rate (mm/min) v_{fa} = 20
Dressing parameters	Wheel speed (m/s) v_{cd} = 95 Roller dresser speed (m/s) v_R = 85 Dressing amounts (µm) a_{ed} = 15 * 2 + 1 * 2 Speed ratio q_d = + 0.89
Results	Q'wmax (mm³ / mm s) = 94.7 Grinding time (min) tg = 10 (40% efficiency increase) Dressing interval mT = 210 journals / dress (50% life increase) Surface finish (um) Rz < 4.5

Main & Pin Journal (Car Engine)

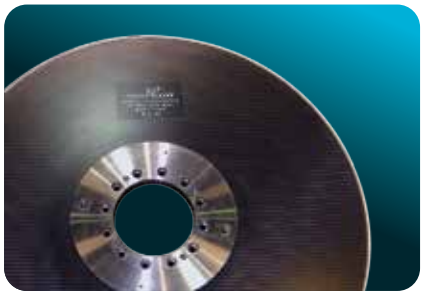
Application	
Workpiece	Crankshaft of car engine : main journal Ø52 mm, pin journal Ø48 mm
Material	38MnV , HRC 48 – 52
Machine	Landis, two spindles
Grinding portion	Diameter of journal
Grinding method	Chase plunge grinding
Coolant	Oil
Grinding wheel	WINTER N7 14A1-600-19,45-5 H140 B151
Dresser	CNC plated diamond roller dresser SG 71P – 120 – 0.6
Grinding parameters	Grinding speed (m/s) v_c = 95 Stock removal (mm) a_e= Ø 0.6
Dressing parameters	Wheel speed (m/s) v_{cd} = 85 Roller dresser speed (m/s) v_R = 54 Dressing amounts (µm) a_{ed} = 2 * 4 + 1 * 2 Speed ratio q_d = + 0.63
Results	Q'wmax (mm³ / mm s) = 8.2 Grinding time (s) tg = 206 Dressing interval mT = 3600 journals/ dress (100% life increase) Surface finish (um) Rz < 4.5

Thrust Wall

Application	
Workpiece	Crankshaft (car engine)
Material	QT-700 , HB 240-290
Machine	Junker
Grinding portion	Thrust wall
Grinding method	Plunge grinding
Coolant	Synthetics
Grinding wheel	WINTER N7 3VG700-500-12-5-2S 76 B126
Dresser	CNC plated diamond roller dresser SG71P-110-20.3
Grinding parameters	Grinding speed (m/s) v_c = 100 Stock removal (mm) a_e= 0.3
Dressing parameters	Wheel speed (m/s) v_{cd} = 100 Roller dresser speed (m/s) v_R = 54 Dressing amounts (µm) a_{ed} = 2 * 3 Speed ratio q_d = + 0.54
Results	Q'wmax (mm^3 / mm s) = 48.9 Grinding time (s) tg = 90 Dressing interval mT = 200 crankshaft / dress (50% life increase) Surface finish (um) Ra < 0.4

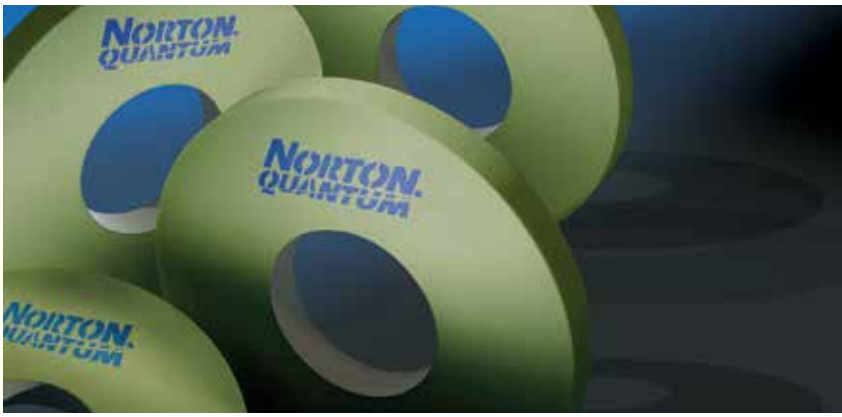
Flange and Post End (Car Engine)

Application	
Workpiece	Crankshaft(car engine) max. diameter Ø 80 mm
Material	38MnV, HRC 48-52
Machine	NAXOS UNION
Grinding portion	Diameter, side wall, radii
Grinding method	Angular plunge grinding
Coolant	Oil
Grinding wheel	WINTER N7 1VG700-600-64.5-6 H132 B107
Dresser	CNC plated diamond roller dresser SG71P-155-0.8
Grinding parameters	Grinding speed (m/s) v_c = 94 Stock removal(mm): diameter a_e = Ø 0.6, side wall a_e= 0.3
Dressing parameters	Wheel speed (m/s) v_{cd} = 94 Roller dresser speed (m/s) v_R = 81 Dressing amounts (µm) a_{ed} = 4 * 3 + 2 * 2 Speed ratio q_d = + 0.86
Results	Q'wmax (mm^3 / mm s) = 83.7 Grinding time (s) tg = 60 Dressing interval mT = 500 crankshafts / dress (60% life increase) Surface finish (um) Rz < 4.0 – 6.0



Solutions to small and medium -volume production of crankshaft

Bonded Abrasives are extensively applied to small- and medium-volume production of crankshafts and camshafts. In addition to common corundum, Saint-Gobain Abrasives provides a variety of new ceramic grains grinding wheels, such as SG, Quantum.



Main Journal

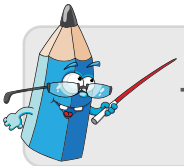
Application		
Machine	Landis, Toyoda, Naxos, Hubei Xiaogan	
Material	Nodular cast Iron：QT800	Cast steel: 40CrNiMo
Hardness	QT800: HB250-320	40CrNiMo: HRC30-48
Stock removal (mm)	Rough: 0.8-1.0 (dia), 0.25 (face)	Finish: 0.2-0.4 (dia)
Surface finish requirement (um)	Rough: Ra 1.5-2.0	Finish: Ra 0.25-0.6
Grinding wheel (mm)	915/1065x47-83x304.8	3NQS60-MVH
Wheel speed (m/s)	45-63	
Other technical outputs	No Burns	Cylindricity < 0.005mm

Pin Journal

Application		
Machine	Toyoda, Naxos Union	
Material	Nodular cast Iron-QT800	Cast steel: 40CrNiMo
Hardness	QT800: HB250-320	40CrNiMo: HRC40-60
Stock removal (mm)	0.3-0.7 (dia)	0.2-0.3 (face)
Surface finish requirement (um)	Ra 0.6-0.8	
Grinding wheel (mm)	1067x25x304.8	3NQS60-LVH
Wheel speed (m/s)	45-63	
Other technical outputs	No Burns	Cylindricity < 0.005mm

Post/Flange End

Application		
Machine	Toyoda, Landis, Shanghai, Beijing No.2	
Material	Nodular cast Iron-QT800	Cast steel: 40CrNiMo
Hardness	QT800: HB250-320	40CrNiMo: HRC30-48
Stock removal (mm)	0.2-0.5 (dia), 0.1-0.4 (face)	
Surface finish requirement (um)	Ra 0.25-0.75 (dia)	Ra 1.25-1.6 (face)
Grinding wheel (mm)	750x50x304.8	1NQS54/80-LVH
Wheel speed (m/s)	35-63	
Other technical outputs	No Burns	Cylindricity < 0.005mm



Tip

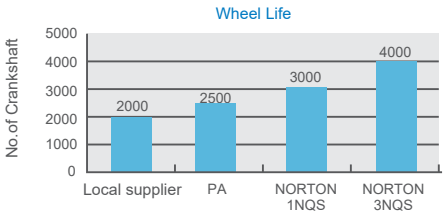
As a critical part that converts heat output to rotating mechanical energy, crankshaft works under high temperature and high mechanical load and needs to minimize energy loss. Therefore, crankshaft should be made of materials with higher wear resistance and calls for suitable tools to perform precision machining.

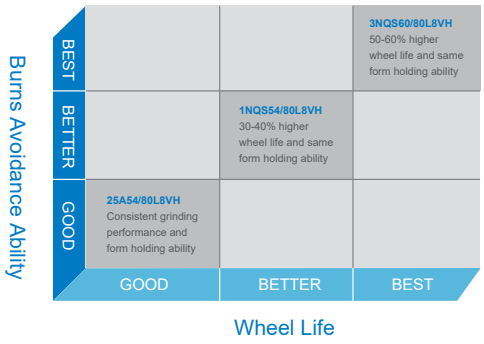
Availability

Vitrified Grinding Wheel

- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 750~1250mm
- Grit: P46 (Roughing)~80 (Semi-Finishing)
- Grade: H (Soft)~N (Mid)
- Bond: VS & VH

Dual zones: As required Sandwich: As required





Diamond Dressing Tools

Bonded abrasives in use needs to be dressed on a regular basis. Saint-Gobain Abrasives provides a full range of diamond dressing tools to work with bonded abrasives, so as to ensure consistency of dressing effect and achieving precision machining on work-piece.

★ To dress vitrified grinding wheels used in pin and main journal

1、WINTER Fliese® stationary dresser

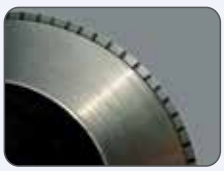
5TFAS115-20-15-36*D1001 T645 J

- **Benefits**: - longer dresser life
  - better dressing consistency

2、 WINTER diamond sinter roller

TS/TSW

- **Benefits:** - higher dressing efficiency and precision
  - longer dresser life
  - especially suitable for dressing of high-speed CNC grinding machines in large quantities



★ To dress vitrified grinding wheels used in post and flange end

1、WINTER D35/D25 series Fliese® stationary dresser

3584-OC/4 & 2585/4

Made of artificial strip CVD/MKD diamond

- **Benefits**: - better dressing consistency
  - longer dresser life

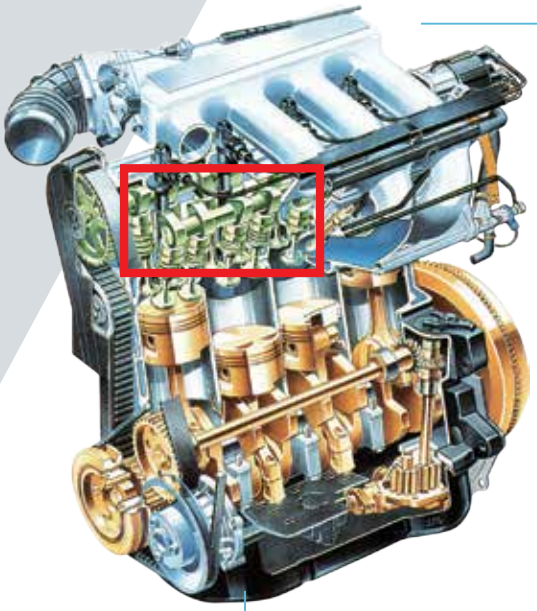
2、 WINTER single-point profile dresser

Made of high-grade natural diamond

- **Benefits:** - high strength
  - high wear resistance
  - extended dresser life

Camshaft

Engine



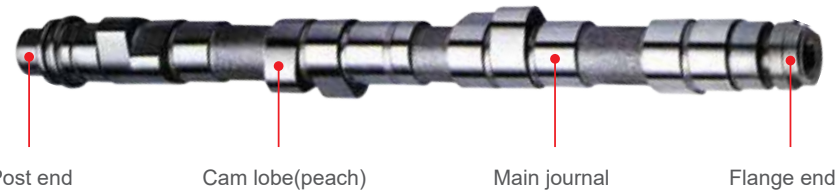
Camshaft serves to control the opening and closing of valve. Reduction of engine vibration is closely relevant to its precision. Camshaft is a cylindrical rod and of the same length as the cylinder assembly, with cams installed on it to drive the valve. One end of the camshaft is the supporting point of the bearing, while the other one connects with driving wheel.

The latest trend

Overhead camshaft (OHC) is widely used in new model engines. Such structure enables higher design flexibility of placing the valve, ignition system and air intake/outlet, speed and compactness of engine will also be effectively improved. This design necessitates better grinding quality.

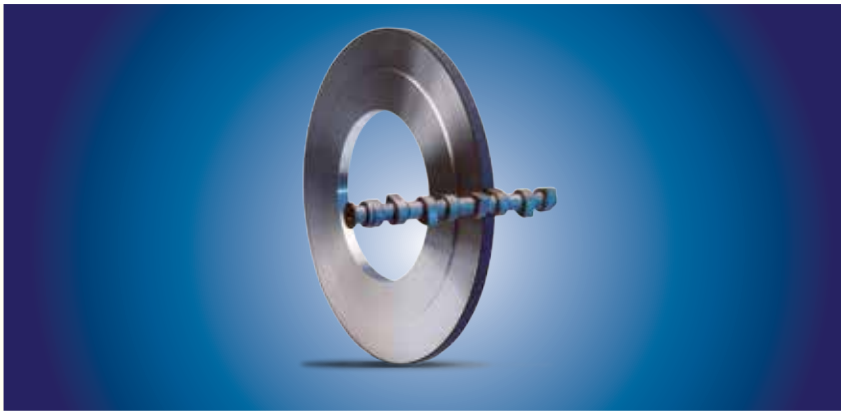
Grinding position

Post & flange end, cam (peach) and main journal.



Solutions to mass production of camshaft

Vitrified CBN grinding wheels can bring about mass production and high efficiency with considerable metal removal. Burns and cracks also drop strikingly.

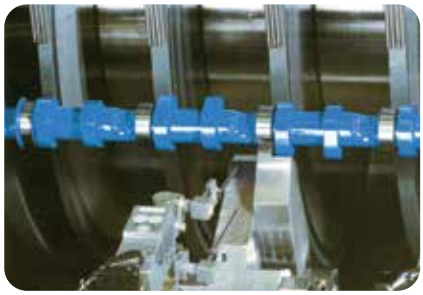


WINTER N7 CAM

Availability

Vitrified Bond CBN Grinding Wheel

- Grain: CBN
- Diameter: 350~500mm
- Grit: FEPA B107-B151
- Hardness: H~J
- Bond: VSS, N7



Cam Lobe

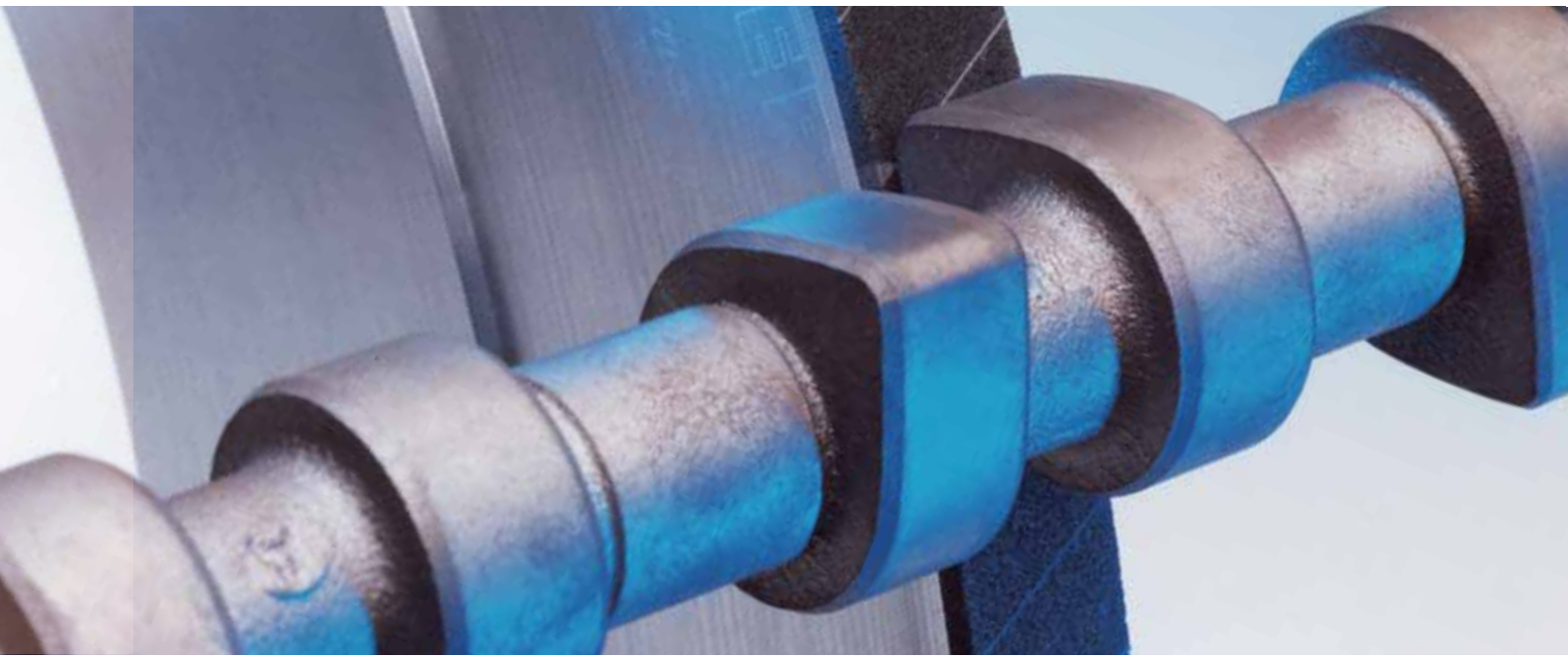
Application	
Workpiece	Camshaft, basic circle Ø 46.8mm
Material	Chilled cast iron HRC 48-52
Machine	Landis LT1
Grinding portion	Camlobe
Grinding method	Chase plunge grinding
Coolant	Oil
Grinding wheel	WINTER 1VG3A1-350-20.5-5 90 B126
Dresser	CNC Sintered diamond roller dresser SD71P-130-1.5-99
Grinding parameters	Grinding speed (m/s) v_c = 100 Stock removal (mm): diameter a_e= Ø 4
Dressing parameters	Grinding speed (m/s) v_{cd} = 100 Roller dresser speed (m/s) v_R = 70 Dressing amounts (µm) a_{ed} = 2 * 3 + 2 * 2 Speed ratio q_d = + 0.70
Results	Q'wmax (mm^3 / mm s) = 147 Grinding time (s) tg = 160 Dressing interval mT = 960 Camlobes / dress (100% life increase) Surface finish (um) Rz < 2.5

Main Journal

Application	
Workpiece	Camshaft: Ø36mm
Material	Chilled cast iron, HRC 48-52
Machine	Landis LT1
Grinding portion	Journal of camshaft
Grinding method	OD grinding
Coolant	Oil
Grinding wheel	WINTER 1VG3A1-350-21.5-5 90 B126
Dresser	CNC plated diamond roller dresser SG 71P – 150 – 0.6
Grinding parameters	Grinding speed (m/s) v_c = 100 Stock removal (mm) a_e= Ø 1.0
Dressing parameters	Grinding speed (m/s) v_{cd} = 100 Roller dresser speed (m/s) v_R = 70 Dressing amounts (µm) a_{ed} = 2 * 3 + 2 * 2 Speed ratio q_d = + 0.70
Results	Q'wmax (mm^3 / mm s) = 5.0 Grinding time (s) tg = 90 Dressing interval mT = 200 Camshaft / dress (100% life increase) Surface finish (um) Rz < 2.5

Flange and Post End

Application	
Workpiece	Camshaft：diameter Ø80 - 44 mm
Material	Chilled cast iron， HRC 48-52
Machine	Landis lund
Grinding portion	Post & flange end
Grinding method	Angular plunge grinding
Coolant	Oil
Grinding wheel	VG 700 - 500 – 24.3 - 5 132 B 126
Dresser	CNC plated diamond roller dresser 2SG 71P-110-0.85-52
Grinding parameters	Grinding speed (m/s) v_c = 80 Stock removal (mm) : diameter a_e = Ø 1.0, Side wall a_e = 0.5
Dressing parameters	Grinding speed (m/s) v_{cd} = 80 Roller dresser speed (m/s) v_R = 28.8 Dressing amounts (µm) a_{ed} = 3 + 2 Speed ratio q_d = + 0.36
Results	Q'wmax (mm^3 / mm s) = 50.3 Grinding time (s) tg = 54 Dressing interval mT = 350 Camshafts / dress (100% life increase) Surface finish (um) Ra < 0.4 um



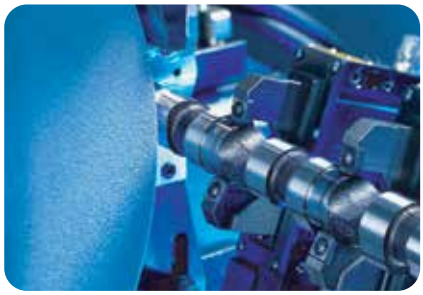
Solutions to small and medium -volume production of camshaft

Saint-Gobain Abrasives provides different vitrified grinding wheels covering from conventional white corundum, monocrystalline corundum to SG and Quantum new ceramic alumina. These products are essential for small and medium-volume production.

Main Journal

Application	
Machine	Junker, Toyota, Landis
Material	Nodular cast Iron-QT700-2, 20Mn,20CrMnTi
Hardness	QT700-2: HB225~305
	20Mn: ＜HB197(no heat treatment)
	20CrMnTi: 56~62HRC
Stock removal (mm)	Rough: 0.6-0.8 (dia)
	Finish: 0.1-0.2 (dia)
Surface finish requirement (um)	Rough: Ra 0.25~0.6
Grinding wheel (mm)	606x19x304.8　1NQS60-MVH
Wheel speed (m/s)	35-60
Other technical outputs	No step and burns
	Good profile

Cam Lobe



Application	
Machine	Junker, Toyota, Landis
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Hardness	QT700-2: HB225~305
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	20CrMnTi: 56~62HRC
Stock removal (mm)	Rough: 0.6-0.8 (dia)
	Finish: 0.1-0.2 (dia)
Surface finish requirement (um)	Rough: Ra 0.25~0.6
Grinding wheel (mm)	606x19x304.8　1NQS60-MVH
Wheel speed (m/s)	35-60
Other technical outputs	No step and burns
	Good profile

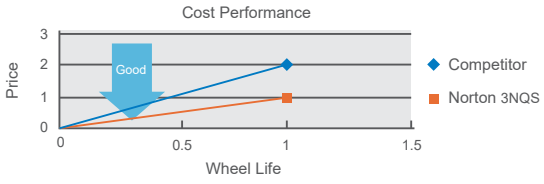
Tip

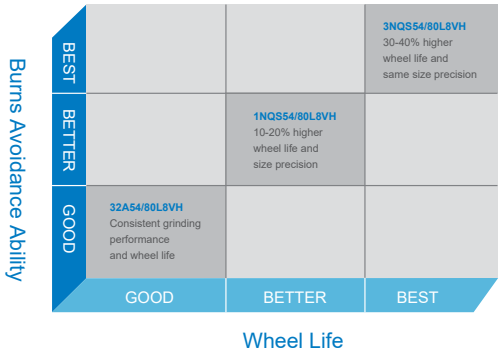
Precision of camshaft determines whether engines run in a smooth and reliable way. Therefore, it is a must that precision of camshafts should be maximized. This can be achieved through the use of high-precision and quality abrasives products.

Availability

Vitrified Grinding Wheel

- Grain: Quantum，32A, 57A, 38A, 25A and blended abrasives
- Diameter: 606~915mm
- Grit: P54 (Roughing)~ 80 (Semi-Finishing)
- Grade: J (Mid)~N (Mid)
- Bond: VS & VH





Diamond Dressing Tools

★ To dress vitrified grinding wheels used in camshaft

1、WINTER Fliese® stationary dresser

3TFAS115-20-15-36*D1001 T645 J

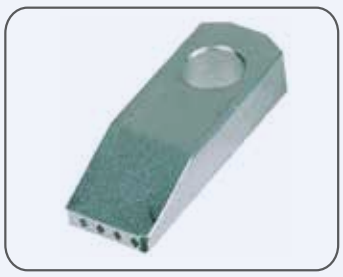
- **Benefits：** - longer life
  - better dressing consistency

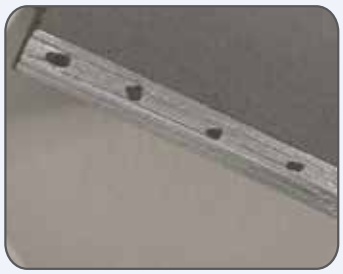
2、WINTER D30 Fliese® stationary dresser

3084 /2 & 3084/3

Made of artificial strip CVD diamond

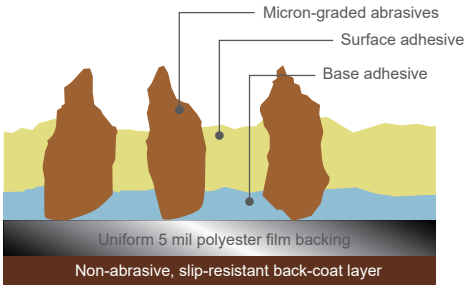
- **Benefits：** - better dressing consistency
  - extended dresser life





The new finishing solutions for polishing precision parts

Premium, heat-treated aluminum oxide grain, and unique coating and backing technology are specifically designed for precision microfinishing film applications delivering high material removal and exceptional finish.



Crankshaft Micro-finishing

Part to polish	Main journal
Material	Cast iron
Coolant	Water-based coolant
Product	Q351 40mic
Work speed (rpm)	190
Oscillation frequency (times/min)	120

Tooling	Urethane
Hardness of tooling	80D
Finishing time (s)	20
Ra before (um)	0.6
Ra after (um)	0.18

NORTON Finiup

Availability

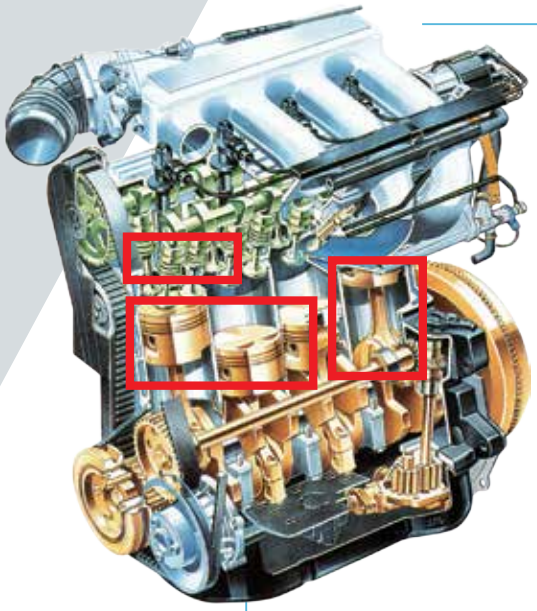
Norton Q351 Film

Grit range/abrasive: 9-80 micron aluminum oxide
Roll widths: 14” and less
Roll length: Maximum 900’
Microstructure: See illustrations at left
Key applications: Camshafts, crankshafts, vehicle axles etc.

Features	Benefits
Application of polyester film backing	Higher tensile strength; can be used for water and oil coolant without deformation; better geometric tolerance obtained
Use of micron-sized grains	Better surface finishing after machining, no unexpected scratches
Use of static flocking	Higher grinding efficiency

Connecting Rod, Spring, Piston Ring

Engine



Connecting rod serves to connect the piston and crankshaft in the engine so as to convert linear movement into rotating movement.

Made of spring steel, **Spring** is a mechanical part that operates with the aid of its own elasticity, and works to control mechanical parts movement, reduce impact and vibration, and store energy.

Piston ring is a split ring mounted on the external groove of piston in reciprocating engine, and mainly responsible for sealing, transferring of heat from piston to cylinder wall, and controlling of engine oil consumption.

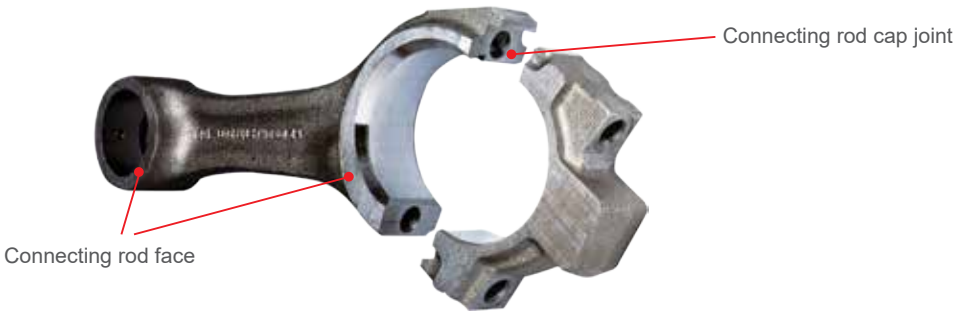
The latest trend

Connecting rod must bear bending and deformation caused by thrust and tension when working. In order to reduce wear, connecting rod must use lightweight material with high strength. Surface grinding finishing is another essential factor to improve the durability.

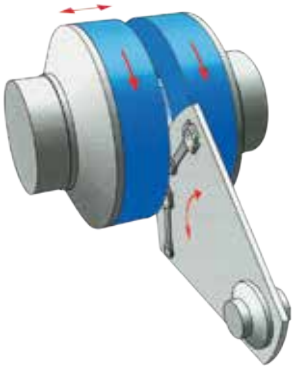
Enhanced wear resistance is requisite for piston ring to reduce loss. Most modernized engines have optimal piston rings with one-layer chromium plated, where contains aluminum oxide or diamond particles.

Grinding position

Connecting rod face and **connecting rod cap joint.**

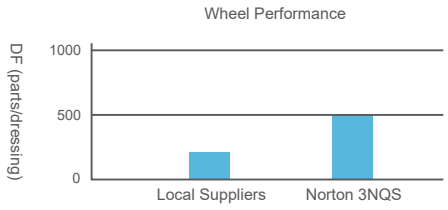


Grinding solutions for connecting rod, spring, piston ring



Connecting Rod

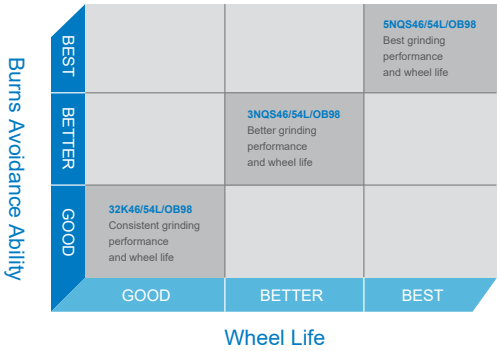
Application	
Machine	Guistina, Shandong machine works
Material	Nodular cast Iron,45#, 40Cr,40CrMo
Hardness	210-280HB
Stock removal (mm)	Rough: 0.4-0.5 (dia)
	Finish: 0.2-0.4 (dia)
Surface finish requirement	Rough: Ra 0.8
Grinding wheel (mm)	915x85x304.8
Wheel speed (m/s)	35
Other technical outputs	No burns
	Parallelism



Availability

Double Disc Grinding Wheel

- Grain: Quantum, 32A, 57A, 38Aand blended abrasives
- Diameter: 500~915mm
- Grit: P36 (Roughing) ~ 400 (Finishing)
- Grade: E (Soft) ~Q(Hard)
- Bond: B98, B81, B60



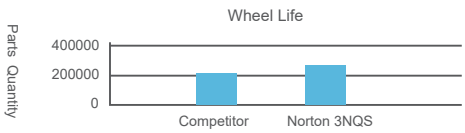
Spring

Application	
Machine	Taihei Japan, local grinding machine
Material	Carbon steel, stainless steel
Hardness	Carbon steel: 530-645HV SS: 30-40HRC
Stock removal (mm)	CS: 2.8 (both)
	SS: 3.2 (both)
Surface finish requirement	Rough: Ra3.2
Grinding wheel (mm)	660x75x150
Wheel speed (m/s)	35
Other technical outputs	No burns

Availability

Double Disc Grinding Wheel

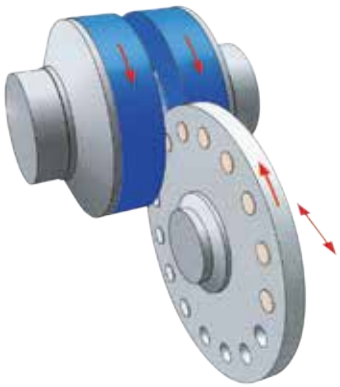
- Grain: Quantum, 37C, 39C and blended abrasives
  (Roughing: 2NQAC24Q22B98，Finishing: 3NQS30M22B98)
- Diameter: 350 ~ 750mm
- Grit: P24 (Roughing) ~ 400 (Finishing)
- Grade: E (Soft) ~ Q(Hard)
- Bond: B98



Tip

Norton B18 and B60 organic bonds are suitable for most grinding applications. Its hardness and porosity make it ideal for high in-feed double disc processing, such as for springs and piston rings.

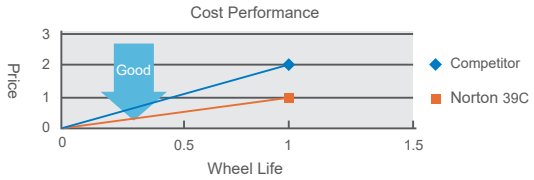
Application	
Machine	Nissei, Shanghai grinding machine
Material	Cast iron, stainless steel
Hardness	Cast iron: 91-108HRB SS: 400-580HV
Stock removal (mm)	Rough: 0.05-0.08 (both)
	Finish: 0.005-0.015 (both)
Surface finish requirement	Rough: Ra<3.2
Grinding wheel (mm)	585x75x195
Wheel speed (m/s)	35
Other technical outputs	No burns & scratches
	Parallelism

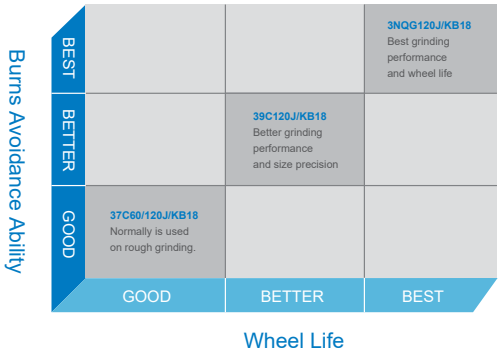


Availability

Double Disc Grinding Wheel

- Grain: Quantum, 37C, 39C and blended abrasives
- Diameter: 500~ 915mm
- Grit: P36 (Roughing) ~ 400 (Finishing)
- Grade: E (Soft) ~ Q(Hard)
- Bond: B18, B60





Tip

Piston ring moves back and forth in the cylinder powered by its own load and gas load, which constitutes the main cause of piston ring wear. To reduce such wear, piston rings are usually made of wear-resistance materials, such as cast iron and high strength steel. Double disc grinding can do large-volume processing on the surface of piston rings.

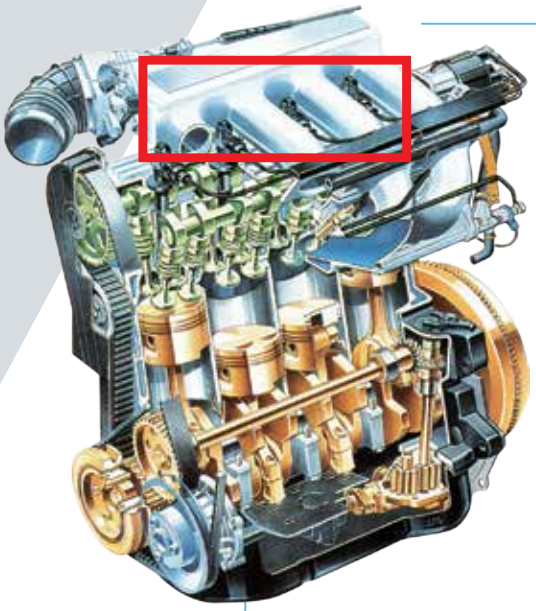
★ Dressing of double disc grinding wheels

1、 WINTER diamond sinter roller

Benefits: - more desirable size and profile precision
- higher dressing consistency & efficiency
- longer roller life
- accurate dressing monitoring
- reduced wear of grinding wheel

Cylinder Block & Head

Engine



Cylinder block, usually made of gray cast iron, vermicular cast iron or aluminum alloy, is designed based on the need of cylinder to bear substantial loads, friction, vibration during the operating process of engine. Cylinder block together with crankshaft, connecting rod, piston and camshaft forms a complete engine system through precision connection. Cylinder head is located on the top of cylinder block, which helps to create an internal combustion chamber platform housing the combustion chamber, valve and spark plug. As the essential part of engine, cylinder block & head are directly related to the volume and compression ratio.

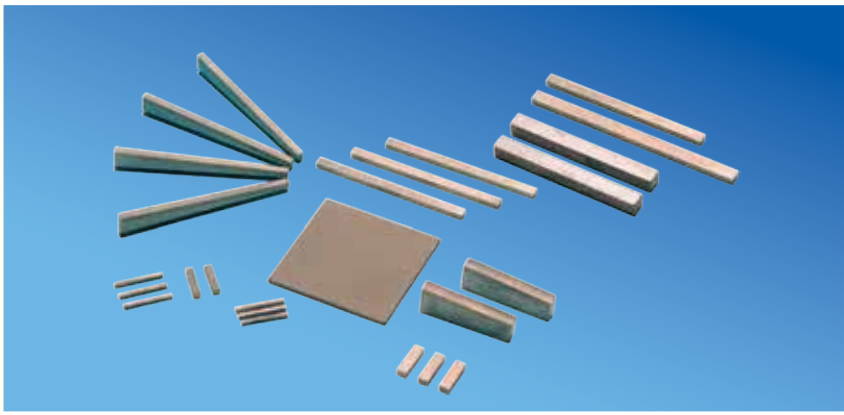
The latest trend

As the requirements for weight, power, displacement, oil consumption and other indicators of auto engine are increasingly strict, the cylinder block & head have to bear more mechanical loads. Therefore, high precision grinding is required to achieve higher shape accuracy and better surface quality.

Grinding position

Bore hole and **bushing block**.

Grinding solutions for cylinder block/head honing



Bore Hole Honing

Application	
Machine	Gehring, Nagel
Material	Gray cast iron
Abrasives	Honing stick
Stock removal (um)	≤80
Surface finish requirement (um)	Ra 0.2-1
Coolant	Honing Oil
Other technical outputs	Aperture, roundness, surface roughness, waviness and other indicators in compliance with requirements

Common Honing Problems & Solutions

	Selection of honing products			
Problem description	Abrasive fragility	Grit	Hardness	Structure No.
Honing stick sliding & scratching	Increased	Reduced	Reduced	Open
Honing stick clogging		Reduced	Reduced	Dense
Workpiece surface too rough		Increased	Increased	Dense
Workpiece surface too smooth		Reduced	Reduced	Open
Short service life of honing stick	Reduced		Increased	Dense
Low MRR	Increased	Reduced	Reduced	Open

	Grinding machine setting			
Problem description	In-feed pressure	Oscillation rate	Workpiece revolution speed	Coolant
Honing stick sliding & scratching	Increased	Increased	Reduced	Clean
Honing stick clogging	Increased	Increased	Reduced	Clean
Workpiece surface too rough	Reduced	Reduced	Increased	
Workpiece surface too smooth	Increased	Increased	Reduced	Clean
Short service life of honing stick	Reduced	Reduced	Increased	
Low MRR	Increased	Increased	Reduced	Clean

Availability

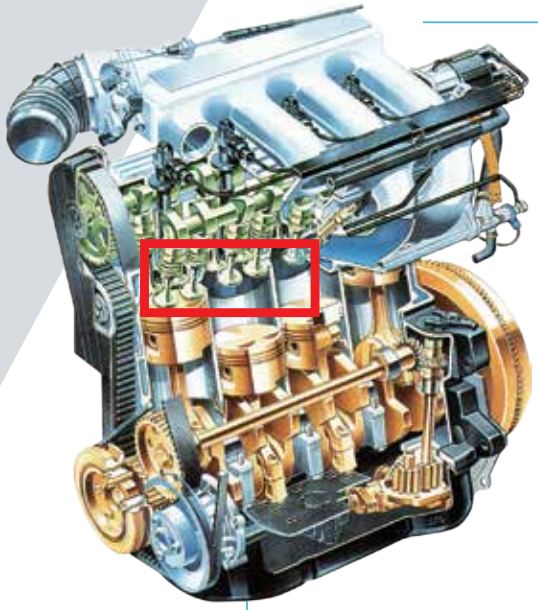
Honing Stick

- Grain: 38A, 37C, 39C, blended abrasives of SG&39C
- Dimension (mm): thickness:1.5-45, width: 2-60, length: 6-160
- Grit: P60(rough) ~ 500(ultra fine)
- Grade: A-R
- Bond: V and VEA
- Treatment method: waxing or sulfurizing

Apart from conventional abrasives, Saint-Gobain Abrasives also provides high precision honing products made of diamond and CBN grain to bring you higher efficiency in mass production of bore holes, large and small fillets of connecting rod and internal gear holes. (For more details, please visit our website)

Valve

Engine



Made of durable and hard material, valve is specially designed to fill the engine with fuel and emit exhaust. It is structurally classified into intake and exhaust valves. Precision grinding of valve seat and groove is challenging, while high precision requires to secure ability to bear extreme heat and mechanical loads generated by the opening and closing of cylinder.

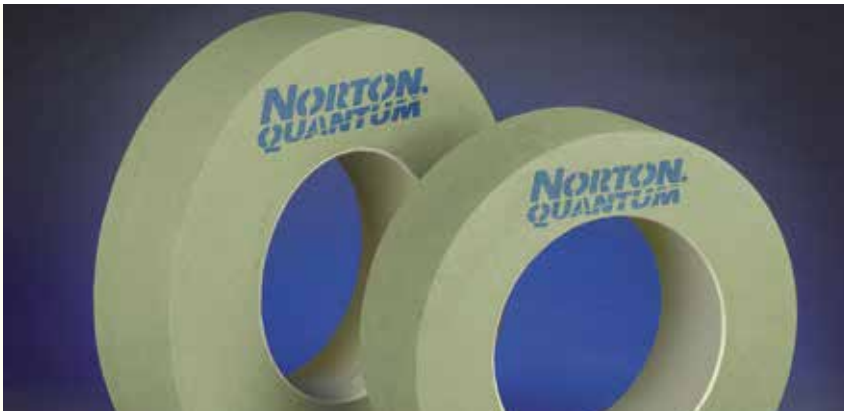
The latest trend

For traditional engines, each cylinder has only one intake valve and one exhaust valve, featuring relative simple structure and low cost. Today, multi-valve technology is adopted by most of manufacturers to increase intake and exhaust efficiency. Besides, high pressure and temperature caused under cyclic loads may lead to more wear of valves. Therefore, the use of wear resistance materials and exact dimension can help extend valve life. As high temperature nickel base alloys are widely used in valve manufacturing, high efficiency and precision wheels are prerequisite for grinding such special materials.

Grinding position

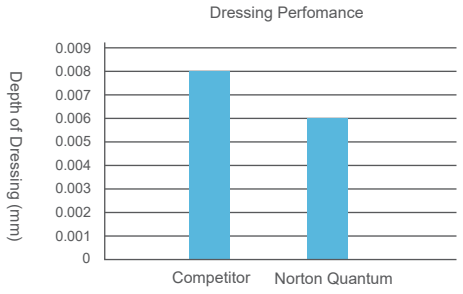
Profile grinding of **cone**, centerless grinding of **rod,** double disc grinding of **seat ring** and grinding of **raceway** etc.

Grinding solutions for valve



Valve

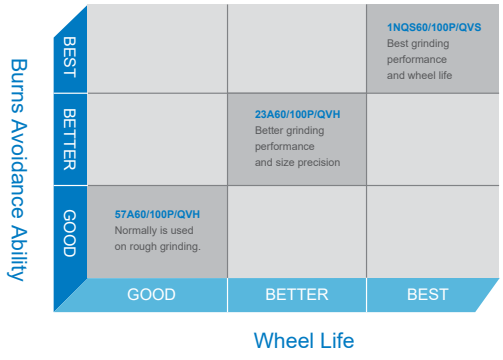
Application	
Machine	Wuxi, Shanghai machine works
Material	Cr alloy, Ni alloy
Hardness	Carbon steel: 37 - 43HRC
Stock removal (mm)	0.1-0.3
Surface finish requirement	Rough: Ra 0.16 - 0.3
Grinding wheel (mm)	610x125x304.8 / 508x19.1x203.2
Wheel speed (m/s)	50-60
Other technical outputs	No burns



Availability

Vitrified Grinding Wheel

- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 500~ 610mm
- Grit: P60 (Roughing) ~ 100 (Semi-Finishing)
- Grade: K (Mid) ~ Q(Hard)
- Bond: VH, V127



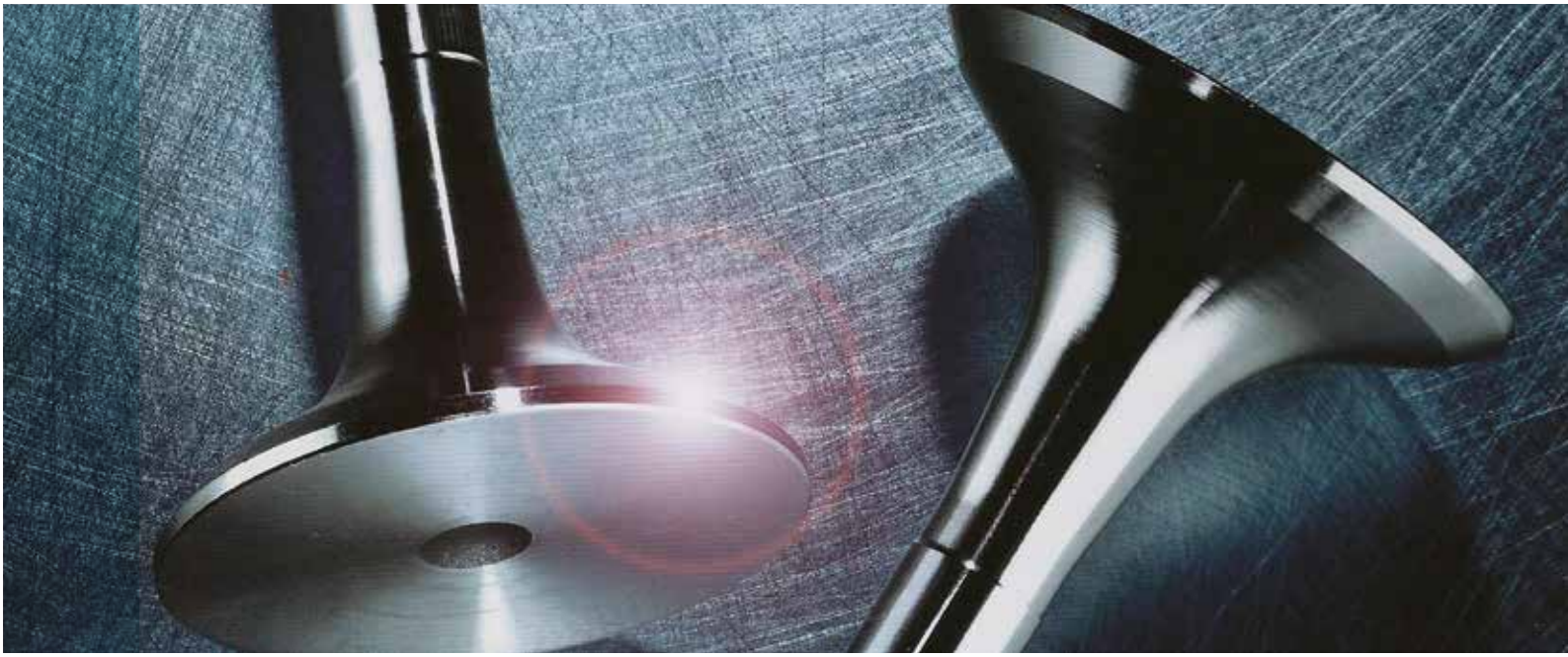
Valve Neck

Application	
Workpiece	Valve
Material	100Cr6, HRC 40
Machine	Tacchella
Grinding portion	Neck
Grinding method	Profile grinding
Coolant	Oil
Grinding wheel	WINTER SH700-500-28 *B181 G950 S33
Grinding parameters	Wheel speed (m/s) v_c = 150 Stock removal (mm) a_e = Ø 1.0 Q'wmax (mm^3 / mm s) = 75 Grinding time (s) tg = 8
Results	Wheel life mT = more than 100,000 valves

Availability

Electroplated Bond CBN Grinding Wheel

- Grain: CBN
- Grit: FEPA B151-B213
- Diameter: 300~500mm
- Bond: Electroplated

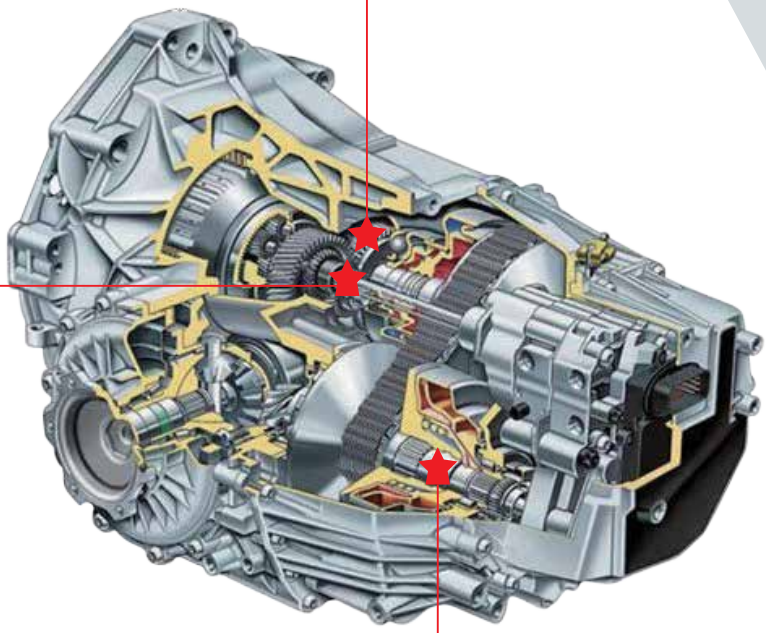


Gearbox mainly consists of gear, gear shaft and transmission shaft. It primarily functions as a device to provide driving force by transmitting the power generated by the engine to auto's driving wheels, thereby allowing the auto to move at a certain speed. With increasingly severe demand on high precision of drive unit and strict standards on geometric dimension, running stability and noise decibel, it is a must to have work-pieces precisely grinded.

Auto Parts

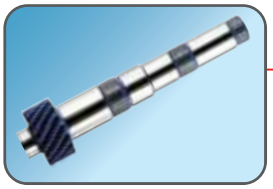
Gearbox

(P47-49)
Gear



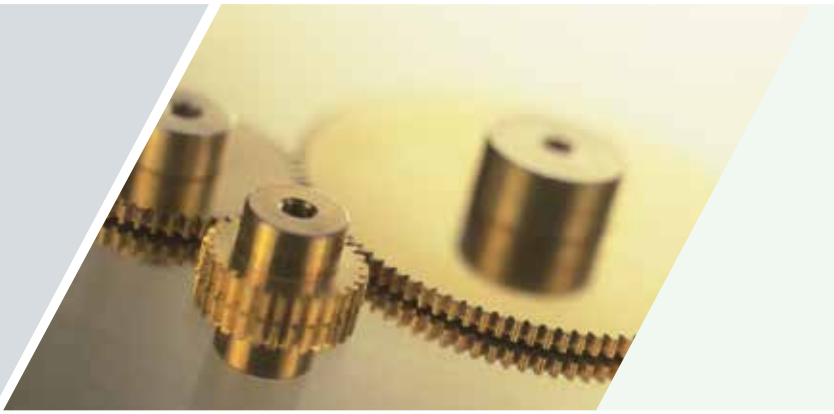
(P53-57)
Gear Shaft

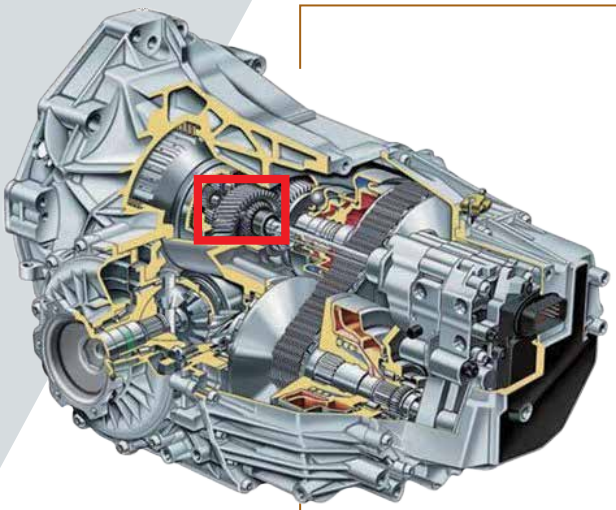
(P51-52)
Transmission Shaft



Gear

Gearbox





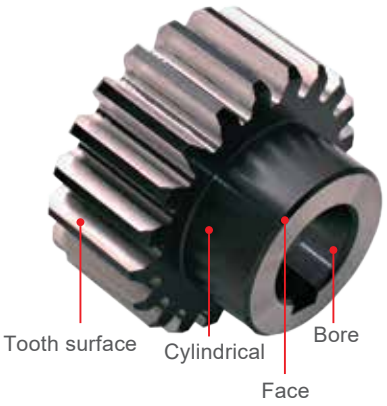
Gear is a critical part for power conversion. Accurate gear geometry and good quality of the tooth surface ensure smooth transmission, and can extend the service life of the gearbox.

The latest trend

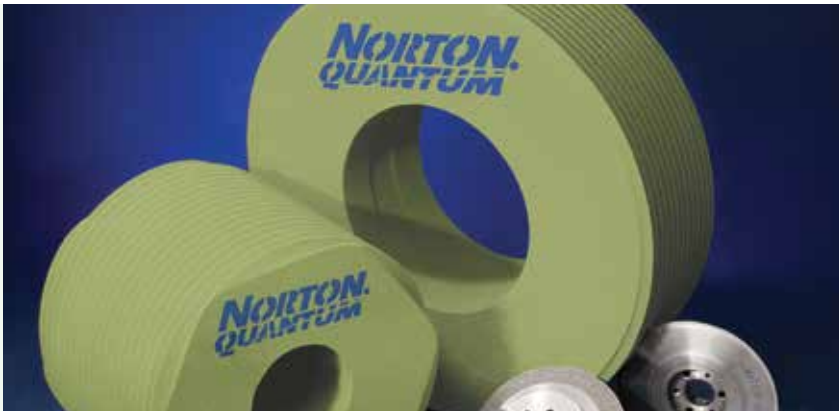
With gear technology making remarkable headway in recent years, processing technology of cutting tools, gear grinding wheels and machines has been enhanced dramatically. Of all these improvements, gear grinding wheel technology directly affects the final accuracy and efficiency of the gear.

Grinding position

Gear bore, cylindrical, face and **tooth surface.**

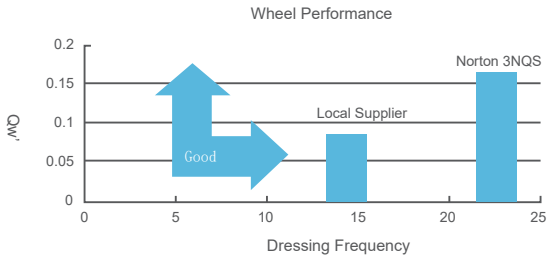


Grinding solutions for gear



Worm Grinding

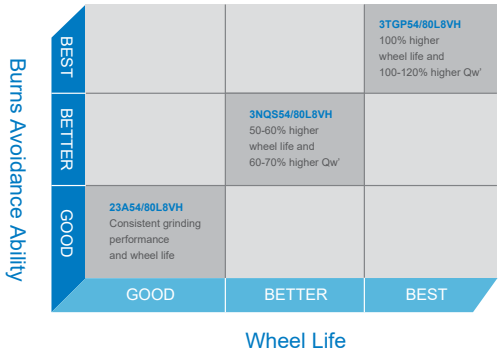
Application	
Machine	Reishauer, Kapp, Liebherr
Material	45#, 40CrNi, 20CrMnTo
Hardness	45#: HB＜350
	40CrNi: HB＞350
	20CrMnTo: HRC48-55
Stock removal (mm)	Rough: 0.4-0.6 (dia)
	Finish: 0.08-0.1 (dia)
Surface finish requirement	Ra 0.32~0.63
Grinding wheel (mm)	280X160X115
	300X125X160
	400X100X203
Wheel speed (m/s)	45-63
Other technical outputs	No burns
	Good profile



Availability

Vitrified Grinding Wheel

- Grain: TG, Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 80 ~ 800mm
- Grit: P36 (Roughing) ~ 280 (Finishing)
- Grade: D (Soft)~O(Mid)
- Bond: VS, VH, V127, VCF2, VXP, VQN，Vitrium^3



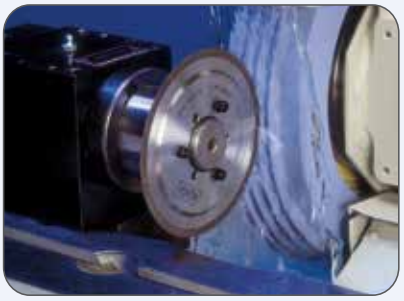
Diamond Dressing Tools

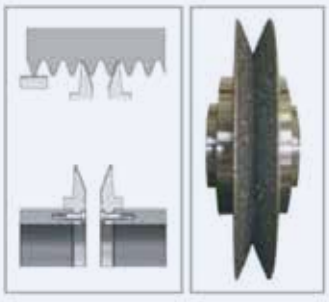
Dressing of Worm Grinding Wheel

★ Single inclined surface diamond roller

WINTER HP electroplated roller

- **Benefits**: - high versatility
  - dress gear grinding wheels with different modulus
  - work in pairs
  - long service life
  - high dressing accuracy and efficiency

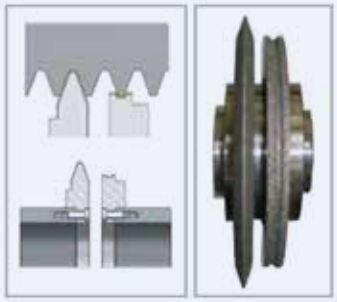




★ Double inclined plane and beveling diamond roller

WINTER HP electroplated roller or VU reverse plated construction (RPC) roller

- **Benefits**: - high dressing accuracy
  - long service life
  - improved dressing efficiency



Single & multi-point diamonds

Diamonds are the first choice where close tolerances, fine finishes, speed and flexibility are required. Since diamond dressing is primarily a machining operation rather than a crushing operation, the surface formed on the wheel is closer than that obtained from mechanical dressers. This results in a slower cutting wheel with better form holding characteristics and superior finish control.

By varying the depth of cut per pass made by the diamond and changing the traverse rate, different wheel surfaces, and hence different cutting actions, can be achieved.

The following are general recommendations for dressing with single-point diamonds.

	Roughing	Finishing
Diamond infeed mm per pass	0,025mm	0,012-0,020mm
Diamond traverse rate mm/wheel rev.	0,18mm	0,10mm

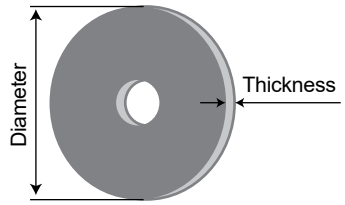
The diamond should always be applied at the centreline of the wheel with a 5°-15° drag angle.

Diamond size

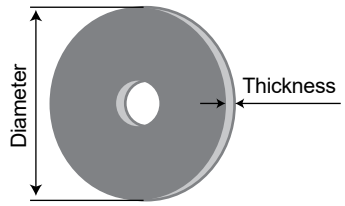
The size of diamond is important when selecting a dressing tool and several factors are relevant in this selection, e.g. large, coarse grit wheels require a larger diamond than smaller, fine grit wheels. If a fine finish is required, the use of a diamond which is too large can adversely affect the finish and cancel the effect of fine grit selection. The trend today is away from single-point dressers and towards multi-point dressers employing a matrix shape to suit the form required.

A useful formula for determining single-point & multi-point diamond size is:

Wheel diameter (mm) x Wheel thickness (mm)

Single-point	Multiply the diameter of the wheel by its thickness	
	Diameter x Thickness (mm)	Carat
	<6000	0,33 Carat
	6000-18000	0,50 Carat
	>18000	1,0 Carat

For best results, always use a coolant when dressing

Multi-point	Multiply the diameter of the wheel by its thickness	
	Diameter x Thickness (mm)	Carat
	<30000	1,3 Carat
	30000-60000	2,5 Carat
	>60000	5,0 Carat

For best results, always use a coolant when dressing

Coolant

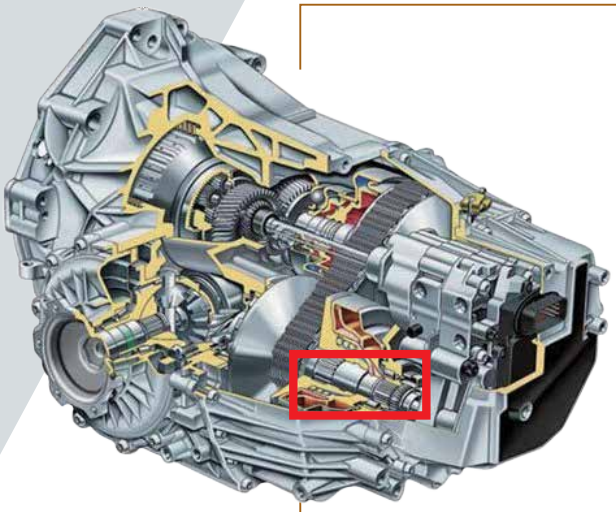
Dressing with diamonds should always be carried out using a copious supply of coolant. The coolant should always be turned on fully before the diamond touches the wheel. The diamond life will deteriorate rapidly if it is allowed to become hot and then cooled rapidly as can be experienced with an intermittent coolant flow.

Rotation of the dressing tool

To ensure maximum diamond life, single-point and conical cluster diamond dressing tools should be systematically rotated after every four or five dressings to ensure that the keen edge generated from the drag angle is constantly presented to the wheel.

Transmission Shaft

Gearbox



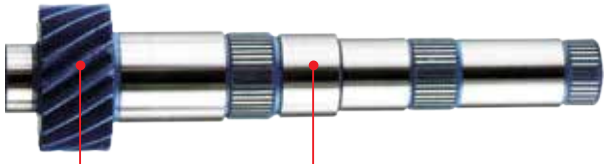
Transmission shaft constitutes a pivotal power transmission component. Combined with the gearbox and driving axle, it transmits power from the engine to the wheels to provide driving force.

The latest trend

With the rapid development of new materials, the accuracy, strength and wear resistance of transmission shaft draw more attentions. Refined grinding of tooth shape and roundness is conducive to improve the performance of the transmission shaft.

Grinding position

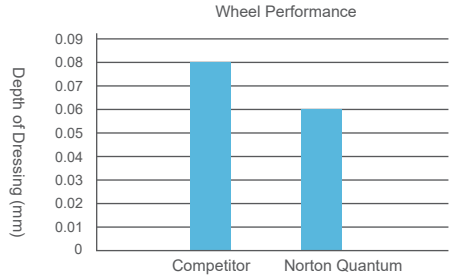
Journal and **tooth profile** of transmission shaft.



Grinding solutions for transmission shaft

Transmission Shaft

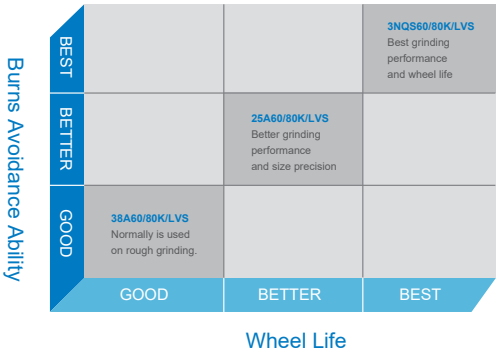
Application	
Machine	Beijing No. 2, Shanghai machine works
Material	42CrMo
Hardness	HRC48 - 55
Stock removal (mm)	OD: 0.1 – 0.3mm（on radius） Face: 0.15mm
Surface finish requirement	Ra 0.8
Grinding wheel (mm)	PDX 750x66x305 PDX 669x44x305
Wheel speed (m/s)	35 or 45
Other technical output	No burns Cylindricity：0.013mm



Availability

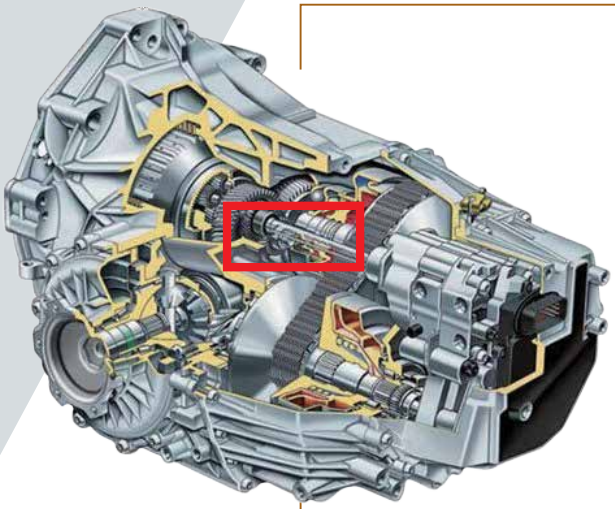
Vitrified Grinding Wheel

- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 610~900mm
- Grit: P46 (Roughing)~80 (Semi-Finishing)
- Grade: J(Mid)~K(Mid)
- Bond: VS



Gear Shaft

Gearbox



Gear shaft is a mechanical component that supports transmission parts and revolves with them to transmit motion, torque or bending moment. It is composed of shaft and gear, is generally metal round rod-shaped, with different diameters. The parts rotating when automotive moving are just mounted on the shaft.

The latest trend

Strength and accuracy of the gear shaft directly affect the automobile performance. WINTER vitrified bond CBN wheel is optimal in grinding hard materials, and can meet the strict tolerance requirements for work-piece surface quality, roundness, flatness and taper.

Grinding position

Journal, raceway, face and **tooth profile** of gear shaft.

High speed grinding solutions for gear shaft

WINTER N7 GEAR

Availability

CBN Grinding Wheel

- Grain: CBN
- Diameter: 350~ 500mm
- Grit: FEPA B126-B151
- Hardness: H~J
- Bond: VSS, N7

Journal

Application	
Workpiece	Gear shaft
Material	16MnCrS5, HRC 58-62
Machine	JUNKER QuickPoint
Grinding portion	Journal of gearshaft
Grinding method	Quickpoint / peel grinding
Coolant	Emulsion
Grinding wheel	WINTER N7 1VG700-350-6-6 127 B126
Dresser	CNC plated diamond roller dresser SG 71P-180-0.4
Grinding parameters	Wheel speed (m/s) v_c = 100 Stock removal (mm): diameter a_e= Ø 0.25~0.3
Dressing parameters	Wheel speed (m/s) v_{cd} = 100 Roller dresser speed (m/s) v_R = 90 Dressing amounts (µm) a_{ed} = 3 * 3 Speed ratio q_d = + 0.90
Results	Q'wmax (mm^3 / mm s) = 80.0 Grinding time (s) tg = 110 Dressing interval mT = 160 gear shaft/ dress (70% increase) Surface finish (um) Rz < 2.0

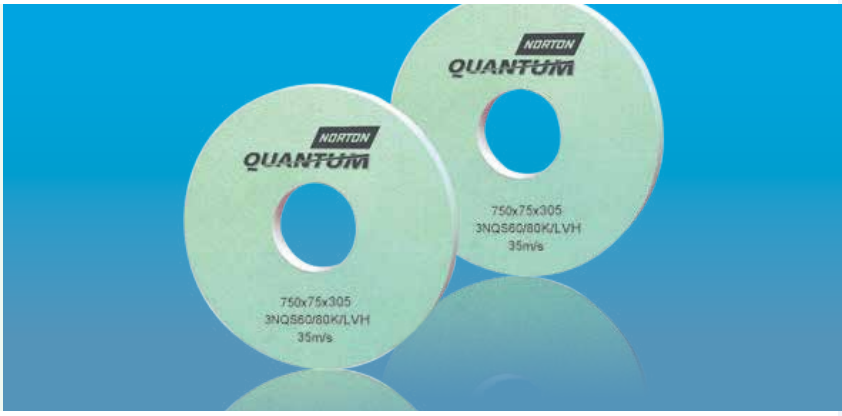
Undercut

Application	
Workpiece	Gear shaft
Material	16 Mn Cr 5, HRC 63
Machine	Overbeck
Grinding portion	Undercut of gear shaft
Grinding method	Profile grinding
Coolant	Oil
Grinding wheel	WINTER HP 400-220 B252 G825 S33
Grinding parameters	Wheel speed (m/s) v_c = 105 Stock removal(mm): diameter a_e= Ø 2.0 Q'wmax (mm^3 / mm s) = 50.0 Grinding time (s) tg = 27
Dressing parameters	Wheel life 100,000 gear shafts/wheel Surface finish (um) Rz < 2.0

Journal of Synchronisation Gear

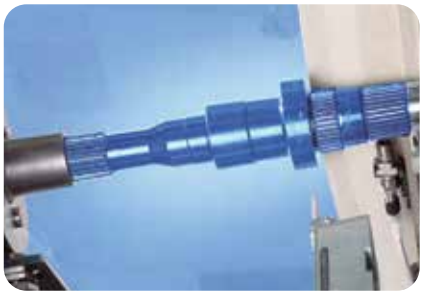
Application	
Workpiece	Synchronisation gear
Material	16MnCrS5，HRC 63
Machine	Buderus
Grinding portion	Taper surface
Grinding method	Plunge grinding
Coolant	Emulsion
Grinding wheel	WINTER N7 3VG3A1-400-12-5 B126
Dresser	CNC plated diamond roller dresser SG71P-100-0,6
Grinding parameters	Wheel speed (m/s) v_c = 80 Stock removal (mm): diameter a_e = Ø 0.4
Dressing parameters	Wheel speed (m/s) v_{cd} = 80 Roller dresser speed (m/s) v_R = 55 Dressing amounts (μm) a_{ed} = 4*2 Speed ratio q_d = + 0.68
Results	Q'wmax (mm^3 / mm s) = 15.0 Dressing interval mT = 300 gears / dress (70% life increase) Surface finish (um) Rz < 2.5

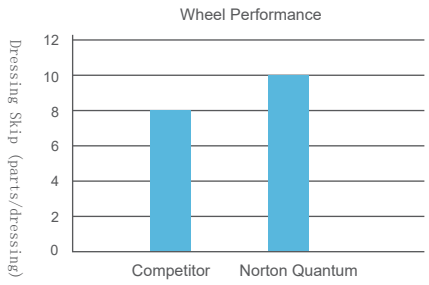
Grinding solutions for gear shaft



Gear Shaft

Application	
Machine	Beijing No.2, Jinan No.4, Shanghai, Wuxi machine works
Material	20CrMoH
Hardness	HRC 58 - 62
Stock removal (mm)	0.1-0.3
Surface finish requirement	Ra 0.8
Grinding wheel (mm)	750x75x305
Wheel speed (m/s)	35
Other technical outputs	No burns

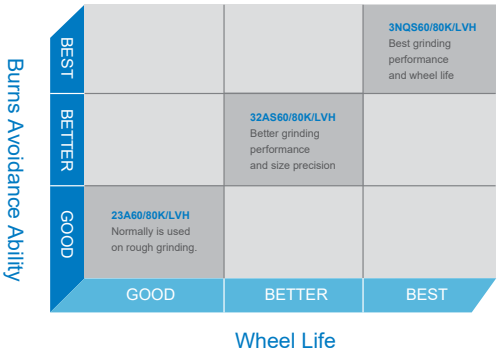




Availability

Vitrified Grinding Wheel

- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 750mm
- Grit: P60 (Roughing) ~ 80 (Semi-Finishing)
- Grade: J(Mid)~M (Mid)
- Bond: VH



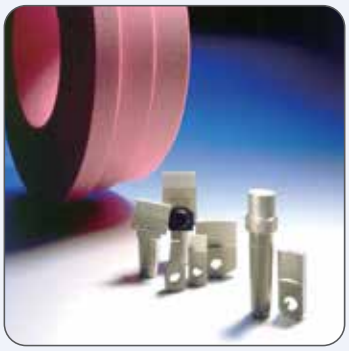
Diamond Dressing Tools

★ To dress vitrified grinding wheel used in gear shaft

1. WINTER Fliese® plate stationary dresser series

D25/D35/HFAS/TFAS

- **Benefits:** - higher dressing consistency
  - increased dressing efficiency
  - extended dresser life



2. WINTER PD dresser series

- **Benefits:** - higher dressing precision
  - longer dresser life

Steering system comprises a series of devices used for changing or keeping auto's traveling or reversing. It is critical to ensure safe driving and with the speed of motor vehicles continuously increased, steering system has an underlying effect on the stability, comfort and durability of the automotive.

Auto Parts

Steering System

(P63-64)
Shock Absorber

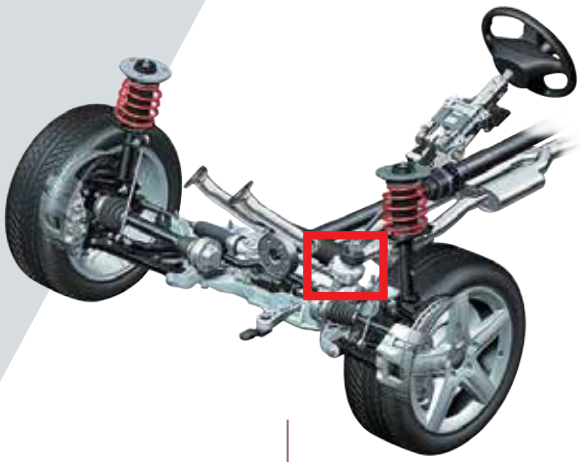
(P65-66)
Steering Rack

(P59-62)
Constant Velocity Joint

(P67-69)
Steering Shaft

Constant Velocity Joint

Steering System



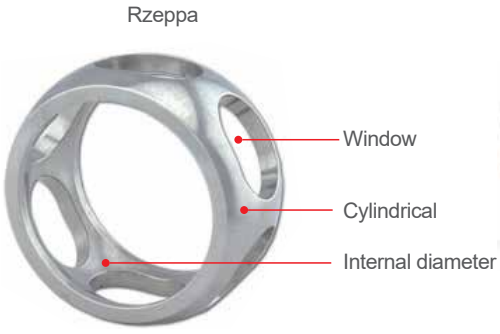
Constant velocity joint uses the rzeppa to realize shaft power output in different directions. Constant velocity joint combined with transmission shaft is called cardan joint steering device. The constant velocity rzeppa cardan joints are commonly used in the automobile.

The latest trend

With continuously improved manufacturing standards of power transmission efficiency, intensity of load and transmission accuracy, grinding tool is required for precision machining during the production of cardan joints, to meet the strict dimensional tolerance requirements.

Grinding position

Cage window, cylindrical, internal diameter, raceway and **bell track**.



High speed grinding solutions for constant velocity joint

WINTER N7 ID

Availability

Vitrified Bond CBN Grinding Wheel

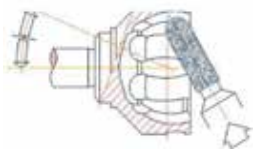
- Grain: CBN
- Diameter: 11~ 20mm
- Grit: FEPA B64-B181
- Hardness: E~H
- Bond: VSS, N7

Bell Track

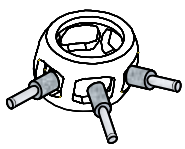
Application	
Workpiece	Bell track
Material	S55C/S53C HRC 58~63
Machine	Ex-Cell-O
Grinding portion	Track
Grinding method	Internal profile grinding
Coolant	Oil
Grinding wheel	C1F8W 13.8-24.5-5.8 8B151-G180-VT2W10
Dresser	CNC cup dresser 4BZ - 25 - 4 - 1
Grinding parameters	Wheel speed (m/s) v_c = 30 Stock removal (mm) a_e= 0.3
Dressing parameters	Wheel speed (m/s) v_{cd} = 30 Roller dresser speed (m/s) v_R = 11 Dressing amounts (μm) a_{ed} = 7 Speed ratio q_d = + 0.36
Results	Dressing interval mT = 5 bells / dress (66% life increase) Surface finish (um) Ra < 0.8

Cage Window

Application	
Workpiece	Cage
Material	20CrMnTi HRC 58~63
Machine	Meccanodora
Grinding portion	Window
Grinding method	Internal grinding
Coolant	Emulsion
Grinding wheel	1VG1A1W-11-13-2-M4-27*B64
Dresser	CNC cup dresser
Grinding parameters	Wheel speed (m/s) v_c = 30 Stock removal (mm) a_e= 0.2
Dressing parameters	Wheel speed (m/s) v_{cd} = 30 Roller dresser speed (m/s) v_R = 8 Dressing amounts (μm) a_{ed} = 2 * 3 Speed ratio q_d = + 0.26
Results	Dressing interval mT = 200cages / dressing (125% life increase) Surface finish (um) Ra < 0.8



ID grinding of bell track



ID grinding of cage window

Know More about Abrasives

Grains selection of vitrified internal grinding wheels

Innovative grains

- **TG:** Strip ceramic sinter alumina, has extremely high material removal capability and grinding efficiency, and can work best in high-speed and high efficient grinding.

- **NQ:** Specially designed ceramic sinter alumina features special abrasion resistance and cool cutting for all the alloy materials, and stands out especially in low grinding force applications (such as internal grinding) for difficult-to-grind materials.

Traditional grains

- **SA:** Monocrystal fused alumina, applies to hard alloy steel materials after thermal treatment, especially in the situation of high removal allowance.

- **PA:** Pink fused alumina, features semi-brittleness and certain toughness, and the grinding performance is between that of white fused alumina and monocrystal fused alumina.

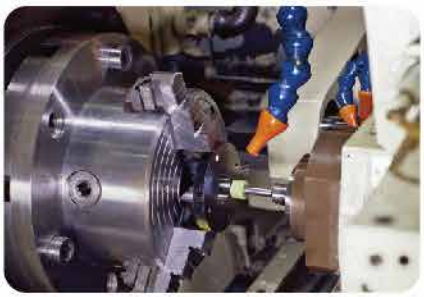
- **WA:** White fused alumina, which is of the greatest brittleness in all the abrasives, is ideal for grinding of alloy materials.

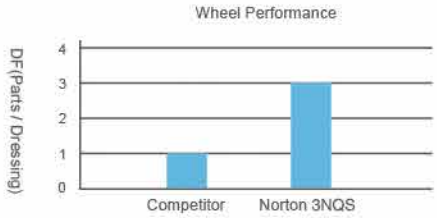
Grinding solutions for constant velocity joint

Cage Window

Application	
Machine	Rabbit
Material	Harden carbon steel CF53
Hardness	HRC 58-60
Stock removal (mm)	0.58-0.65
Surface finish requirement	Ra 1.2
Grinding wheel (mm)	50x38x12 5NQ80 OVH
Wheel speed (m/s)	60
Other technical output	No burns

Recommended products	Performance
ID grinding: 3TGS100L10VS	High grinding efficiency and reduce cycle time
Track grinding: 3TGS120G12VCF2	
OD grinding: 3NQS100LVS	





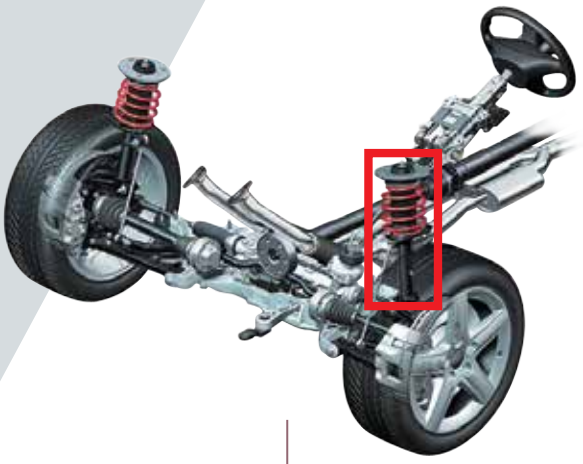
Availability

Vitrified Grinding Wheel

- Grain: TG, Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 16~ 800mm
- Grit: P60 (Roughing) ~ 150 (Finishing)
- Grade: F (Soft) ~ M(Mid)
- Bond: VS, VH, V127, VCF2, VSP, VXP, VQN, Vitrium^3

Shock Absorber

Steering System



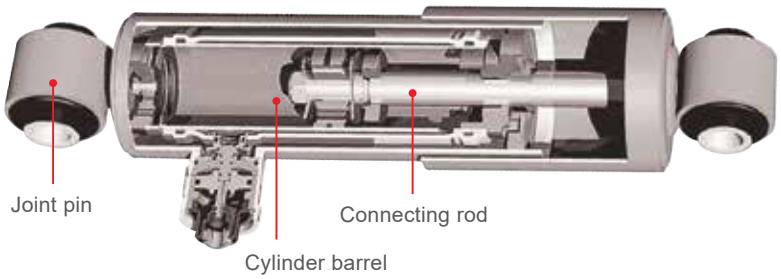
Shock absorber, a part of automotive suspension, is mainly used to restrain the bounce oscillation after shock absorption of the spring and the impact from the pavement. It can effectively reduce the vibration when the vehicle is traveling, thus enhancing the riding comfort. Shock absorber is classified into three types, hydraulic, air inflation and variable damping shock absorber.

The latest trend

Shock absorber is prone to wearing. It directly affects the stability and comfort when the automobile is running. Parts of the shock absorber can achieve the required accuracy through high-precision centerless grinding.

Grinding position

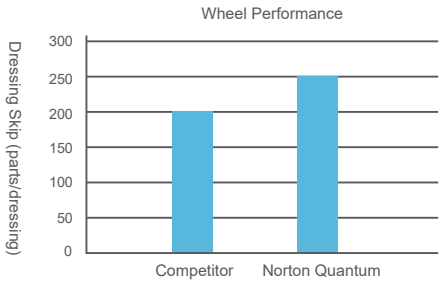
Joint pin, connecting rod and **cylinder barrel.**



Grinding solutions for shock absorber

Shock Absorber

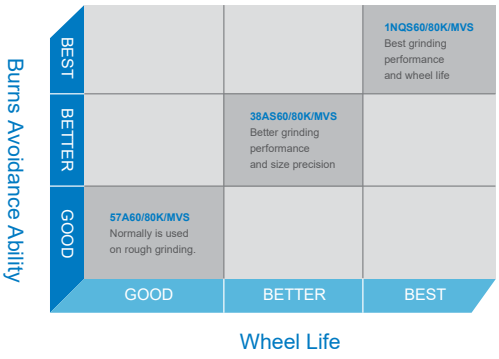
Application	
Machine	Wuxi, Koyo, Taiwan JHC, Henfux, Taiwan Rongguang
Material	#45 Carbon Steel
Hardness	Roughing: HRC 25 - 30 Semi & Finishing: HRC 45 – 52
Stock removal (mm)	0.125
Surface finish requirement	Rough: Ra 0.8 Semi finish: Ra 0.6 Finish: Ra 0.4
Grinding wheel (mm)	600x300x304.8
Wheel speed (m/s)	35
Other technical output	No burns



Availability

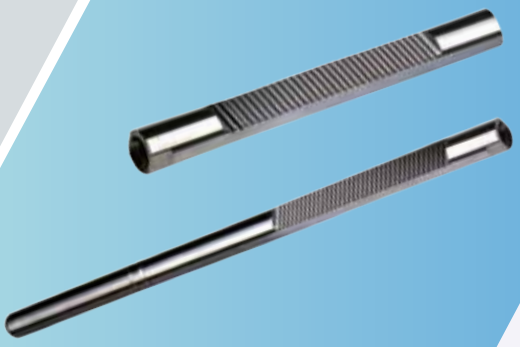
Vitrified Grinding Wheel

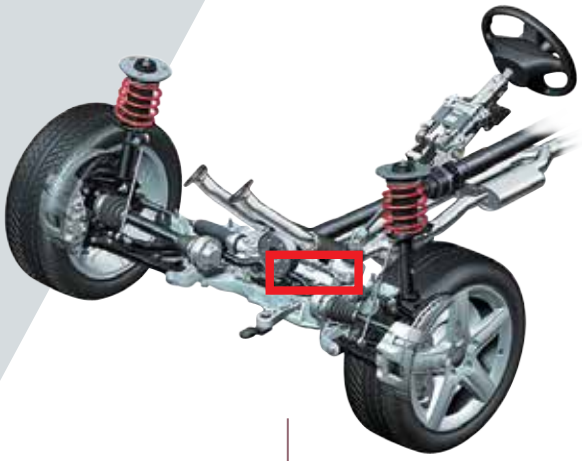
- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 350~750mm
- Grit: P60 (Roughing)~80 (Semi-Finishing)
- Grade: J (Mid)~M (Mid)
- Bond: VS



Steering Rack

Steering System





Steering rack is categorized into straight tooth gear rack and helical rack, which are respectively used with straight tooth and helical tooth cylindrical gears.

The latest trend

The steering rack's performance is particularly important and fine grinding on its tooth profile and roundness is directly related to the precision, strength and abrasion resistance of the steering rack.

Grinding position

Rod and tooth profile.

Grinding solutions for steering rack

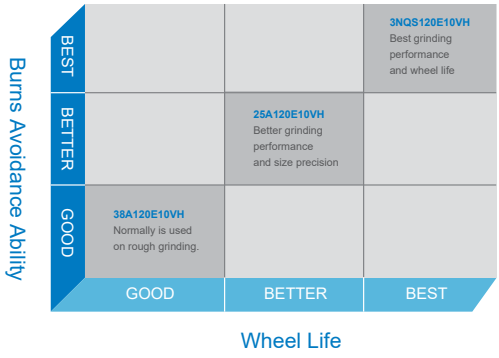
Steering Rack

Application	
Machine	ABA, Taiwan Fengmao
Material	High-speed steel (TL4521)
Hardness	HB160-240
Stock removal (mm)	0.2
Surface finish requirement	Ra 0.16-0.32
Grinding wheel (mm)	600x126x304.8 3NQS 120 E 10 VH
Wheel speed (m/s)	35
Other technical output	No burns

Availability

Vitrified Grinding Wheel

- Grain: TG, Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 400~750mm
- Grit: P60 (Roughing)~120 (Semi-Finishing)
- Grade: E、F(Soft)
- Bond: Vitrium3，VS，VH

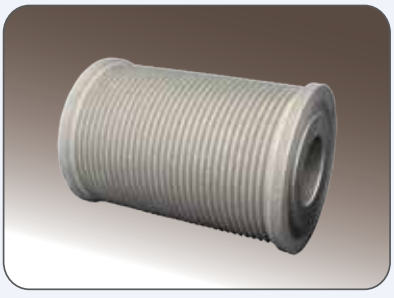


Diamond Dressing Tool

To dress creep-feed grinding wheel used in steering rack

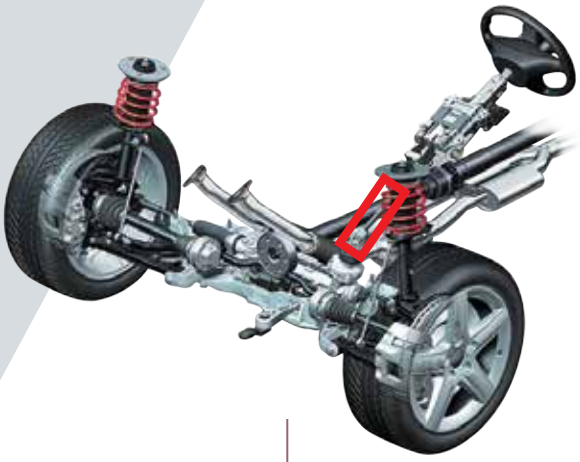
WINTER reverse plated construction (RPC) roller

- Benefits: - Winter's patented reverse plated construction technology
  - the only manufacturer of diamond dressing tools to guarantee 2um single tooth profile accuracy and 15um accumulative tooth profile accuracy (number of teeth: 26-36)



Steering Shaft

Steering System



Steering shaft, as an indispensable part in the auto steering system, is mainly used to control turning radius. Steering shafts can be classified into single steering shaft and double steering shaft.

The latest trend

As the vehicles require excellent turning stability when traveling at a high speed, the steering shaft should be equipped with higher strength, rigidity and abrasion resistance. The production of steering shaft in a mass and professional way is a new development trend.

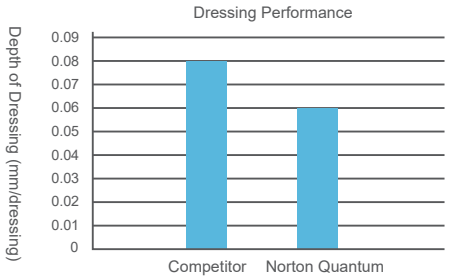
Grinding position

Journal and **Raceway.**

Grinding solutions for steering shaft

Steering Shaft

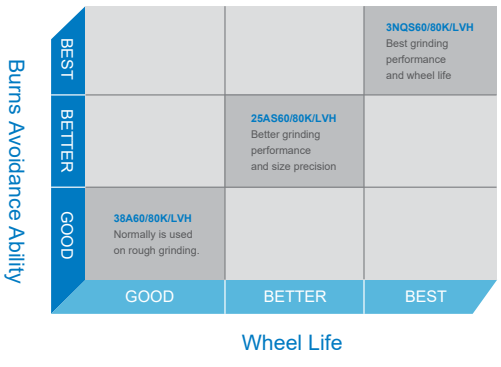
Application	
Machine	Beijing No.2, Shanghai, Taiwan Stsupetec
Material	Gear Steel 42CrMo 40MnB
Hardness	Gear Steel: HRC 58-62 42CrMo: HRC 48-55 40MnB: HRC 40-47
Stock removal (mm)	OD: 0.1-0.3 Face: 0.15
Surface finish requirement	Ra 0.8 -1.6
Grinding wheel (mm)	610-900x55-220x254-305
Wheel speed (m/s)	35
Other technical output	No burns



Availability

Vitrified Grinding Wheel

- Grain: Quantum, 32A, 57A, 38A, 25A and blended abrasives
- Diameter: 610~900mm
- Grit: P46 (Roughing)~80 (Semi-Finishing)
- Hardness: J(Mid)~K(Mid)
- Bond: VS



Diamond Dressing Tools

★ Dressing of centerless and cylindrical grinding wheels

1. WINTER diamond sinter roller

- Benefits: - higher dressing efficiency and accuracy
  - longer service life

2. WINTER Fliese® plate stationary dresser series

D30/HFAS/TFAS

- Benefits: - high cost-effectiveness
  - better dressing consistency
  - ideal for dressing in limited quantities

3、WINTER Igel® multi-point stationary dresser series

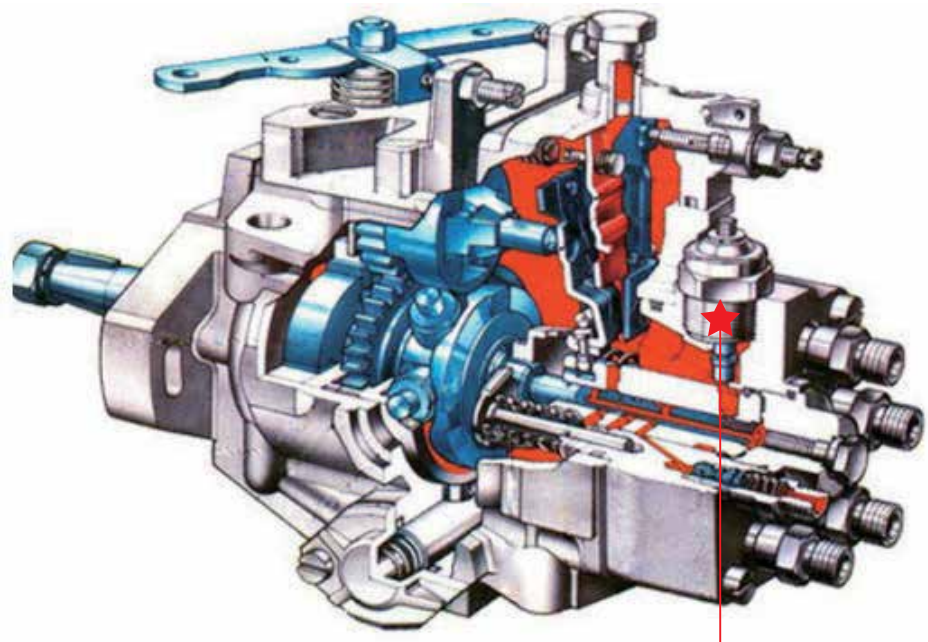
Norton Multi-point dresser series

- Benefits: - high cost-effectiveness
  - better dressing consistency

The working principle of fuel injection system, in simple terms, is to feed the fuel into high-pressure oil circuit after being compressed. With the improvement of high pressure fuel oil injection technology, high precision grinding on the fuel injection device is conducive to the accuracy control of oil injection process and reaching high injection pressure, thus making the injected fuel oil atomized and burnt more effectively, and reducing emission and fuel costs.

Auto Parts

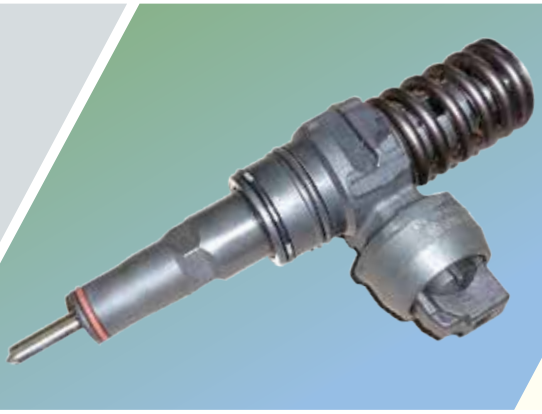
Other Auxiliary Precision Parts (Injection System)

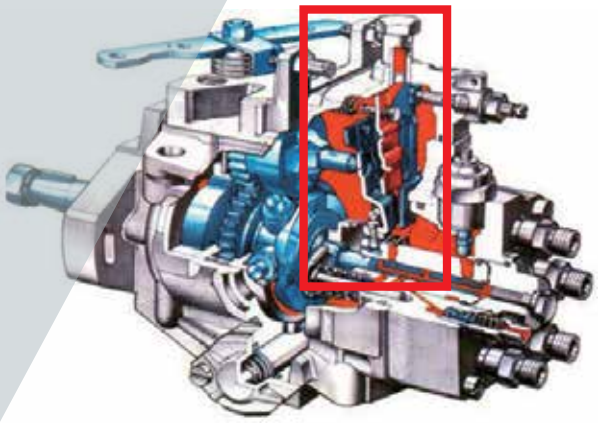


(P71-73)
Fuel Injection System

Fuel Injection

Injection System





To achieve best efficiency and optimal performance, Fuel injection is essential. The injector atomizes fuel delivered by the fuel pump. Since the injector works under high pressure and temperature, the physical dimension and precision of its work-piece surface are critical to ensure operation safety and extended service life.

The latest trend

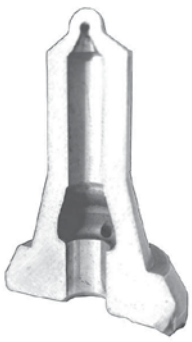
Fuel injection has a direct impact on a series of auto performance indicators, such as dynamic property, economical efficiency, reliability, emission and start-up performance. It is required to be more precise, so as to achieve better fuel atomization effect. In addition, its perfect physical dimension and high quality surface grinding ensure the performance of the engine.

Grinding Position

Hydraulic cam, fuel injection needle and **nozzle body.**

Hydraulic cam

Fuel injection needle



Nozzle body

High speed grinding solutions for fuel injection system

WINTER N7 ID

Availability

Vitrified Bond CBN Grinding Wheel

- Grain: CBN
- Diameter: 350~480mm (Camshaft)
  3.5~10mm (Bore)
- Grit: FEPA B107-B126 (Camshaft)
  FEPA B30-B90 (Bore)
- Hardness: E-H (Camshaft)
  D-J (Bore)
- Bond: VSS, N7

Fuel Injection Camshaft

Application	
Workpiece	Camshaft
Material	16MnCr5, HRC 60-65
Machine	Kopp
Grinding portion	Cam lobe
Grinding method	Chase plunge grinding
Coolant	Emulsion
Grinding wheel	WINTER 4VG3A1-400-22-5 B107
Dresser	CNC Sintered diamond roller dresser DS71P-120-1-2 40
Grinding parameters	Wheel speed (m/s) v_c = 80 Stock removal (mm) a_e = Ø 0.8
Dressing parameters	Wheel speed (m/s) v_{cd} = 80 Roller dresser speed (m/s) v_R = 52 Dressing amounts (µm) a_{ed} = 3 * 3 + 1 * 1 Speed ratio q_d = + 0.65
Results	Grinding time tg = 177 s (20%efficiency increase) Dressing interval mT = 180 cam lobes / dressing (50% life increase) Surface finish (um) Ra < 0.3

Fuel Injector Bore

Application	
Workpiece	Fuel injector
Material	52-100 Steel, HRC 60
Machine	Tripet
Grinding portion	Bore of fuel injector
Grinding method	Internal grinding
Coolant	oil
Grinding wheel	B91G200VT2
Grinding parameters	Wheel speed (RPM) 20000 Work speed (RPM) 3000 Stock removal (mm) a_e= 0.2
Results	Grinding time (s) 60 Surface finish Ra 0.8 (semi-finishing) Roundness (um) 2 Taper (um) 5 Straightness (um) 8 Tolerance (um) +/- 10

Fuel Injector Bore

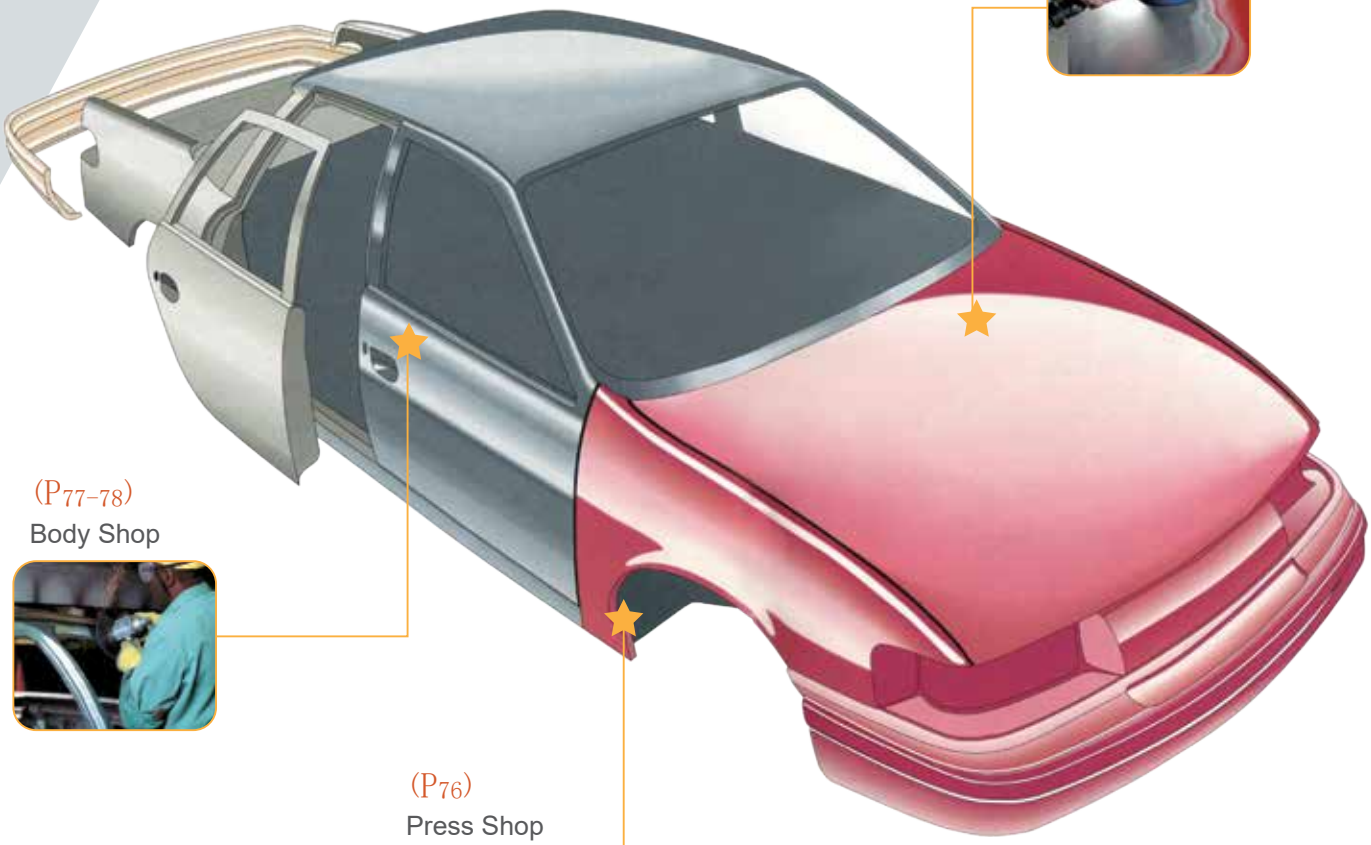
Application	
Workpiece	Fuel injector
Material	Hardened steel HRC 62
Machine	Micron internal grinder
Grinding portion	Seat of fuel injector
Grinding method	Internal grinding
Coolant	Oil
Grinding wheel	B46J200VT2
Grinding parameters	Wheel speed (RPM) 120000 Work speed (RPM) 2500 Stock removal (mm) a_e= 0.12
Results	Dressing interval mT = 75 parts / dress Grinding time (s) 12.4 Surface finish Ra 0.08 Roundness (um) 0.5

Assembly Plant

Auto Manufacturers

Since the first automobile was invented, design and manufacturing process of auto body have experienced dramatic changes. Saint-Gobain Abrasives has always been devoted to serving the auto manufacturing industry. We can provide a comprehensive grinding solution covering from stamping, body shop, paint shop to final assembly.

(P79-80)
Paint / Assembly Shop



(P77-78)
Body Shop

(P76)
Press Shop

Assembly Plant

Press Shop

Stamping component repair

The main purpose of grinding in press shop is to remove stamping defects on the components to prepare for welding and painting. Tiny defects in stamping tools will leave dents in covering parts, which are typically removed in two steps.

Step 1: Rough removal

Highlight the defects and use file to rub them down, then use 7″ sanding disc with grit P80-P100 in combination with 7″ angle grinder to remove the file mark.

Availability

Norton H231 hook & loop disc

Characteristics	Close coat, heavy paper
	3”, 5”, 7X5”hook&loop disc available
	Grit range P60-P400
Features	Premium P-graded aluminum oxide abrasives
	New strong heavy paper
	Anti-static treatment
Benefits	Fast cutting action
	Provides good consistency and stability Maximum durability and tear resistance
	Provides maximum load resistance

Norton F282 fiber disc

Characteristics	Fiber backing, close coat
	5”, 7” disc available
	Grit range P24-P120
Features	Heavy duty backing
	Improved backing treatment
Benefits	Durable, reduced edge wear
	More flat, no curling issues

Step 2: Blending

Use 5″ sanding disc with grit P100-P120 to blend the surface. Use 5″ random orbital sander to achieve better surface result. The grinding area should be as small as possible to reduce reworking load.

Availability

Norton H231 hook & loop disc

Weld removal

Step 2: Smooth/Blend

Use 5'' sanding disc with grit P100-P120 in combination with 5'' random orbital sander to smooth the grinding trace on the front track.

Availability

Norton H231 hook & loop disc

Tip | Due to different positions to be grinded, the edge of the sanding discs may be torn in the process. Norton H231 sanding disc can perfectly solve this problem, making it ideal for processing.

3. Remove welding slag

When spot welding is performed to the edges of the door frame, some splashed welding slags may remain. To solve this problem, 5'' sanding disc with grit P100-P120 is usually used with 5'' random orbital sander to perform grinding.

Availability

Norton H231 hook & loop disc

4. Auto body repairing

In the process of transporting or assembly, unexpected crash or scratch are usually caused on the auto body. Before painting, these defects must be removed. Therefore, parts of the external auto body shall be polished. The processing method is equivalent to that of the press shop.

Step 1: Rough grinding

Highlight the defects with sharpening stone or sanding disc and use file to rub them down, and then use 5'' or 7'' sanding disc with grit P80-P100 in combination with 5'' or 7'' angle grinder to quickly remove the file mark.

Availability

Norton H231 hook & loop disc

Step 2: Smooth/Blend

Use sanding disc with grit P100-P120. To achieve better surface results, it's recommended to use 5'' random orbital sander to smooth the grinding trace on the front track.

Availability

Norton H231 hook & loop disc

Tip | When grinding, hold the pneumatic tool tight with hands, and approach and leave the work-piece surface in a stable and slow way. If random orbital sander is used, please place the tool on the work-piece surface first, then start the tool to perform grinding operation to avoid overcutting.

Paint & Assembly Shop

Assembly Plant

Nowadays, as the paint of the auto body surface has become thinner, many manufacturers start to use painting technology without premier coat process. Therefore, the thickness of clear coat relatively increases, while the thickness of color coat decreases. These changed processes pose higher standards for defect polishing, and different sanding methods are used according to various defects, including dry sanding, wet sanding and damp sanding. The main purpose of sanding in paint & assembly shop is to remove sagging, particles, accumulation and degumming, and the sanding is mainly classified into electro/premier coat sanding and finish paint repair. Based on the painting process, it includes steps of body sanding before electro coat, sanding after electro coat, sanding before premier coat, sanding before top coat and repairing after top coat.

Relatively speaking, the sanding applications in assembly shop are fewer, while much more in top coat repairing when the autos are off line.

Electro and premier coat sanding

When common defects occur in the electro coat and premier coat, such as pinhole, particle, sagging, orange peel and fish eye, they can be repaired through the same steps.

Step 1: Major defects repair

Use random orbital sander to repair major paint finish defects like sagging and orange peel. Norton A275 5'' gum sanding disc with No-fil coating is recommended, and typical grit sizes are P180-P400.

Availability

Norton A275 stick and sand disc

Characteristics	Open coat, No-fil coating
	5", 6" stick & sand disc available
	Grit range P80-P800
Features	Premium P-graded, heat-treated aluminum oxide abrasive
	Unique fiber-reinforced, B-wt. latex-saturated backing
	Water-based stearate, non-pigmented, No-Fil coating
	Full resin adhesive bond
Benefits	Superior life, fast cut rate, consistent finish
	Exceptional flexibility, improve tear strength
	Provides maximum load resistance and extended life
	Provides exceptional resistance to abrasive grain shedding, long life

Step 2: Small particles removal

Remove the small particles on the external covering parts through hand grinding. Dry or wet sanding methods can be used under different circumstances. The sanding discs or sand papers are commonly used for grinding, and typical grit sizes are P320-P600. Hand grinding needs to be supported by hand pallet.

Availability

Norton A275 stick and sand disc

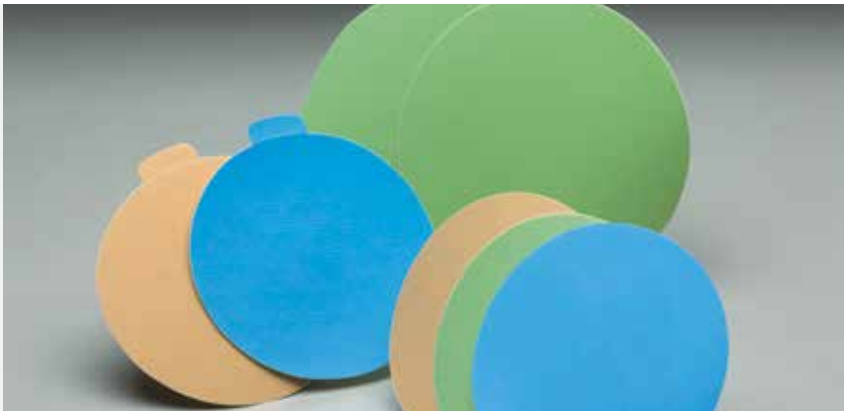
Norton T278 waterproof paper

Characteristics	Waterproof paper
	9X11" sheet
	Grit range P60-P2000
Features	Premium silicon carbide abrasive
	Latex waterproof paper backing
Benefits	Ultimate life and finish in wet applications
	Ultimate flexibility

Tip

Dry sanding characterizes fast speed, low cost, observable and user-friendly. Advantages of wet sanding cover good finishing and less blocking, while it is more expensive, nondisposable, and not easily observable.

Paint sanding



(After step 2)

Norton Q132 disc

Characteristics	Film backing
	3X7/8"stick&sand / hook&loop disc available
	Grit Range 20mic, 30mic, 40mic
Features	Extremely uniform film
	Micron-grade aluminum oxide grain
	Electro coating
Benefits	Increased tear resistance; can be used wet
	Generates a very uniform surface without deep scratches
	High cut rate

Step 3: Top coat sanding

Even though the current painting system can effectively reduce common painting problems, such as particles, sagging, orange peel, these problems cannot be completely resolved. When polishing on the clear coat, it is recommended to use abrasives with thin backing and fine grit, so as to avoid damaging the color coat. For hand sanding, hand pad is required.

Availability

Norton T401 waterproof paper

Characteristics	Waterproof paper
	9X11" sheet available
	Grit range P1000-P2500
Features	Ultra fine silicon carbide abrasive
	High-strength high-latex, waterproof paper backing
	Improved resin bond system
Benefits	Ultimate finish in wet applications
	Ultimate flexibility, with wet-curl resistance
	Long life in wet applications

Norton NORaX sand disc

Characteristics	1-1/4" stick and sand disc
	Grit X5
Features	Specially treated grain usingmulti-layer technology
	Waterproof backing
Benefits	Consistent cut throughout the life of the disc without wild scratches
	Longest product life
	Can be used wet

Tip

When NORaX sand disc is used, the selected sanding area should be as small as possible. Even force and stable movement should be guaranteed during sanding and the edge of the sanding disc cannot be used. After sanding, use wool pad, foam pad and polishing compound to polish the surface, so as to achieve better surface gloss.

Notes

Technical Information

Cylindrical grinding

Issue	Cause	Solution
Spirals on the workpiece surface	Loose workpiece centre	Check whether the chuck or centre is loose
	Insufficient lubrication on key way	Adjust or replace lubrication oil
Out of round wok when plunge grinding	There is burr in the centre hole, which is out-of-round or loose or not deep enough	Check the centre hole
	The workpiece is too tight on centers	Adjust the tailstock spring
	Insufficient coolant flow	Adjust the coolant flow
Poor surface finish	Inappropriate grinding wheel hardness	Select proper grinding wheel hardness
	The coolant is contaminated	Increase filtering or replace coolant
	The dressing speed is high	Slow down the dressing speed
	Diamond dresser is not sharp enough	Turn the dresser angle or replace the dresser
	The in-feed rate is high	Reduce the in-feed rate
	The traverse speed is high	Lower the traverse movement speed
Adjacent diameter of workpiece **not concentric**	Loose workpiece centre	Check the centre hole
	Workpiece centre is not on the centre line	Check the centre hole
Chatters on the workpiece surface	The in-feed rate is high	Reduce the in-feed rate
	Slender workpiece unsupported	Use proper supporting device
	Machine tool vibrates	Check out vibration of the machine tool and surroundings
	The grinding wheel is hard	Select softer grinding wheel, increase workpiece rotating speed and dressing speed, reduce grinding wheel speed, and increase coolant flow
Burns or cracks on the workpiece surface	The grinding wheel is hard	Try to use the grinding wheel with more porosity
	The grinding in-feed rate is high	Separate rough grinding and finishing
	Insufficient coolant flow or wrong nozzle direction	Adjust cooling method
	The grinding wheel is not dressed properly	Dress the grinding wheel again with correct method
Waviness on the workpiece surface	Vibration comes from belt, hydraulic system and motor	Check the machine tool equipment
	The grinding wheel is not balanced	Balanced and dressed the grinding wheel
	Wheel oil soaked on one side	Replace the grinding wheel

Surface grinding

Issue	Cause	Solution
Uneven or non-parallel workpiece surface	The in-feed rate is high	Reduce the in-feed rate, especially in the finish grinding process
	The workpiece burns	Use correct granularity and hardness
	Residual stress of the workpiece	Relieve residual stress prior to refined grinding
	The electromagnetic chuck is contaminated	Clean the electromagnetic chuck prior to refined grinding
	The grinding spindle is not well adjusted	Readjust to make the grinding spindle parallel the table top
Scratches on the workpiece surface	The coolant is not clean	Clean the cooling bath or replace the coolant
	The grinding wheel is too soft	Select the harder grinding wheel
	The grinding wheel is too coarse	Select the harder grinding wheel or slow down the dressing speed
	Dressing problems	Check the dressing device
Chatters on the workpiece surface	The main shaft bearing wears	Check the main shaft bearing
	Wheel worn out of round	Dress the grinding wheel again and check the installation
	The grinding wheel is too hard	Select the softer grinding wheel
	The grinding wheel structure is too dense	Select the grinding wheel with more open structure
	The clamping is loose	Check the flange bolt or flatness
The workpiece burns or stalls during grinding	The grinding wheel is hard	Select and use softer or rougher grinding wheel or the grinding wheel with open structure
	The table speed is too low	Increase the table speed
	The grinding contact area is too large	Decrease the transverse range
	The grinding wheel is dressed too close	Dress the grinding wheel more open
	The in-feed is high	Reduce the in-feed rate
	The coolant flow is too small	Increase the coolant flow

Double disc grinding

Issue	Cause	Solution
Poor surface finishing of the workpiece	The grinding wheel grit is not proper	Select proper grinding wheel grit
	The coolant is not filtered clean	Check the coolant filtering system
	The dressing speed is too high or the dresser is not sharp enough	Slow down the dressing speed or change the dresser angle or replace with a new dresser
	The in-feed rate is high	Reduce the in-feed rate
	The workpiece speed is too low	Increase the workpiece speed
	The grinding wheel speed is too low	Increase the grinding wheel speed
Poor consistency of the workpiece dimension	The grinding wheel is soft	Select the harder grinding wheel
Poor discontinuity of the workpiece dimension	The grinding wheel is hard	Select the softer grinding wheel
Burns on the workpiece	The in-feed rate is high	Reduce the in-feed rate
	Insufficient coolant flow or wrong nozzle direction	Increase coolant flow or adjust nozzle direction
	The grinding wheel is hard	Select softer grinding wheel or the grinding wheel with open structure
	The grinding wheel is not dressed properly	Re-dress the grinding wheel or replace the dresser
	The metal chips in the coolant are not filtered	Check the filtering system
Chatters on the workpiece	The grinding wheel is not dressed even	Re-dress the grinding wheel
	The in-feed rate is too high	Reduce the in-feed rate
	Machine tool vibrates	Check out vibration of the machine tool and surroundings
	The grinding wheel is hard	Reduce the hardness, increase the workpiece rotating speed and speed up dressing

Crankshaft grinding

Issue	Cause	Solution
Poor surface finishing of the workpiece	The grinding wheel grit is not proper	Select proper grinding wheel grit
	The coolant is not filtered clean	Check the coolant filtering system
	The dressing speed is too high or the dresser is not sharp enough	Slow down the dressing speed or change the dresser angle or replace with a new dresser
	The in-feed rate is high	Reduce the in-feed rate
	The workpiece speed is high	Reduce the workpiece speed
	The grinding wheel speed is too low	Increase the grinding wheel speed
Poor consistency of the workpiece dimension	The grinding wheel is soft	Select the harder grinding wheel
Poor discontinuity of the workpiece dimension	The roundness of the grinding wheel is not desirable	Control the roundness of the grinding wheel, and make the arrow upward upon installation
	The balance of the grinding wheel is poor	Improve the balance of the grinding wheel
	The grinding wheel is hard	Select the softer grinding wheel
Burns on the workpiece	The in-feed rate is high	Reduce the in-feed rate
	Insufficient coolant flow or wrong nozzle direction	Increase coolant flow or adjust nozzle direction
	The grinding wheel is hard	Select the softer grinding wheel or the grinding wheel with more open structure
	The grinding wheel is not dressed properly	Re-dress the grinding wheel or replace the dresser
	The metal chips in the coolant are not properly filtered	Check the filtering system
	The grinding wheel is loaded due to insufficient grinding force of the abrasives	Try new type ceramic grain, such as NQ
Chatters on the workpiece	The grinding wheel is not dressed even	Re-dress the grinding wheel
	The in-feed rate is too high	Reduce the in-feed rate
	Machine tool vibrates	Check out vibration of the machine tool and surroundings
	The grinding wheel is hard	Reduce the hardness, increase the workpiece rotating speed and speed up dressing

Internal grinding

Issue	Cause	Solution
Poor surface finishing of the workpiece	The grinding wheel grit is not proper	Select proper grinding wheel grit
	The coolant is not filtered clean	Check the coolant filtering system
	The dressing speed is too high or the dresser is not sharp enough	Slow down the dressing speed or change the dresser angle or replace with a new dresser
	The in-feed rate is high	Reduce the in-feed rate
	The workpiece speed is too high	Decrease the workpiece speed
	The grinding wheel speed is too low	Increase the grinding wheel speed
Poor consistency of the workpiece dimension	The grinding wheel is soft	Select the harder grinding wheel
Poor discontinuity of the workpiece dimension	The grinding wheel is hard	Select the softer grinding wheel
Burns on the workpiece	The in-feed rate is high	Reduce the in-feed rate
	Insufficient coolant flow or wrong nozzle direction	Increase coolant flow or adjust nozzle direction
	The grinding wheel is hard	Select softer grinding wheel or the grinding wheel with open structure
	The grinding wheel is not dressed in properly	Re-dress the grinding wheel or replace the dresser
	The metal chips in the coolant are not filtered	Check the filtering system
	The grinding wheel is loaded due to insufficient grinding force of the abrasives	Tyr new type ceramic grain, such as NQ
Chatters on the workpiece	The grinding wheel is not dressed even	Re-dress the grinding wheel
	The in-feed rate is too high	Reduce the in-feed rate
	Machine tool vibrates	Check out vibration of the machine tool and surroundings
	The grinding wheel is hard	Reduce the hardness, increase the workpiece rotating speed and speed up dressing

Gear grinding

Issue	Cause	Solution
Poor surface finishing of the workpiece	The grinding wheel grit is not proper	Select proper grinding wheel grit
	The coolant is not filtered clean	Check the coolant filtering system
	The dressing speed is too high or the dresser is not sharp enough	Slow down the dressing speed or change the dresser angle or replace with a new dresser
	The in-feed rate is high	Reduce the in-feed rate
	The stroke is too fast	Reduce the stroke
	The grinding wheel speed is too low	Increase the grinding wheel speed
Poor discrepancy of tooth profile (based on the test result)	The grinding wheel is soft	Select the harder grinding wheel
	The grinding cycle is not optimal	Adjust the stock removal of finishing grinding
Burns on the workpiece	The in-feed rate is high	Reduce the in-feed rate
	Insufficient coolant flow or wrong nozzle direction	Increase coolant flow or adjust nozzle direction
	The grinding wheel is hard	Select softer grinding wheel or the grinding wheel with open structure
	The grinding wheel is not dressed properly	Re-dress the grinding wheel or replace the dresser
	The metal chips in the coolant are not filtered	Check the filtering system
	The grinding wheel is loaded due to insufficient grinding force of the abrasives	Tyr new type ceramic grain, such as NQ
Chatters on the workpiece	The grinding wheel is not dressed even	Re-dress the grinding wheel
	The in-feed rate is too high	Reduce the in-feed rate
	Machine tool vibrates	Check out vibration of the machine tool and surroundings
	The grinding wheel is hard	Reduce the hardness, increase the workpiece rotating speed and speed up dressing

Safety in the storage & use of grinding wheels

Stringent safety standards are maintained throughout the manufacture of Norton Grinding Wheels. To reduce the risk of accidents further, the law requires that certain basic precautions are taken in the storage and use of abrasive wheels.

Receipt

On receipt, grinding wheels should be thoroughly examined to see if they show any signs of damage, such as chips, cracks or discolouration. Damaged wheels must not be used.

Handling

Any mishandling that results in the wheel being subjected to any shock loading can damage all grinding wheels. This can occur if the wheel is inadvertently dropped, knocked over or banged against any other object. This is equally true if the wheel is secured on a pallet, which has been dropped heavily from a forklift truck.

Any grinding wheel subjected to such mishandling should be carefully examined for signs of damage. If in any doubt – do not use.

Storage

Small wheels up to 80mm diameter, together with cones, plugs, mounted points and wheels may be stored in suitable bins, drawers or boxes. Type 02 cylinder wheels, type 06 straight cup wheels, type 12 dish wheels and type 13 saucer wheels should normally be stacked on flat sides with cushioning material between them. Thick rim and hard grade cylinder and straight cup wheels may be stored on their periphery as for plain wheels. Soft grade, straight cup wheels, and all type 11 taper cup wheels, should be stored base to base and rim to rim, to prevent chipping of edges and cracking of walls. Thin plain wheels, such as cutting-off wheels or saw sharpening wheels should be stacked on a flat surface of steel, or similar rigid material. Other plain or shaped wheels of appreciable thickness, are best supported on their periphery in racks. The racks should provide cushioned, two point, cradle support to prevent the wheels from rolling.

Storage conditions

During storage, grinding wheels must not be subjected to:

- Exposure to humidity, water or other liquids
- Freezing temperatures
- Any temperature low enough to cause the formation of condensation on the wheels when moving from storage to an area of high temperature

Shelf life of resinoid & vitrified bonded wheels

The outer surfaces of certain organically bonded wheels may be affected by oxidation if they are stored for long periods. These types of wheel should not be stored for more than three years and proper stock control should ensure that older wheels are used first. In use, a three year old Resinoid product will act considerably softer than a brand new wheel (wheel will wear away more quickly).The glass bonding system used in vitrified wheels is very inert and generally only attacked by certain acids. Cold temperatures can result in a vitrified wheel cracking if wheels are put away wet and are subjected to freezing temperatures. It must be remembered that the longer a product is in storage the chances of it becoming damaged increases. Provided vitrified wheels are stored correctly, thoroughly examined and mounted correctly they will last for many years.

Ring test

The ring test depends upon the damping characteristics of a cracked wheel to alter the sound emitted when it is lightly tapped. The test is applicable only to vitrified bonded wheels.

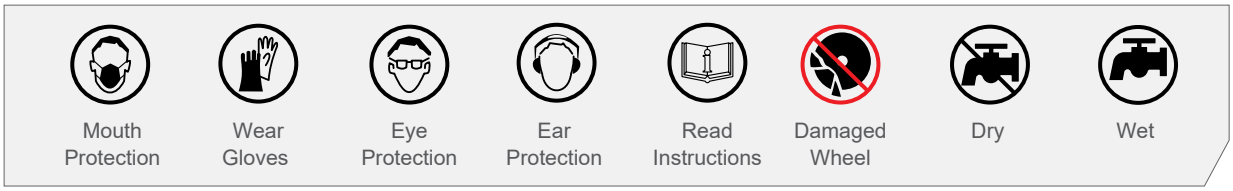
To perform the ring test; support the wheel gently with a finger through the bore section. Using a light non-metallic implement (a file handle is ideal), gently tap the wheel about 45° each side of the vertical centre line. Rotate the wheel 45° and repeat the test.

The sound and undamaged wheel will omit a clear tone. If cracked, there will be a dead dull sound – not a clear ring – and the wheel should not be used. The ring test should be carried out in a place where the ring can easily be heard.

Safe working practices

Personal protection

Safety goggles, ear defenders, safety gloves, dust masks and, if conditions are severe, additional face protection. Leather aprons and safety shoes must be worn.



Training of operators

Grinding operators should be trained in the safe use of each machine they operate.

Speeds

No abrasive wheel should be operated at a speed in excess of the maximum permissible speed marked on the wheel in RPM when the wheel is new and full size. It is permissible, however, to increase the spindle speed of the machine beyond the RPM stated on the wheel provided the increase is in proportion to the reduction in diameter and that the original peripheral speed is not exceeded (quoted on the wheel in metres/sec). In high production areas it is now normal for machines to have constant peripheral speed spindles. This is an electronic device that automatically increases the spindle speed of the machine as the wheel diameter wears down and prevents most of the reduction in wheel performance that is experienced when the wheel becomes smaller.

Coolants

The strength of resin bonded grinding wheels can be reduced by coolants. The concentration and alkalinity of coolants should be regularly checked and a pH value of 8 should not be exceeded. Prolonged immersion of a stationary wheel in coolant can produce an out of balance condition. Coolant should be shut off before stopping a wet grinding wheel, and the wheel allowed to run free until all the coolant has been spun out.

Work rests

Work rests should be kept adjusted as close as possible (gap between wheel and work rest should not exceed 3mm) to the wheel and maintained in good condition.

Truing & dressing

Re-dressing of wheels that have become malformed and out of truth in off-hand operations must only be performed by a competent person.
If an out of balance condition, due to the wheel wearing excessively out-of-round, cannot be corrected by truing, the wheel should be removed from the machine. Wheels should be dressed regularly to avoid loading

Side grinding

Side grinding should only be performed with wheels designed for this purpose (straight cups etc.).

Grinding on the flat sides of wheels designed for peripheral grinding may be dangerous and cause a wheel breakage. This does not preclude their use for certain precision applications such as shoulder and form grinding, where it is recognised that a limited amount of side grinding is performed; however, in these operations the operator has control of the pressure through the hand wheels of the machine whereas with bench grinding and off-hand machines the pressure is uncontrolled. Extreme caution should be exercised not to use excessive pressure.

As a general guide, do not use a straight wheel which has a thickness of less than 10% of the wheel diameter for side grinding.

Organic cutting-off wheels

'Non-reinforced' cutting-off wheels should never be used:

- On a portable grinding machine
- On any machine where the workpiece is fed into the wheel by hand

Cutting-off wheels should only be mounted on machines designed for their use.

Cutting-off wheels should be inspected for warping before use. Warped wheels should not be used.

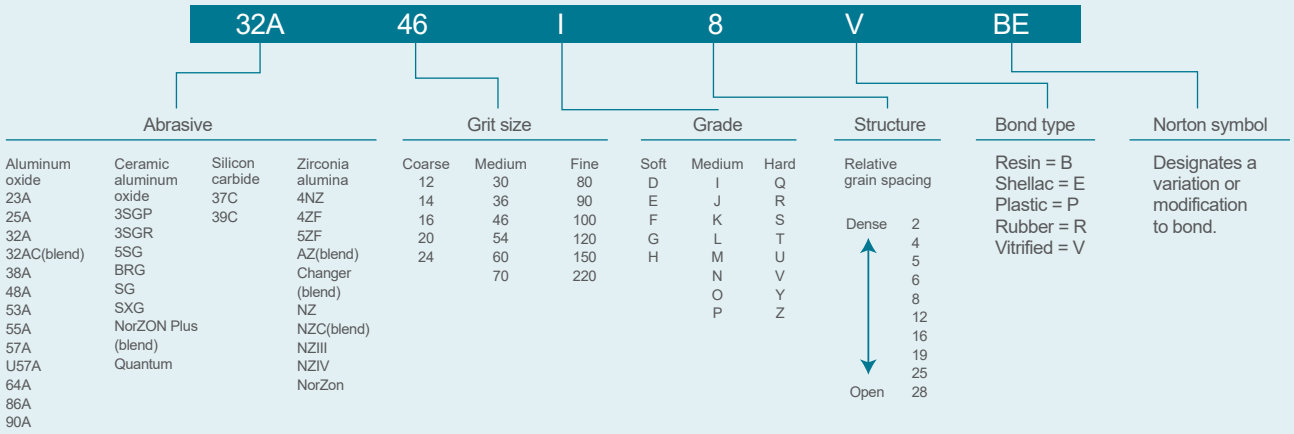
When grinding, twisting or the exertion of any pressure on the side of the wheel should be avoided.

Workpieces should be rigidly supported and firmly clamped wherever possible.

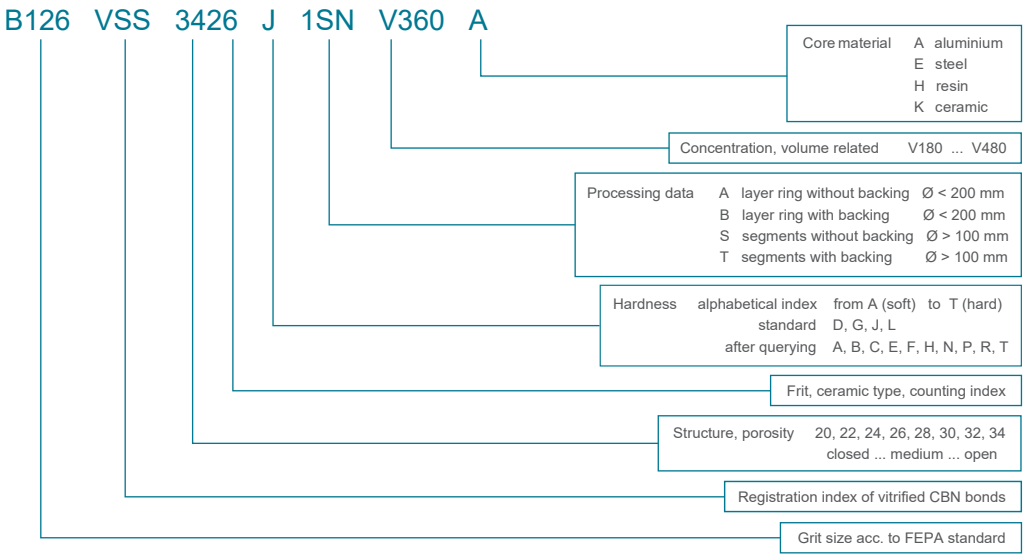
Stopping wheels

Wheels should not be brought to rest by applying pressure to the periphery or face of the wheel.

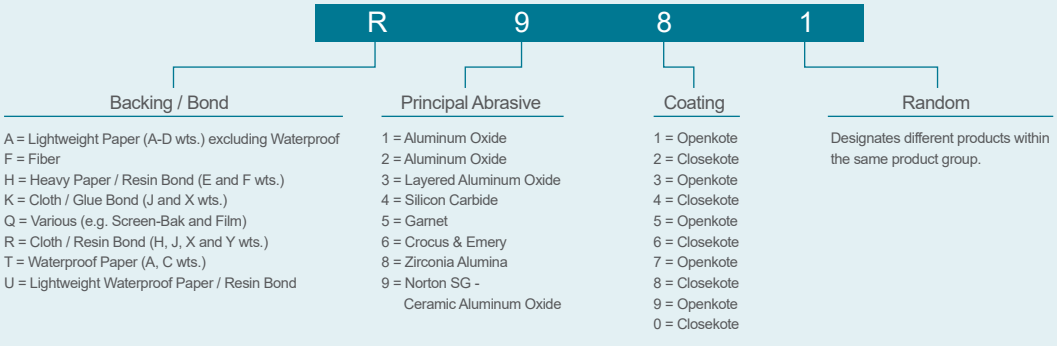
Conventional Grinding Wheels



Superabrasives



Coated Abrasives



What is a grinding wheel?

A grinding wheel is a precision tool with thousands of cutting points. It consists of abrasive grains held in a matrix of bond and separated by pores. The abrasive grains are the cutting points while the purpose of the bond is to hold the individual grains together. The pores (hollow spaces between adjacent abrasive grains and the bond) serve to provide clearance for coolant penetration and metal chips removed in the grinding process.

When the wheel is rotated at grinding speed and applied to the workpiece, the abrasive grains cut the material that is being ground, removing the material in small chips.

Under the action of the forces imposed during grinding the abrasive cutting points are worn flat, resulting in the points becoming blunt. This causes an increase in friction, and a build up of heat.

The increase in grinding forces causes either the abrasive to fracture, exposing new cutting edges, or fractures the bond bridges holding the abrasive grains. In the latter case fresh abrasive grains are exposed to cut the workpiece.

In normal vitrified grinding applications the wheel has to be dressed.

By varying the properties of the abrasive, the typeof bond, the make-up of the wheel, it is possible to produce grinding wheels with a vast range of different grinding characteristics.

Abrasives

Modern synthetic abrasives allow accurate control over the physical properties and form of the abrasive grain. This helps to ensure that grinding wheels can be manufactured with consistent cutting properties.

Norton offers a comprehensive selection of abrasive types to provide a wide range of specific grinding characteristics. This is necessary for maximum efficiency in the large variety of operations demanded by the industry today.

Abrasive grain size

The grain or grit size is most important in determining a wheel's ability to achieve the required surface finish and remove stock. The size is designated by a number which increases as grain size decreases. For example 10 grit has a median size of about 2,0mm and 60 grit 0,25mm.

Standard sizes are used in all Norton wheels as specified in the European Standards laid down by FEPA.

An ideal grinding abrasive has the ability to stay sharp with minimum point dulling, and when dulling begins it fractures revealing new sharp cutting edges. Abrasive grains used in the manufacture of bonded abrasives come in three main categories.

Understanding the specification

Abrasive			Grit Size			Grade			Structure		Bond
Aluminium oxide	Silicon carbide	Ceramic aluminium oxide	Coarse	Medium	Fine	Soft	Medium	Hard	Closed	Open	
A	37C	SGB	12	30	80	E	I	Q	5	10	VS
19A	39C	3SG	16	36	90	F	J	R		11	VXP
25A		5SG	20	46	100	G	K	S		12	VXPM
38A		1TGP	24	54	120	H	L	T			VTECH
40A				60			M				
57A				70			N				
86A							O				
IPA				60				EH		17	VTX
								XH		20	
		ES5		60	80		J	L			VX
							K				

Abrasive types

Abrasive Types	Description
A	This is a particularly tough form of aluminium oxide. Its toughness is due to the presence of 3% of titanium oxide in the abrasive. Fired at low temperature the abrasive retains its natural brown colour. Fired at high temperature further oxidation of the titanium oxide takes place which changes the normal brown colour to a grey-blue. Because of its toughness, regular brown alumina is suitable for grinding high tensile strength materials, specifically off-hand grinding (bench grinding wheels) & sharpening stones.
19A	A blend of A & 38A abrasives. This abrasive gives a grinding action that can be compared to the average of its components. It is supplied in some standard tool room wheels, used for surface, cylindrical, centreless & miscellaneous grinding on less heat sensitive steels.
38A	White fused aluminium oxide (99,8% pure). The most friable & cool cutting of the aluminium oxides. This abrasive is supplied in all types of standard range wheels ideal for use on hard & heat sensitive steels & alloys. It has traditionally been used for sharpening high-speed steel & cast alloy tools & cutters.38A is used for cylindrical, surface & internal grinding of tools, dies & gauges.
57A	Semi-pure brown fused aluminium oxide (98% pure). The higher purity of 57A makes it a good general purpose abrasive. Its versatility enables it to be used for grinding steel parts in both soft & hard states, especially on large cylindrical & centreless operations. U Treatment (U57A) is a ceramic coating applied to this abrasive to increase its durability in resin bonded cutting-off wheels. It is used in the advanced range resinoid cut-off wheels.
86A	Pink aluminium oxide is a highly refined form of alumina containing a small proportion of chromium oxide. This addition makes 86A a little tougher than pure white, increasing the strength along the shear planes. This abrasive is available in a range of mounted points & wheels.
SGB	A blend of premium abrasives that include a medium concentration of ceramic Norton SG.
3SG	A blend of premium abrasives that include a high concentration of ceramic Norton SG.
5SG	A blend of premium abrasives that include a very high concentration of ceramic Norton SG.
37C	Crystolon silicon carbide abrasive. Supplied mainly in the resin bonds of advanced wheels used for grinding grey iron, non-ferrous metals & in vitrified bonds for grinding non-metallic materials, such as rubber & stone.
39C	Crystolon is the highest purity silicon carbide abrasive. It is ideal for grinding cemented carbide cutting tools, fired ceramics & glass, where it provides advanced performance.

Bond types

Vitrified

Vitrified bonds are the most common precision grinding bond. Porosity and strength of the wheels made with this bond give high stock removal along with their rigidity helping to attain high precision. Not affected by water, acid, oils or ordinary temperature variations. The most common vitrified bonds are:

V	V is the original high temperature vitrified bond, usually used where tougher acting wheels are required
VS	VS is a very versatile, low temperature, high performance vitrified bond system used in almost all applications but predominately for tool room, centreless, cylindrical, & surface grinding
VTECH	Low temperature, very technical bond, used with conventional abrasives & recommended for high tech applications to maximise performance & dressing parameters
VX	VX bond provides improved corner/form holding for most applications – it is the first choice bond for our premium abrasives
VXP	Induced porosity VX bond suitable for large contact areas & surface grinding

Bonds

Organic

These bonds are used in two types of wheels. Firstly, wheels used on portable or fixed machines for the rapid removal of metal. Secondly, cutting-off wheels either un-reinforced or reinforced, for use on portable or fixed machines. The most common organic bonds are:

Snagging & wheel & cups

B & B3	Foundry wheels: multi-purpose bond that gives satisfactory results on most applications
B28	Foundry wheels: high level bond suitable for most technical applications requiring high powered machines

Cutting-off wheels

BF1	Specific bond ensuring the best quality of cut in dry or wet conditions
BF3	New generation bond assuring the best wheel life in dry cutting operations; versatile & long wheel life. Ideal for heavy duty operations
B24	New generation bond used on silicon carbide cut-off wheels that gives the best performance & the ultimate cut quality on non-ferrous metals in wet conditions
B25	Standard multi-purpose bond that offers durability & freeness of cut in a wide variety of materials & applications. Can also be used in wet cutting on softer grades
B26	New generation bond used on aluminium oxide cut-off wheels that gives the best performance & the ultimate cut quality on ferrous metals in wet conditions
B65	Traditional bond gives good performance & long wheel life in dry cutting conditions

Wheel grades

The grade indicates the relative holding power of the bond, which holds abrasive grains in a wheel.
This is represented in the specification by letters running through the alphabet from hardest to softest.
The following rules should be followed with regard to grade:

Use soft grade

- For hard materials such as hard tool steels & carbides
- For large areas of contact
- For rapid stock removal

Use hard grade

- For soft materials
- For small or narrow areas on contact
- For longer wheel life

Common range of grades

E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
					Cylindrical / Centreless											
Surface Grinding																
					ID Grinding											
				Tool Grinding												
						Thread Grinding										
	Non-reinforced Organic															
											Reinforced Organic					

Availability summary

Abrasive type	Bond	Abrasive colour
IPA	VTX	White
SGB-3SG-5SG-ES5-1TGP	VX-VXP	Blue
A–19A	VS	Brown
86A	VS-VXP-VTECH	Ruby
38A	VS	White
37C	V-VP	Black
39C	V-VS	Green

Selecting the right product

There are nine main factors to be considered when selecting a grinding wheel for any application:

- The material to be ground – its type & hardness
- The stock to be removed
- The workpiece geometry & surface finishes required
- The grinding machine, the type of machine, the power available & its conditions
- Wheel speeds & feeds
- Grinding contact area
- Grinding fluid – whether the operation is wet or dry
- The severity of the grinding operation
- The dressing method

Material to be ground

The type of material affects the selection of abrasive, grit size and grade. Alumina type abrasives are the most suitable for grinding high tensile materials such as steel and ferritic cast irons. The more friable types of alumina are preferred on harder steels and applications having large arcs of contact.

Low tensile strength materials and non-metallic materials are most efficiently ground or cut with silicon carbide abrasive.

The hardness of the material governs the amount of penetration that can be achieved by the abrasive. For this reason finer grit size wheels are required to grind hard materials and soft materials are best ground with medium to coarse grit size wheels.

For most efficient operation, the grade must be adjusted to suit the hardness of the material. As a general guide, the harder the material, the softer the grade of wheel required.

Stock to be removed

This affects the choice of abrasive size and bond type.

High stock removal rates, as in fettling operations, require coarse grit wheels, typically 12 to 24 mesh. Fine finishes and tight limits on finished workpiece geometry require finer grit sizes.

Final surface finish is often achieved by ‘spark out’. No further infeed is applied and the wheel is allowed to grind until the majority of the grinding sparks cease.

Surface finish

Usage key ● Highly recommended		Surface finish & Grit size							
Surface	Finish	Grain size							
µ in CLA	µ m Ra	46	60	80	100	120	150	180	220
42	1,10	●							
32	0,80	●							
26	0,70	●							
21	0,50		●						
16	0,40		●						
14	0,35		●	●					
11	0,25		●	●					
8	0,20			●	●				
7	0,17			●	●	●			
6	0,14				●	●	●		
5	0,12					●	●	●	
4	0,10						●	●	●
3	0,08							●	●
2	0,05								●
Min form radius	Metric (mm)	0,75	0,50	0,40	0,25	0,20	0,18	0,13	0,10
	Imp Ins	,030	,020	,015	,010	,008	,007	,005	,004

The achievable surface finish in any grinding operation is highly dependent upon the grit size of the grinding wheel. The following chart shows the range of surface finishes achievable when using grinding wheels of different grit sizes on conventional precision grinding applications, together with the minimum form radius that can beground using each grit size.

Other factors can affect the surface finish achieved. In particular:

- Production grinding applications, with higher stock removal ranges, will give surface finishes at the coarser end of the range
- Plunge grinding applications will often require the selection of a grit size one size finer than shown
- Dressing techniques & the type of material can also affect the surface finish achieved

Achieving improved surface finishs

By changing the wheel dressing technique, it is possible to achieve finer surface finishes than those shown. As well as reducing the dresser infeed per revolution of the grinding wheel, it is also possible to reduce the infeed and traverse rate when grinding, thus reducing the stock removal rate. Obviously this approach will have limited application in production grinding but it can be very useful in tool room work.

The grinding machine

The type of machine can effectively define the grinding contact area and the ease with which grinding fluid can be applied to the grinding zone.

The power available on the machine governs the stock removal rate. The greater the power available, the harder the grade of wheel that is required for efficient operation.

Any deterioration in the condition of machine bearings and slideways will lead to vibration and, consequently, premature wheel breakdown. This can, in part, be overcome by using a harder grade wheel and/or a tougher abrasive but the only effective solution is to maintain the machine as recommended by the machine manufacturer.

Speeds & feeds

The effect of speeds and feeds on grinding action and, hence, the selection of wheel, can best be summarised in the following table:

Effect on grinding action

Speed	Increased	Decreased
Wheel speed*	Harder	Softer
Work speed	Softer	Harder
Traverse speed	Softer	Harder
Infeed rate	Softer	Harder

*The maximum peripheral speed (m/s) specified for the wheel must never be exceeded

Grinding contact area

The contact area affects the selection of wheel grade and structure. Large contact areas, as on segmental grinders, generally produce low grinding pressures and require soft grade, open structure wheels. Induced porosity wheels are most efficient for grinding very large contact areas. Conversely, small contact areas, as on cylindrical grinding machines, require harder grade and/or closer structure wheels.

The size of workpiece can also affect the grinding contact area. In general, the larger the workpiece, relative to the grinding wheel diameter, the larger the contact area, requiring softer grade wheels.

Grinding fluid

Dry grinding with vitrified wheels require wheels one or two grades softer than when wet grinding.

Severity of the grinding operation

This can affect the choice of abrasive type, grade and even bond type. Where the wheel is subjected to shock loads, as in fettling operations, a resinoid bond should be used. In general, the more severe the grinding operation, the harder the grade of wheel required and the tougher the abrasive that can be used. Severity of grinding operation can be due to heavy infeeds, high work speeds and traverse rates or intermittent grinding contact. The latter is usually due to workpiece geometry, resulting in a dressing action on the wheel.

Grinding wheel dressing & truing

Truing and dressing of grinding wheels are often considered to be the same thing, since they are frequently performed as one operation. Truing is performed to ensure concentricity and introduce any profile that may be required on the wheel face. Dressing conditions the wheel surface to give the desired cutting action.

Bonds

To meet the challenges of the wide diversity of grinding applications, it is inevitable that a wide range of bond systems is required. Bonds are categorised according to the fundamental material type used, and many variations exist within each type.

Resin bond systems

These are based on either phenolic or polyimide resins, usually together with added fillers, as well as the abrasive grains. Resin bonds are at the lower end of the hardness scale, and are used in a wide range of applications due to their fast and cool grinding behaviour.

Sintered metal bonds

Most metal bonds are based on bronze, although harder systems may be based on steel or even hardmetal. Sintered bronze bonds are relatively soft and at their softest can overlap the hardest resin bonds. Steel and hardmetal bonds are more wear resistant, so therefore act harder and grip the abrasive grains more strongly, leading to longer tool life, although the abrasive can sometimes appear blunt.

Metal bonded grinding wheels generally grind more slowly, in most applications acting harder, and more grinding heat is developed than in resin bonded wheels. However, metal bonds can also readily dissipate heat, which also impacts the grinding process. Metal bonds are ideal for grinding wheels with sharp edge profiles, and for machining abrasive materials that would otherwise wear the bond. Furthermore, metal bonds are shock-resistant, and are suitable for very aggressive operating conditions. Metal bonds are mostly used in wet grinding. Special variants are crushable, brittle metal bonds that can be dressed on the machine in a special crushing process. These bonds are especially useful in creep feed grinding.

Electroplated bonds

In this bond system, the metal bond is deposited electrolytically onto a bronze or steel body. The grit is tenaciously achored by the bond, and grain tips can protrude from the bond layer by 30 - 50 % of the grain diameter. This leads to a grinding layer with a very high material-removal-rate capability. However, only the outermost grain layer acts in this way, which is why these tools are mainly designed in single-layer versions. Such single layer bond systems are suitable for profiled wheel bodies of all kinds; profile accuracy is dependent on the grit size specified.

Vitrified bonds

Vitrified bonds are based on fusible glasses combined with fillers and the abrasive grains. While resin and metal bonds are generally fully dense, vitrified bonds are usually produced with a defined porosity, and are available in different hardness levels. This variation in porosity and hardness is analogous to the vitrified bonds of conventional grinding wheels. The main features of vitrified bonds are:

— Good dressability and profileability
— Free-cutting due to the porosity and self sharpening behaviour
— Fluid availability, due to porosity, in the grinding zone allows cool grinding at low grinding forces
— High cutting speeds and material removal rates are possible.

Concentration

According to the WINTER system, the concentration value defines the volume fraction of diamond or cBN in the abrasive layer as follows:

Diamond		
Concentration	Carat / cm³	Volume %
C50	2,2	12,5
C75	3,3	18,75
C100	4,4	25
C125	5,5	31,25

CBN		
Concentration	Carat / cm³	Volume %
V120	2,09	12
V180	3,13	18
V240	4,18	24
V300	5,22	30

These definitions are not applicable for single layer electroplated tools.

Conditioning

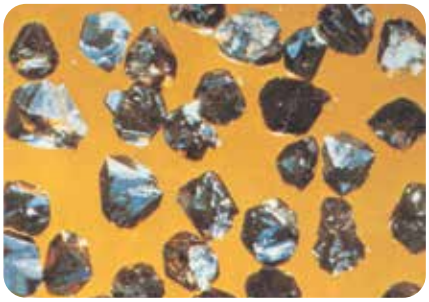
Conditioning of a grinding wheel consists of dressing and cleaning:

Dressing		Cleaning
Profiling	Sharpening	
Influences macrostructure	Influences microstructure	Influences microstructure
Produces concentricity and grinding wheel profile	Generates topography and grain exposure by eroding the bond	Removes chips from chip space
Need: Shape or re-shape the wheel surface	Need: Create grit protrusion	Need: No change in the surface

Cubic boron nitride (CBN)

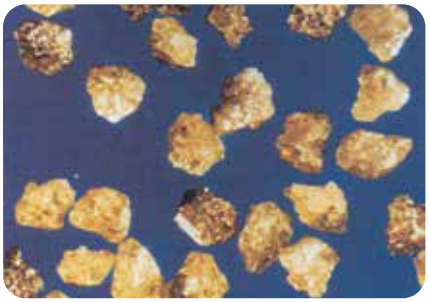
Boron nitride is found in two structural modifications: Cubic boron nitride (CBN) has the zinc-blende crystal structure equivalentto diamond, and has a hardness just a little below that of diamond. The graphite-like hexagonal modification of boron nitride (HBN) is soft and is used as a lubricant.

Compared to diamond, CBN has technological and economic advantages when grinding materials having a chemical affinity to carbon, such as steels and ferrous alloys. Applications for CBN are becoming increasingly economic, and CBN grinding of workpieces with hardness as low as 50 HRC have been demonstrated.



Diamond

Together with graphite and fullerenes, diamond is one of the three carbon modifications and, with a Moh‘s hardness of 10, diamond is the hardest material known. The grinding (Rosiwal) hardness is 140 times higher than that of corundum. Because of its hardness and wear resistance, diamond is used for grinding hard, brittle and short-chipping materials. Examples are tungsten carbide, glass, ceramics, quarz, semiconductor materials, graphite and wear-resistant thermal spray alloys as well as hardfacing alloys, plastics with glass fiber reinforcement and other difficult to machine materials. Natural diamond is used as well as synthetic diamonds.



Direction of rotation indicator

Resin and metal bond diamond and cBN grinding wheels always show an indicator for the direction of rotation. At the end of the production chain of a multilayer grinding wheel is the profiling and sharpening process. In the sharpening process, a bond tail is formed behind each of the active abrasive grains. This bond tail supports the grain and prevents the grain from untimely fracture. If the wheel is mounted the wrong way round, this bond tail would precede the grains during cutting, which would lead to lower chip-space, increased grinding pressure, and early grain fracture. Therefore, it is important to adhere to the rotational direction shown by the indication arrow or to re-sharpen the grinding wheel before use, if you chose to change the direction of rotation.

Dressing = Truing + Sharpening

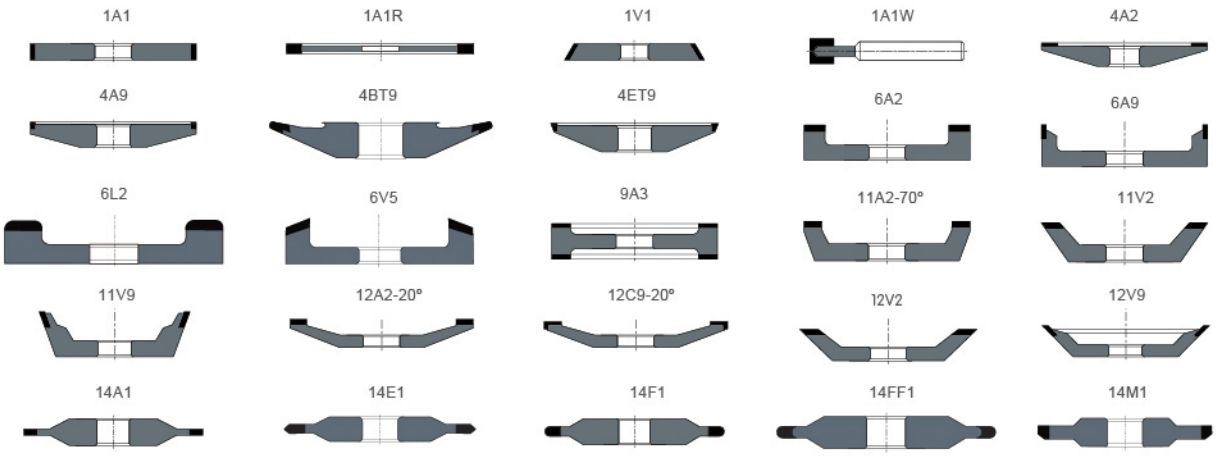
It is necessary to distuinguish between the key wheel preparation steps of truing, sharpening and cleaning of the grinding wheel surface.

Dressing describes the processes of truing and sharpening a grinding wheel. When grinding with conventional alumina or silicon carbide wheels, "dressing" is the combined process of truing and sharpening. However, for superabrasive grinding wheels containing either diamond or CBN abrasives in a resin or metal bond, after truing, a separate sharpening step is usually required to remove some of the bond material and expose the grains. In addition, the grinding wheel surface must be cleaned (Dressing + Cleaning = Reconditioning) periodically. The dressing interval depends upon the grinding process parameters being used, and the type of workpiece material being ground.

Grinding wheel truing generates the correct geometric shape, develops the necessary concentricity, and also removes any surface contamination. In so doing, worn blunted grains are either removed or resharpened, and fresh grains are exposed. To achieve optimum results, dressing tools, dressing parameters and dressing strategy must be finely tuned to the grinding wheel and grinding process. Therefore, different tools and methods are used, such as either alumina-based or SiC sharpending stones, SiC grinding wheels, the WINTER brake-dressing device, CNC rotary dressers, diamond dressing sticks, rotary profile dressers, etc.

FEPA-Shapes

These drawings show the most important grinding wheel geometries:



Grinding

According to DIN 8589, grinding is defined as material removal using geometrically undefined cutting edges. All grinding wheels with either diamond or cubic boron nitride (CBN) are grinding tools according DIN 8589. The “cutting edges“ are composed of the diamond or CBN grit.

Grinding ratio (G-ratio)

The grinding-ratio is calculated as a ratio of the ground workpiece volume V_W to the wheel wear volume V_S.

Grinding wheel bodies

The body of a grinding wheel provides the static and dynamic stiffness to the tool. Dependent on the kind of grinding layer, it may consist of aluminium, filled resin, brass, steel or ceramics. The body significantly influences the vibration behaviour and the thermal conductivity of the grinding wheel; the following table shows examples for superabrasive grinding wheel bodies.

Body material type	Label	Vibration Absorbtion	Heat Transmission	Mechanical Stiffness
Resin with metal fillers	H	medium	sufficient	good
Resin with non-metallic fillers	B or D	good	bad	satisfactory (not sufficient with thin-walled bodies)
Aluminium	A	bad	good	very good
Steel	E	bad	satisfactory	very good
Copper	C	bad	very good	very good
Composite material	CFK	good	bad	good

Grit sizes

The seive-sizes for diamond and CBN range according to FEPA standards (also ISO 6106) and are shown in the following table. As abrasives always contain a range of grit sizes, the values given for average grit sizes and particles per carat are approximations. D-prefix indicates diamond, while B-prefix refers to CBN.

FEPA grit size D or B	Standard [Mesh]	Average grit size [µm]	Particles per ct
1181	16/18	1100	60
1001	18/20	930	100
851	20/25	780	160
711	25/30	660	270
601	30/35	555	450
501	35/40	465	760
426	40/45	395	1200
356	45/50	330	2100
301	50/60	280	3500
251	60/70	233	6000
213	70/80	197	10000
181	80/100	167	16000
151	100/120	140	28000
126	120/140	118	46000
107	140/170	99	80000
91	170/200	83	135000
76	200/230	72	200000
64	230/270	63	300000
54	270/325	55	460000
46	325/400	47	750000
39	400/500	38	1400000
33	500/600	33	2100000

WINTER has its own classification for fine and microgrit sizes. FEPA standards are similar (M 63…M1.0).

WINTER diamond classification	Grit size [µm]
D 25	40 - 60
D 20 C	34 - 45
D 20 B	25 - 37
D 20 A	20 - 30
D 15	8 - 25

WINTER diamond classification	Grit size [µm]
D 15 C	15 - 25
D 15 B	10 - 20
D 15 A	8 - 15
D 10	6 - 10
D 7	5 - 10
D 5	3 - 7
D 3	2 - 5
D 1	0,5 - 2
D 0,7	0 - 1
D 0,25	0 - 0,5

Hardness of abrasives

The hardness value of a material is generally influenced by the method of measurement. Different measuring methods and equipment result in different scales and units which cannot easily be compared. Thus several scales exist, for example:

Moh‘s hardness: abrasion behaviour (measure of scratch resistance)
Rosiwal hardness: stock removal behaviour (measure of resistance to stock removal)
Vicker‘s Microhardness: indentation behaviour (resistance to penetration)

In the following table, different hardness values for abrasives are given and compared to some reference materials:

Material	Moh‘s Hardness	Rosiwal Hardness	Vickers Microhardness (HV)
Diamond	10	140,000	10,000
CBN	9,9		9,000
Silicon carbide	9,6		2,600
Corundum	9	1.000	2,060
Quarz	7	120	1,120
Manganese	5	6.5	540
Gypsum	2	1.25	36
Talc	1	0.03	2.6

Diamond‘s stock removal resistance (Rosiwal hardness) is 140 times higher than corundum (alumina), even though its penetration hardness (Vickers) is only 5 times higher.

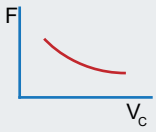
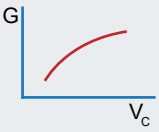
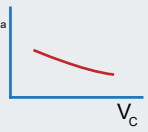
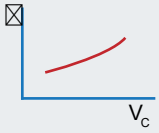
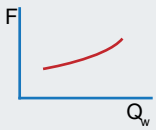
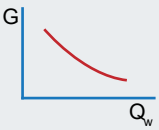
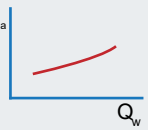
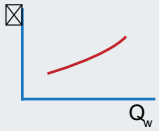
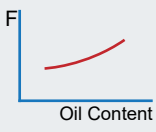
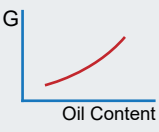
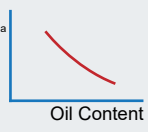
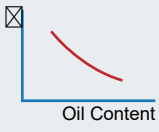
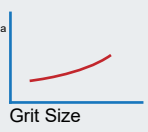
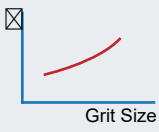
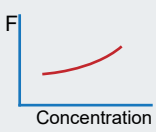
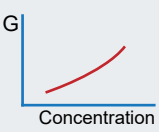
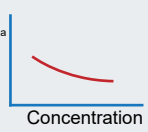
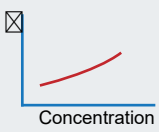
Material removal rate

The material removal rate, MRR, is expressed in mm3/s and defines the volume of workpiece material ground per unit time (second).

The specific material removal rate, MRR', refers to the removal rate per millimetre of wheel contact width and is expressed in units of [$mm^3/(s \cdot mm)$].

Parameters influencing grinding results

The table shows some correlations between process variables and the grinding results.

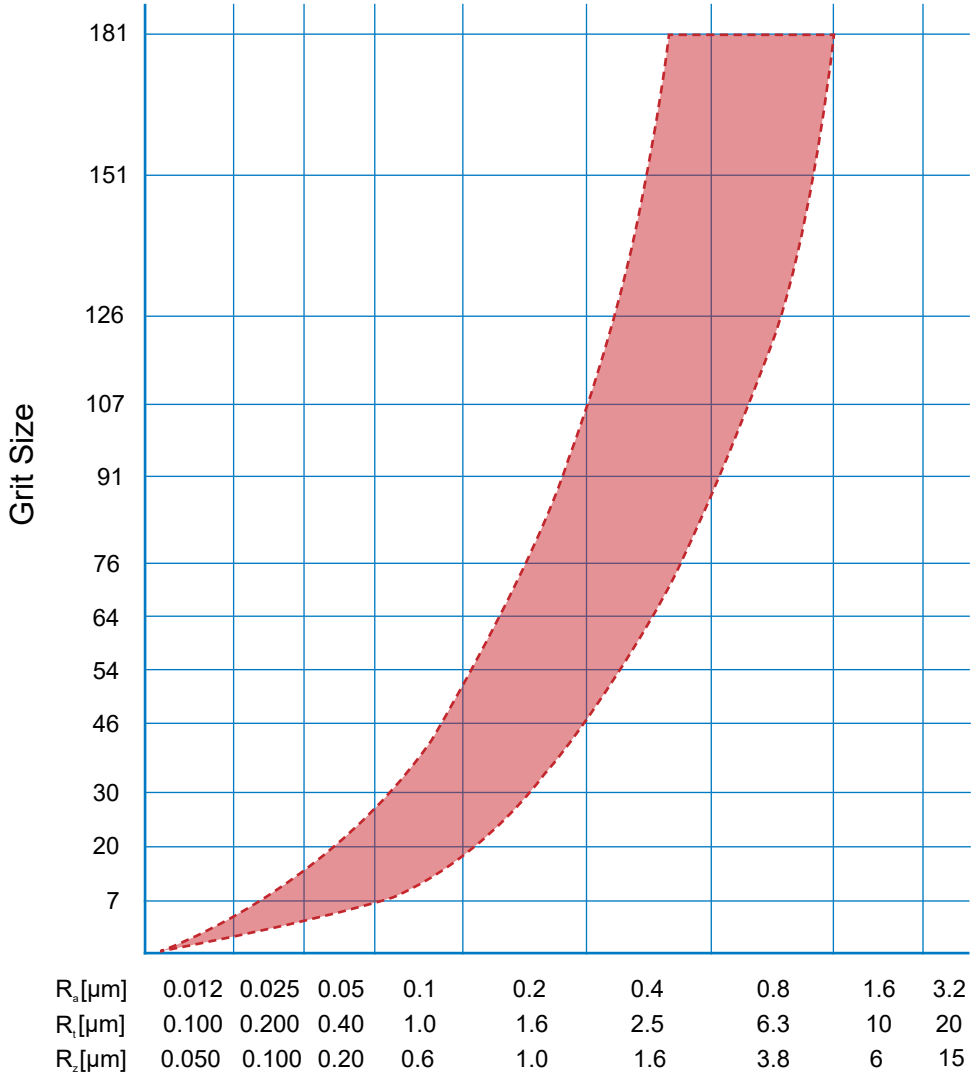
Influencing Paramters \ Appraisal criterion		Cutting Force F F= f(…)	Grinding Ratio G G= f(…)	Roughness R_a R_a= f(…)	Temperature☒ ☒= f(…)
Machine- and Operation Paramters	Cutting Speed v_c(m/s)				
	Material Removal Rate Q_w (mm^3/s)				
	Coolant (Oil Content)				
Grinding Wheel	Grit Size (µm)				
	Concentration (Carat/cm^3)				

Roughness

The surface roughness of a ground workpiece is influenced by many diverse parameters:

- Grit size of abrasive grain
- Concentration of abrasive grain
- Specification of bond system
- Type and hardness of work piece
- Grinding process
- Grinding parameters
- Dressing parameters

A general and qualitative correlation between grit size and surface roughness is shown below:



Specification

The specification is the general description of the grinding tool and contains all relevant information concerning the product's features. In general, the specification always contains the following details:

Example:

11V9	100-2-10-20	D126	K+888R	C75	A
Shape	Dimension	Grit Size	Bond	Concentration	Body Material

Furthermore, the specification can contain additional information regarding drawing index, production method, structure, and other details.

Superabrasives

Diamond and cubic boron nitride are the hardest materials existing in industry today, according to the current state of knowledge. The levels of hardness of diamond and CBN are significantly higher than those of conventional abrasives like alumina (corundum) and silicon carbide (see hardness).

Wear effects on diamond and CBN

The hardness of an abrasive grit type alone is not sufficient to determine the grinding tool's grinding behaviour. Diamond and CBN grains can wear in many ways, causing different effects.

Primarily, there are two main types of wear.

Mechanical wear:

Abrasion, micro-chipping of cutting edges, grit macrofracture, and breakout of grain from the bond.

Chemical and thermal wear

Carbon diffusion, graphitization, oxidation, and reaction with grinding fluids.

Diamond not only reacts with iron (above a certain threshold temperature), but also with chromium, vanadium and tungsten. CBN does not show chemical reaction with iron or other metals.
Therefore, CBN has proven to give better tool performance when machining, for example, high speed steel, although it is not as hard as diamond.
An outward sign of the occurance of thermo-chemical wear is the rapid appearance of wear flats on the grains, when no grain chipping from mechanical wear is present.

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