# MASTER®

## Grinding Wheels

SOLUTIONS FOR INDUSTRY

www.master-abrasives.co.uk

MASTER®

# Introduction

## Master Abrasives

Master Abrasives has a hard and long earned reputation in the UK abrasives market for providing solutions with high quality products and professional service. Established in Daventry in 1967, we have served British industry for over half a century, now as an independent UK owned abrasive company with an extensive range of abrasive products and applications engineering support. The MASTER® brand provides solutions for industry, offering high quality as well as affordable products and services.

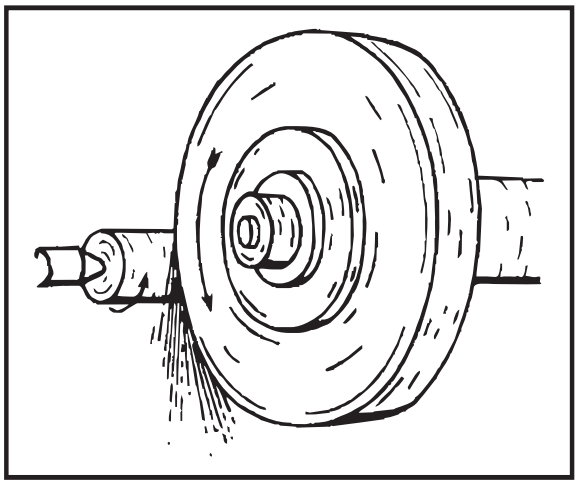

Master branded grinding wheels are manufactured to EN 12413 and provide consistently high quality under ISO 9001. The product range is extensive covering vitrified and resin bonds. Complementing the Master branded grinding wheel selection is the comprehensive range of dressing tools and auxiliary equipment.

Our engineers can assess your application needs and work with you to develop both the product and process with a view to optimising your productivity. Offering high quality products at competitive prices backed up by a professional and technical service, we aim to provide ultimate solutions for industry.

# CONTENTS

# GRINDING PROCESS

“Grinding” in simple terms can be defined as a process of abrasion. The material is removed by using sharp abrasive grains on the face or on the sides of bonded grinding wheels. The grains actually cut chips out of the work. The two major types of grinding are off-hand grinding and precision grinding.



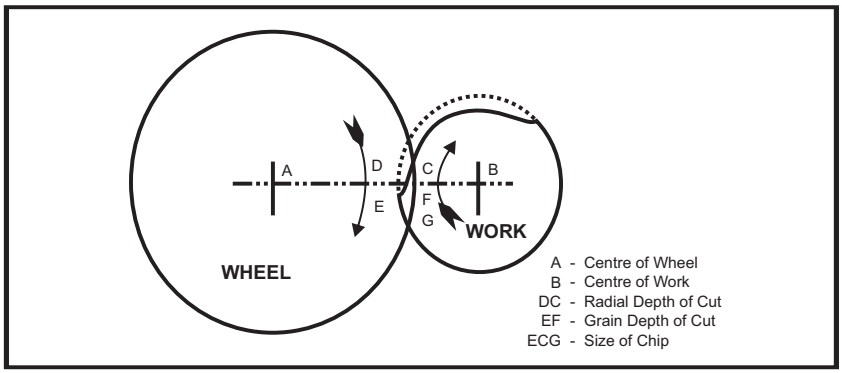
A Grinding wheel actually cuts away chips from the piece being ground

**Off–hand grinding or non-precision grinding** is where the grinding wheel is applied manually to the work or where the work is applied off-hand to the grinding wheel. Off-hand grinding includes snagging of castings/forging, tool sharpening, weld grinding, cutting off, bench grinding or pedestal grinding applications.

**Precision grinding** is machine grinding where the traverse and or feed rates can be set and process parameters are measured and controlled. As the name indicates, here the need is more on surface finish, geometry, size control etc. Precision grinding operations include Cylindrical grinding, Centreless grinding, Internal grinding, Surface grinding , Tool and Cutter grinding, Thread grinding, Crankshaft and Camshaft grinding.

**A Grinding Wheel** is basically a precision tool composed of abrasive grains held together by a bonding material or ' bond'. The abrasive grains provide the wheel with its cutting points , which in turn help in cutting the material to the required dimensional accuracy or help impart a fine surface finish.

The arrangement of the abrasive grain and the bond in the grinding wheel gives a definite characteristic known as **'structure'** or **'pores'**. These pores are designed based on application needs and provide for chip clearance.




The abrasive grain cuts into the work until it becomes dull. Then it breaks down (fractures) and exposes new cutting crystals with sharp edges to the work.

**Types of Abrasives :**

Aluminium oxide and Silicon carbide are the two major abrasives used in the manufacture of grinding wheels. These synthetic or manufactured abrasives allow accurate control over the form and physical characteristics of the abrasive grain. It is therefore used in the manufacture of grinding wheels with very specific requirements of performance allied to application needs.

**Aluminium Oxide**

This grain is derived by refining bauxite ores in an electric furnace. The bauxite is first heated to drive off moisture and then mixed with coke and iron borings to form the furnace charge. After the mixture has been fused and cooled, the resulting rock–like mass is crushed and screened into various sizes.

The colour and the toughness of the abrasive is determined by the amount of impurities (iron oxide, titanium oxide and silica).Toughness is also strongly affected by additives.

Aluminium oxide, the most popular abrasive by a wide margin, is usually recommended for grinding most steels, annealed, malleable and ductile iron, and non-ferrous cast alloys.

**White Aluminium Oxide** is a highly refined form of aluminium oxide containing over 99 % pure alumina. The high purity of this abrasive not only bestows its characteristic white colour, but also lends it with its unique property of high friability. The hardness of this abrasive is however similar to that of Brown Aluminium Oxide (1700 – 2000 kg/mm$^2$ knoop).

This white abrasive has exceptionally fast and cool cutting and grinding characteristics, especially suitable for grinding hardened or high speed steel in varied precision grinding operations.

**Zirconia**

Specialised alumina or Zirconia Aluminium Oxide is a fused mixture of zirconium oxide and aluminium oxide which is used for high production snagging. While sintered alumina, which is extremely tough, is ideal for billet conditioning and very high stock removal snagging operations.

**Pink Aluminium Oxide**

Aluminium oxide and chromium oxide alloy is used to combine the cool, low stress grinding action of high purity aluminium with low abrasive wear. The result is a pink grinding abrasive which is slightly tougher and less friable than white abrasive, while still retaining its free cutting properties. This is particularly well suited for grinding abrasive resistant, heat sensitive tool steels.

**Ceramic Aluminium Oxide**

Ceramic aluminium oxide abrasive is an extremely tough and durable abrasive produced in a unique sol or seeded gel process. The resulting grain is chemically quite pure, of uniform quality and is comprised of a complex polycrystalline micro structure. This is blended in varied percentages, with more friable conventional aluminium oxide, to make sol – gel wheels.

The wheel made out of this abrasive stays sharper because the grains actually discard microscopic crystals during use, which creates new grinding surfaces. Free cutting and with a much longer and more productive life, these wheels are best suited for a variety of applications including centreless, centred, micro-centric, surface, internal, tool and cutter grinding applications.

**Silicon Carbide**

Silicon Carbide (SiC) is produced by fusing a mixture of pure white quartz (sand) and fine petroleum coke in an electric furnace. This process is one of synthesising or combining the sand and coke, in contrast to refining bauxite into aluminium oxide. Again the resulting crystalline mass is crushed and graded by particle size.

Silicon carbide abrasives are not only harder than aluminium oxide abrasives but also more friable.

These characteristics make silicon carbide abrasives ideal for grinding low tensile materials like grey iron and unannealed malleable iron, non-metallic materials such as glass, gem stones, plastic and rubber.

There are two types of Silicon carbide, Black Silicon carbide “C” & Green Silicon carbide “GC”.

Black Silicon carbide is very hard and more friable than Aluminium Oxide. It is used for general grinding, heavy duty snagging, cylindrical, centreless and internal grinding. With a specialised bonding process, it is also used for grinding cemented carbide, for bench grinding and centreless grinding applications. Also used for non–ferrous material, cast iron, stainless steel and rough grinding applications.

Green Silicon carbide is also hard and friable. It is used for hard and high chilled cast iron, rolls etc.

**Diamond**

Diamond is the hardest known substance. Until recently, use of diamond abrasive was generally limited to hard and dense materials like cemented carbides, marble, granite, glass and ceramics. However, recent developments in manufactured diamonds leading to controlled crystal configurations and surface coatings have expanded its use in some specialised cases, for grinding of other metals also.

**Cubic Boron Nitride (CBN)**

This newest manufactured abrasive has a hardness second only to diamond and is 2.5 times as hard as aluminium oxide. It can withstand a temperature of 300° C, unlike diamond which begins to burn around 600°C. In its metal-coated form, CBN has proven generally superior to both manufactured diamond and aluminum oxide in grinding super hard, high speed steel, tool steel and die steel.

**Aluminium Oxide / Silicon Carbide Mix (AC)**

A blend of Aluminium Oxide and Silicon carbide, this is used for specialised precision and non-precision applications.

# TYPES OF BONDS

## Types of Bond used in grinding wheels

The various bonds used in grinding wheels or bonded abrasives are Vitrified, Resinoid, Rubber, Silicate, Shellac, Magnesite and Metal bonds. Besides holding the grains in the wheel, these bonds also help in defining the type and character of the grinding wheel.

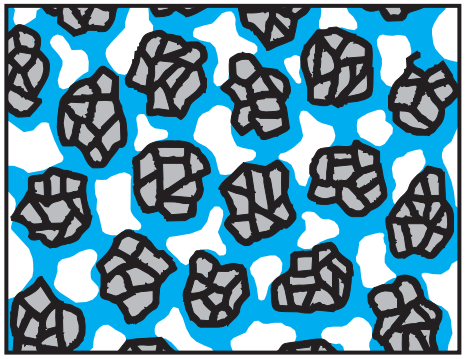


Illustration showing bond “Post” holding abrasives grain particles (Cyan portion representation bond “Post”)

## Vitrified (V) or Ceramic bonds

These are made from clays, feldspar and other fusible materials in a carefully monitored process. Wheels which use this bond have a porous structure and are fired in kilns with temperatures exceeding 1000$^{\circ}$ C. Vitrified wheels are unaffected by water, acids oils or normal temperature variation. The porosity and strength of these wheels make them ideal for high stock removal operations. Added to this, Vitrified bonded wheels have a high modulus of elasticity and this rigidity makes them suitable for precision grinding applications.

## Resinoid or Organic (B) bonds

Resinoid or Organic Bonds are made from phenolic type ‘plastics’ or ‘resins’ and cured in ovens under carefully controlled conditions of temperature ranging between 150$^{\circ}$ c to 200$^{\circ}$ c. Resinoid wheels are tougher and less rigid than vitrified wheels and are ideally suited for high operating speeds and also for heavy duty of operations, often with the aid of fabric or steel ring reinforcement. Their lower modulus of elasticity helps in achieving finer finishes. Unlike vitrified wheels, resinoid bonded wheels are affected by alkali, humidity or extremes of climatic conditions and tend to deteriorate over a period of time.

**Rubber (R) bonds**

These are made of both natural and synthetic rubber in a varied range of formulations. Used mainly in centreless and control wheels, these are ideally suited for grinding operations that require a high degree of precision and fine surface finish. In wet grinding operations, thin cut-off wheels used to produce burr and burn free cuts are also made of rubber.

**Silicate (S) bond**

This type of bond releases abrasive grains readily and thus gives the wheels a comparatively mild and cool cutting action ideal for operations that require minimum heat and for sharpening edged tools.

**Shellac (E ) Bonds**

Denoted by the letter “E” these are made of both natural and synthetic shellac. Wheels made from these bonds have exceptionally cool cutting properties and are particularly suited for grinding very soft materials such as copper. Shellac bonded wheels are highly recommended for very special grinding applications that require high surface finish such as razor blade and roll grinding.

**Magnesite (O ) Bond**

Magnesium Oxychloride denoted by the letter “O” is once again used in a very limited range of wheels. It is cool cutting even without a coolant and is greatly favoured in disc grinders. Being a cold setting bond this is also used for grinding heavy stocks like spring grinding, file grinding etc.

**Metal Bonds**

Compared to vitrified and organic bonds, the use of metal bonds is very limited. The major use of metal bonds is with diamond abrasive for grinding under harsh conditions. The metal bonded diamond wheel removes material slowly and frequently with high heat generation, but in many applications such as certain glass grinding, abrasive wheel shaping and concrete or stone sawing, the long life out weighs these disadvantages.

Metal bonds are also used with aluminium oxide or diamond abrasives to provide conductive wheels for electrolytic grinding.

# ABRASIVE TYPES, PROPERTIES & USAGE

| Abrasive | Abrasive denotion | Properties | Major Applications |
|---|---|---|---|
| Brown Aluminium Oxide | "A" | Very tough abrasive | Used for heavy duty work such as snagging steel casting and for stock removal in cylindrical grinding, on all but the hardest and most heat-sensitive steels like low alloy steel, cast cast steel and rough grinding applications. |
| White Aluminium Oxide | "WA" | More friable than Brown Aluminium Oxide. This is also a cool cutting grain. | WA is used for light grinding of all kinds of hard, heat-sensitive steels. It is excellent for tool room grinding, sharpening of high speed steel, cast alloy tools like hardend steel, H.S.S., Tool steels S.S (400 series) and chrome plated material. It is also recommended for cylindrical, surface and internal grinding applications of tools, dies and gauges. |
| Mixture of brown and white aluminium oxide | "DA" or "MA" | DA is a blend of brown regular A and white WA and therefore, has intermediate grinding actions. | Used in applications where high stock removal rate with less thermal damage and better form holding is required. E.g. : Cylindrical plain and angular head grinding, camlobe grinding, Inner ring track grinding, bore grinding. |
| Pink Aluminium Oxide | "PA" | PA (Pink)-Chromic oxide alloyed with Brown Regular alumina give a darker pink abrasive, which is very sharp and less friable than white aluminium oxide. | Very cool cutting, retains better form and a sharp cutting edge for a longer time. Used for bore grinding, cylindrical and some specialised precision applications, good on tool steel, H.S.S. applications where protecting components from thermal damage is of critical importance. |

| Abrasive | Abrasive denotion | Properties | Major Applications |
|---|---|---|---|
| Pink aluminium oxide | "PWA" | PWA (Pink)-Chromic oxide alloyed with white aluminium gives a pink abrasive. Free cutting properties, slightly tougher and less friable than white aluminium oxide. | Excellent for dry grinding in tool sharpening and tool room grinding applications. Very cool cutting and sharp on 5% to 10% cobalt steels, Alloyed HSS and on difficult-to-grind materials. A popular abrasive and cost effective for tool room applications. |
| Black silicon carbide | "C" | Very hard and more friable than Aluminium oxide | It is used for general grinding, heavy duty snagging, cylindrical, centreless and internal grinding. With specialised bonding process, it is also used for grinding cemented carbide, for bench grinding and centreless grinding applications. Also used for non-ferrous materials, cast iron, stainless steel and rough grinding applications. |
| Green silicon carbide | "GC" | Hard and friable | Used for grinding cemented carbide tools, hard and high chilled cast iron rolls etc. |
| Combination of black and green SiC | "CGC" | Combined properties of C and GC | Used mainly in the mining field and also in double disc grinding application for grinding piston rings. |
| Blend of Aluminium oxide & Silicon carbide | "AC" | Combined properties of A and C. | Used mainly in specialised precision and non precision applications. |

| Abrasive | Abrasive denotion | Properties | Major Applications |
|---|---|---|---|
| Zirconia with Brown Aluminium Oxide | “ZA” | Free cutting, very tough and long life abrasive | Ideal for heavy stock removal operation. Used for de-scaling in stainless steel applications. |
| Micro Crystalline Grains | "MCA" | High hardness and micro fracturing | It is suited for a wide variety of applications from general grinding to precision grinding of high hardness tools and steels. E.g. Internal Grinding wheels, gear grinding wheels, Tool Industry (flute grinding wheels). |
| Ruby Grains | "RB" | The presence of chromium oxide in the lattice of the fused aluminium oxide alters the friability of the material | Used mainly in vitrified bonds for precision grinding of hardened steel, high speed steel and tool steel. |
| Semi friable Aluminium Oxide | "FS" | Its friability and chemical composition is in between that of brown and white aluminium oxide. | Good form holding and a high degree of versatility makes its suitable for precision grinding operations E.g. crankshaft, surface and cylindrical grinding of sensitive steels, metal, and alloys due to its particularly cool and fast cutting qualities. |
| Sol Gel Grain | "CG" | Multi fracturing | Very cool cutting with self sharpening cutting edges. Very durable, this abrasive is ideal for very high material removal. E.g.: Used in centerless micro-centric, surface internal, cylindrical, tool & cutter, roll grinding gear grinding etc. |

# ELEMENTS OF ABRASIVES

### Grain or Grit Size

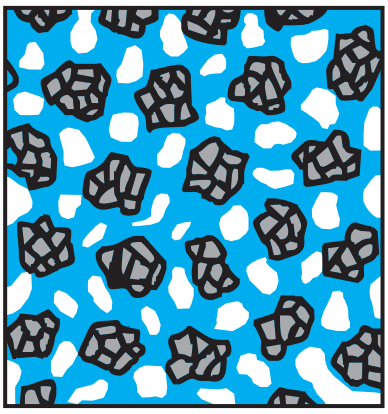
The size of the abrasive grain is expressed by the size of the screen opening through which the grains are sifted or sorted. For instance, a grain or grit which goes through a screen 8 mesh or openings per linear inch is called 8 grain or grit size, while a 24 grit size is roughly twenty fourth of an inch across. The higher the grit size, the finer its type.

### Structure

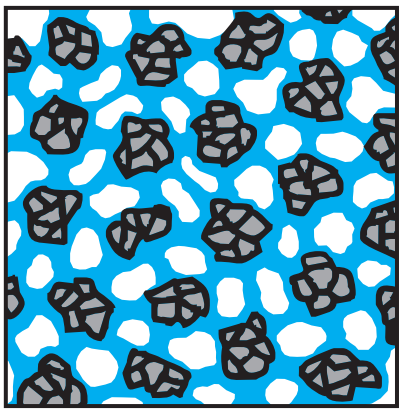
This is basically the spacing of the abrasive grains in a wheel or the volume content of the abrasive in the wheel. This is defined by the 'voids' or spaces between the abrasive grain and the bonding material and is called wheel 'porosity'. A 'close' structure wheel is one where the volume of closely packed grains are more. These are given structured numbers of 1 and 2. Conversely, 'open' structure wheels are those with wider grain spacing.

### Wheel Grade

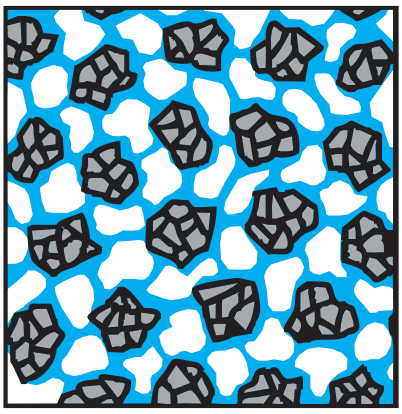
This is generally a measure of 'hardness' or bonding strength of the wheel. For a wheel of a particular bond type, the amount of bond used in the wheel mainly determines its hardness. When the amount of bond is increased, the size of the bond posts connecting each abrasive grain to its neighbours is also increased. The larger bond post is naturally stronger, thereby increasing the wheel's hardness.



Strong “Posts”
(closed structure)



Medium Strength “Posts”



Weak “Posts”
(open structure)

Grade is therefore not a measure of the hardness of the abrasive material but of the durability of the wheel. A hard abrasive can be bonded into a 'soft', free cutting wheel by using less bond, while an increase in the amount of bond can make the wheel act harder. Wheel gradings range from 'D' for the softest, to 'Z' for the hardest.

# HOW TO SPECIFY A WHEEL

To specify a grinding wheel requirement, it is important to follow the following steps:

**Standard Wheels :**

1. Specify the wheel size by quoting in mm the overall dimension of

   Diameter x Thickness x Bore

   The diameter and thickness can be specified in nominal dimension whereas the bore diameter should be indicated to the closest two decimal places.

   E.g 400 x 53 x 127 mm

2. Indicate the type and shape of the wheel face.

3. Specify wheel grading.

**Customised Wheels:**

1. Specify the dimensions in the order of

   Diameter x Thickness x Bore

2. Mention the type of wheel required.

3. Indicate the recess size and depth for types 5 & 7 wheels (ROS & RBS)

4. Indicate the shape of the wheel face, if it is applicable

5. If the dimension has special tolerance of diameter, thickness or bore, this needs to be indicated.

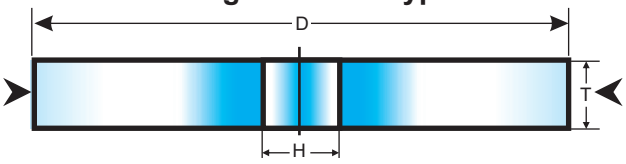
6. Specify wheel grading.

7. A detailed drawing of the wheel to be provided.

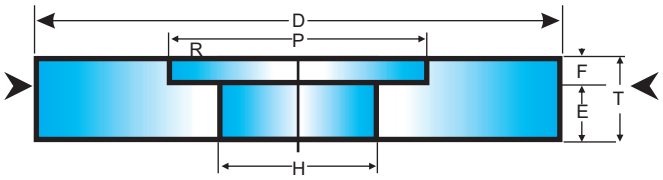
Grinding wheels can be manufactured in a wide range of standard shapes or customised to different application requirements. For ease of selection, refer to the list of Standard Grinding Wheel Shapes.

# STANDARD GRINDING WHEEL SHAPES

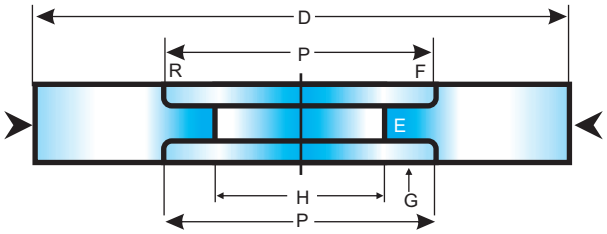
## Straight Wheels Types




Type No. 1 – Straight



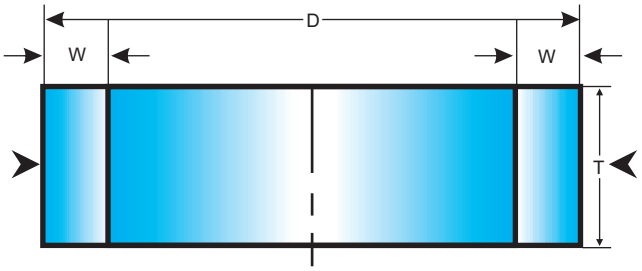

Type No. 5 – Recessed One Side




Type No. 7 – Recessed Both Sides

### Straight Wheels

Wheel Type Nos.1, 5 & 7 are standard for internal grinding, cylindrical grinding, tool grinding, off-hand grinding and snagging. The recesses in Type Nos. 5 and 7 give clearance for the mounting flanges.



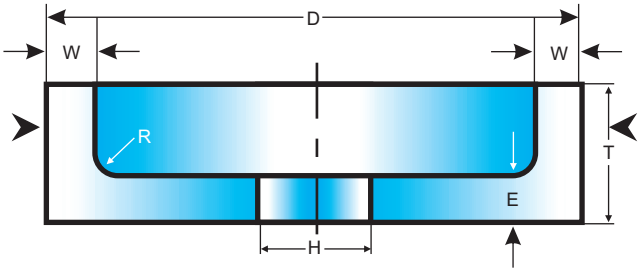

Type No. 2 – Cylinder

### Cylinder Wheels

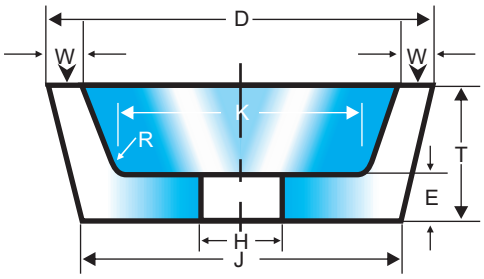
Wheel Type No.2 is used for surface grinding on both horizontal and vertical spindle machines with the grinding performed on the face of the wheel.

### Straight Cup Wheels

Wheel Type No.6 is a straight cup wheel and is used primarily for surface grinding on horizontal or vertical spindle machines. It is also useful for off-hand grinding when a flat surface on the work being ground is desired. Available in either plain or bevel face.




Type No. 6 – Straight Cup



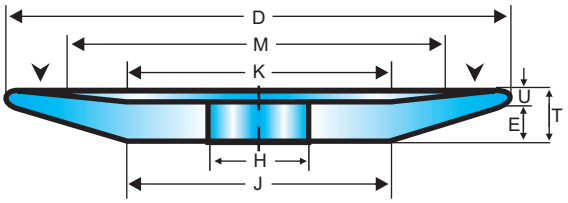

Type No. 11 – Flaring Cup

## Flaring Cup Wheels

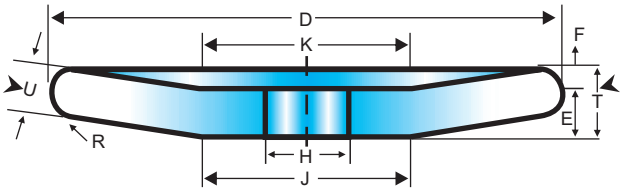
Wheel Type No. 11 is a flaring cup wheel used for grinding in the tool room and in resinoid bonds for snagging. It is supplied with either a plain or bevelled face.

## Dish Wheels

Wheel Type No. 12 is a dish wheel for grinding in the tool room. Its thinness permits the insertion of the grinding edge of the wheel into narrow places.




Type No. 12 – Dish

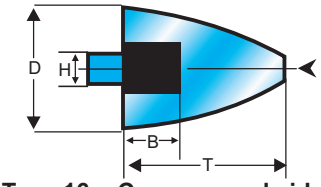



Type No. 13 – Saucer

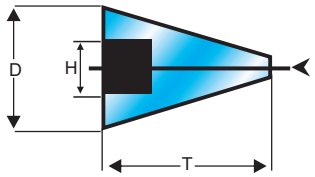
## Saucer Wheels

Wheel Type No. 13 is a saucer wheel or saw gummer. Its name is derived from its use for re-sharpening saws. (saw gumming).

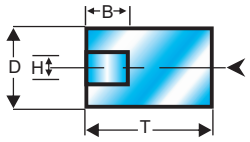
| | | | |
|---|---|---|---|
| **D** | **Diameter (overall)** | **K** | **Diameter of inside flat** |
| **E** | **Thickness at hole or back thickness** | **M** | **Large Diameter of bevel** |
| **F** | **Depth of recess (see type 5 & 7)** | **P** | **Diameter of recess** |
| **G** | **Depth or recess (see type 7)** | **R** | **Radius of corner** |
| **H** | **Hole** | **T** | **Thickness (Overall)** |
| **J** | **Diameter of outside flat** | **U** | **Width of edge** |
| | | **W** | **Wall thickness of grinding face** |



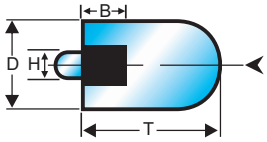

Type 16. - Cone. curved side



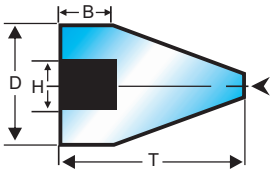

Type 17. - Cone.
straight side square tip.



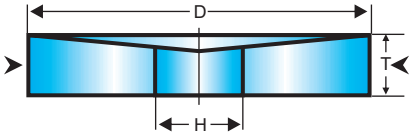

Type 18 - Plug.
Square end



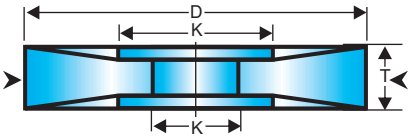

Type 18R - Plug.
Round end



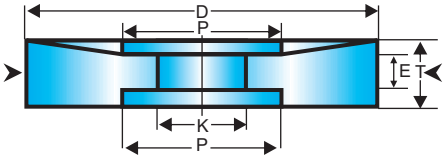

Type 19 - Plug.
Conical end, square tip



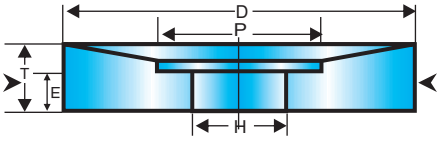

Type 20R - Wheel, relieved one side.



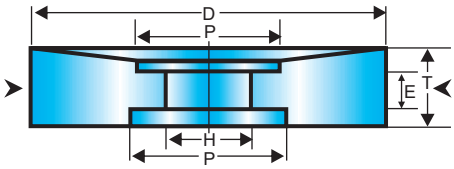

Type 21 - Wheel, relieved two sides.



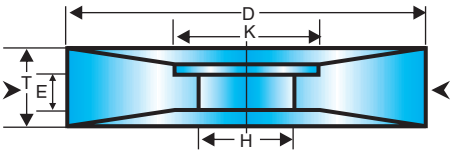

Type 22 - Wheel, relieved one side.
recessed other side.



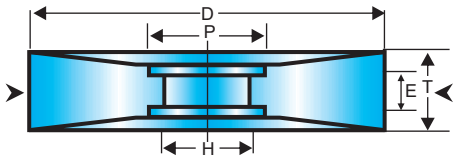

Type 23 - Wheel, relieved and recessed
same side.




Type 24 - Wheel relieved and
recessed side, recessed other side.

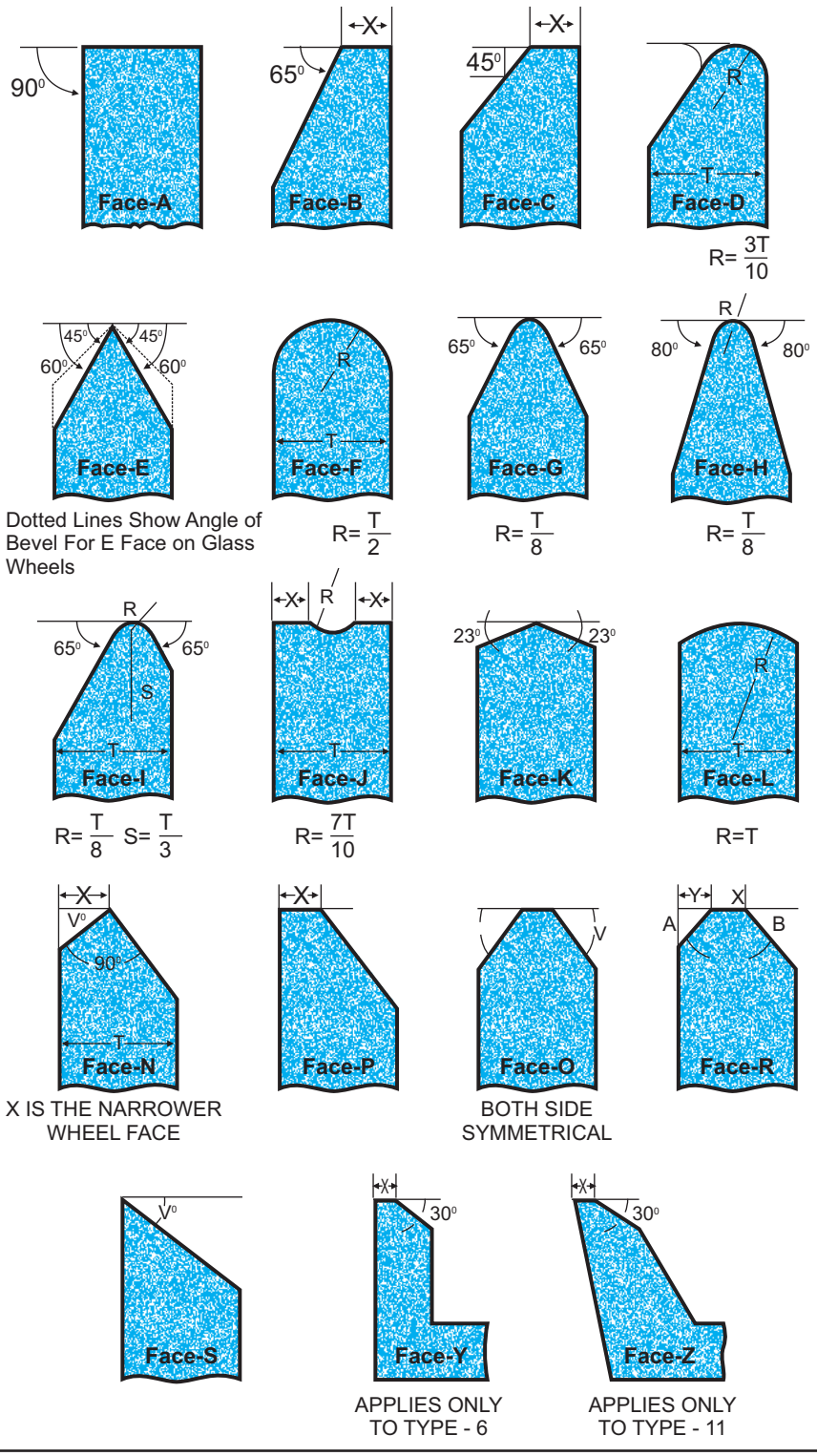



Type 25 - Wheel, relieved and
recessed one side, relieved other side.




Type 26 - Wheel, relieved and
recessed both sides.

# STANDARD SHAPES OF GRINDING WHEEL FACES



# NOMENCLATURE OF GRINDING WHEELS

| A | 46 | 3 | L | 5 | V15 |
|---|---|---|---|---|---|
| Type of abrasives | Grain size | Grain Combination | Hardness | Structure | Bond Type |
| A : Regular Aluminium Oxide | 8 | 1 | D | 3 | V - Vitrified Bond |
| WA : White Aluminium Oxide | 10 | | E | 4 | |
| DA : Regular + White Aluminium Oxide | 12 | 3 | F | 5 | |
| PA : Pink Aluminium Oxide | 14 | | G | 6 | BS - Resinoid Bond |
| PWA : Pink + White Aluminium Oxide | 16 | 5 | H | 7 | |
| ZR : Zirconia Grains | 20 | | I | 8 | |
| CG : Ceramic Grains | 24 | 7 | J | 9 | EF - Shellac Bond |
| SZ : Special Zirconia Grains | 30 | | K | 10 | |
| MCA : Mono Crystalline Abrasives | 36 | | L | 11 | |
| FS : Semi Friable Aluminium Oxide | 46 | | M | 12 | |
| RB : Ruby Grains | 54 | | N | 13 | |
| C : Black Silicon Carbide | 60 | | O | 14 | |
| GC : Green Silicon Carbide | 70 | | P | 15 | |
| CGC : Black + Green Silicon Carbide | 80 | | Q | 16 | |
| | 90 | | S | 18 | |
| | 100 | | T | 19 | |
| | 120 | | | 20 | |
| | 150 | | | 21 | |
| | 180 | | | 22 | |
| | 220 | | | 23 | |
| | 320 | | | 24 | |
| | 400 | | | | |
| | 500 | | | | |
| | 600 | | | | |
| | 800 | | | | |

# BOND INFORMATION

| Sr.No | Name of the Bond | Characteristic | Application |
|---|---|---|---|
| 1 | V4 & V4 - M | Suitable for Black & Green Silicon Carbide Wheel | (1) S.S. Bright - Bar Grinding<br>(2) Cylinder Line Grinding<br>(3) S.G. Cast Iron Grinding<br>(4) Carbide Tips Sharpening Grinding<br>(5) V4-M is used for Saw Gumming Industry |
| 2 | V5 | Suitable for Alu.Oxide Grain i.e. White, Pink, Brown, Ceramic Grain & Ruby Grain | (1) Bore grinding for Bearing Industries<br>(2) Internal Grinding for Automobile Parts |
| 3 | VC 8 | Suitable for Alu.Oxide grain like White, Pink, Ruby, MCA & Ceramic Grains | (1) Surface grinding and Tool Room Application<br>(2) Bearing Industries for centreless wheel<br>(3) Hard grade Wheel for Thread Grinding/Precision Grinding<br>(4) Non porous segment for surface grinding application<br>(5) Cylindrical Grinding Operation for general purpose |
| 4 | V15 - M | Suitable for Brown Alu.Oxide Grain | (1) Centreless Wheel for Brightbar grinding application<br>(2) Surface Grinding Application<br>(3) Cylindrical and Roll grinding Application |
| 5 | VC10 | Suitable for Brown Alu.Oxide Grain | (1) Surface grinding and Tool Room Application<br>(2) Bearing Industries for centreless wheel<br>(3) Hard grade Wheel for Thread Grinding/Precision Grinding<br>(4) Non porous segment for surface grinding application<br>(5) Cylindrical Grinding Operation for general purpose |
| 6 | V5C | Suitable with Brown, White, Ceramic PA, MCA grain having speed required 60 M/S & Good Form Retention | (1) Crank Shaft Grinding<br>(2) High Porous Segment for surface grinding<br>(3) Creep-feed grinding<br>(4) Gear grinding for open structure soft grade Wheel |
| 7 | VP7 | Suitable with Brown, White, Ceramic PA, MCA grain having speed required 60 M/S & Good Form Retention | (1) Inner Track, Outer Track of Bearing Industries<br>(2) Gear Grinding Application |
| 8 | V9 | Suitable with Brown, White, PA Grain | (1) Fettling and Snagging Industry<br>(2) Spring Industry<br>(3) Offhand Tool Grinding |
| 9 | V13 | Suitable with Black & Green Silicon Carbide Grain | (1) Works well in Rice Whitening Roller, Fettling operations for in SG Cast Iron Industry. |
| 10 | V18 Old | Suitable with White Alu.Oxide Grain | (1) Surface grinding Application for Segment & Ring Wheel used in Bearing, Con-Rod and Autoparts Grinding |
| 11 | V84 | Suitable with White Alu.Oxide Grain | (1) Used in Tool Room Industries as a Orange Colour Bond. |
| 12 | BS | Resinoid Grinding Wheel | (1) Snagging Operation in Foundry & Casting Industries.<br>(2) Face Grinding Operation in Bearing, Spring & Con Rod Grinding<br>(3) Automobile Industries<br>(4) Surface Grinding Operation<br>(5) Centreless Wheels for Brightbar Polishing<br>(6) Cylinder & Liner OD grinding |
| 13 | EFP & EF | Shellac Bonded Wheel for Cool Cutting | (1) Surgical Blade Grinding<br>(2) Hypodermic Needle Grinding<br>(3) Razor Blade and Roll Grinding Industries<br>(4) Lapping Application for Mirror finishing |

# ADVANCE BOND SYSTEMS

Continuous bond developments include cool grind bonds for Vitrified Aluminium oxide grinding.

| Sr.No. | Name of the Bond | Characteristic | Application |
|---|---|---|---|
| 14 | VTR | - High fusibility bond suitable for Brown, White, Pink, MCA Grain.<br>- It is highly suitable for ceramic grain having cool grind properties<br>- Excellent form retention suitable for high speed wheel (60 m/s) | - Crank shaft application<br>- Creep feed application<br>- Gear grinding<br>- Surface grinding operation for segment<br>- I. R. Track grinding wheel for 60 m/s speed for above 300 mm dia. |
| 15 | V31 | - Semi fusibility bond suitable for Brown, White, Pink & MCA Grain<br>- Highly suitable for ceramic grain wheel having good Cool Grind properties<br>- Suitable for high speed wheel (60 m/s) | - Tool room industries<br>- Centreless grinding wheel for bearing, bright bar and automobile parts.<br>- Thread grinding application for hard grade wheel non-ferrous segment & ring wheel for surface grinding<br>- Cylindrical grinding operation for general purpose.<br>- IR track grinding operation up to 300mm dia wheel<br>- Regrind crankshaft application |
| 16 | V68 | - Highly fusible bond suitable for Brown, White, Pink, MCA & Ceramic grain<br>- Suitable for 60 m/s wheel speed<br>- 1000° Temp. cool cut Bond<br>- Good form retention | - For Internal wheel up to 100mm dia Wheel |
| 17 | V32 | - Highly glossy fusible bond suitable for ceramic grain, MCA, White, Pink & Ruby Grain<br>- Suitable for up to 60 m/s Wheel speed<br>- Cool cut and good form retention | - IR Track, precision grinding, automobile industries.<br>- Tool room application<br>- Highly suitable for ceramic grain grinding wheel<br>- Ceramic wheel for crank shaft industries. |
| 18 | V75 | - Semi Glassy fusible bond suitable for Aluminium oxide grain like Brown, White, Pink, Ruby, MCA, Ceramic Grain | - Highly suitable for porous and open structure wheel up to operating speed of 60 m/s<br>- Creep feed wheel |

# WHEEL SELECTION

Available in standard sizes or customised to specific grinding applications, wheels are manufactured to suit the grinding needs of all customer requirement. Since there are as many types of wheels as there are grinding applications, correct wheel selection is of critical importance.

**Factors affecting the Selection of a Grinding Wheel**

Wheel selection is dependant on the kind of material to be ground and the type of grinding operation. The eight important factors that need to be considered in the selection of a grinding wheel are:

1. Material to be ground and its hardness
2. Stock removal and surface finish
3. The grinding process - wet or dry
4. Peripheral speed of the wheel
5. The area of grinding contact - large or small
6. The grinding application
7. Condition of the grinding machine
8. The type of grinding machine

**1. Material to be ground and its hardness :**

The type of material to be ground determines the selection of abrasives, its grit size and grade. Aluminium oxide abrasives are ideal for grinding hard or high tensile materials such as alloy steel, high speed steel, annealed malleable iron and other ferrous metals.

Silicon Carbide abrasives are excellent for grinding or cutting low tensile strength materials such as cast iron, bronze, aluminium, copper and other non metallic materials.

While choosing the grit size, the hardness of the material is a major determining factor. While finer grit wheels are required for hard and brittle materials, coarser grit wheels are ideal for soft and ductile materials.

Material hardness also dictates the choice of wheel grades. For optimum performance, harder grade wheels are recommended for soft and easily penetrated materials while softer grades are ideal for hard materials.

**2. Stock removal and surface finish :**

The amount of stock removal and the degree of surface finish required also depends on the abrasive size and the type of bond. When an operation demands high stock removal rates, as in fettling, coarse grit wheels are used. Whereas, fine grit wheels are ideally suited to achieve extremely close surface tolerances and fine geometrical finish.

Resinoid, rubber or shellac bonded wheels are usually recommended for operations that require fine finishes. The following table illustrates the grit size vs form radius for grinding wheels that are commonly in use :

**Grit Size vs Form Radius**

| Work Radius (mm) | Grit Size | Abrasive Particle Dia. (microns) |
|---|---|---|
| 1 | 36 | 500 |
| 0.75 | 46 | 350 |
| 0.50 | 60 | 250 |
| 0.40 | 80 | 177 |
| 0.20 | 120 | 100 |
| 0.13 | 180 | 70 |
| 0.10 | 220 | 60 |

### 3. Grinding Process - Wet or Dry

The grade of the wheel is influenced by whether the operation is wet or dry. During dry grinding with vitrified wheels, in order to minimise the heat generated, soft grade wheels should be used. These can be at least one or two grades softer than the ones chosen for wet grinding operations.

In wet grinding applications, where coolants reduce the heat, harder grade wheels can be used.

### 4. Peripheral Speed of the Wheel

The speed at which the grinding edge of the wheel passes the work surface is called the 'Peripheral Speed' of the wheel. This is a very important factor in grinding wheel selection.

The maximum operating speed for standard vitrified wheels can be up to 60 m/s. This is indicated on the blotter or on the face of the wheel. Organically bonded wheels (resinoid, rubber or shellac) are used for most applications where the required speed rate is up to 48 m/s. Higher speeds for reinforced products can go up to 100mps. Reducing the wheel speed reduces the wheel hardness.

The following table illustrates the effect of speed on grinding action:

| Speed | Effect on Grinding Action when Speed is | |
|---|---|---|
| | Increased | Decreased |
| Wheel Speed | Harder | Softer |
| Work Speed | Softer | Harder |
| Traverse Speed | Softer | Harder |
| Infeed rate | Softer | Harder |

### 5. Area of Grinding Contact - Large or Small

The area of grinding contact influences the selection of wheel grade and grit size. As far as wheel grade is concerned, it is normal practice to use soft grade wheels where the area of grinding contact is large and harder grade wheels where the area of grinding contact is small.

In surface grinding, for instance, where the area of grinding is large, coarser grit, open structure wheels are recommended. Conversely, fine grit, closer structure wheels are ideal for use in narrower and close precision areas of contact, as in cylindrical grinding operations.

**6. The grinding application :**

Severity of a grinding operation can be due to various factors such as, the pressure of shock loads, heavy in feeds, high work speeds and traverse rates and intermittent grinding contact. Hence, for wheel selection, the grinding operation influences the choice of abrasive type, grade and even type of bond.

The greater the severity of the grinding operation, the harder the grade of wheel required and tougher the abrasive that should be used. For example, for severe grinding operations, like snagging, a tough abrasive like A or ZA is required. Medium and soft grade wheels are ideally suited for precision grinding jobs.

**7. Condition of the Grinding Machine :**

Many grinding faults can be traced to poor machine conditions. These can vary from loose bearings, uneven or improperly spliced belts, belt slippage, worn gears, wrong alignment of machine, inadequate foundation or general machine vibration. It is very important that all grinding machines must be installed or fixed on flat and strong foundations.

**8. The Type of Grinding Machine :**

A very important factor in a grinding wheel selection, is the type of the grinding machine. The type of wheel and grinding operation defines the type of machine to be used. Therefore the correct choice of the wheel for the application and the machine is essential.

**a. The Power of the Machine (Kw) :**

The power of the machine is also an important factor. This greatly influences the stock removal rate. If the motor power is insufficient, then the speed of the grinding wheel will be correspondingly reduced, along with the cutting power. This can result in increased temperatures and excessive pressure between the wheel and the work piece. If the power of the machine is high then a wheel of a harder grade can be used for more efficient operation.

**b. Machine Speed :**

The user should take care to check that the maximum rpm stated on the wheel is compatible with that stated on the machine. Under no circumstances should the user exceed the permissible speed limits. Machines with adjustable rotational speeds should be fitted with a locking system to prevent wheels from exceeding the stated maximum permissible speed.

# TECHNICAL GRINDING INFORMATION

**Wheel Spindle :**

The design of the wheel spindle should suit the requirements of the grinding wheel with which it is to be used (dimensions, weight, speed etc.) and the loads to which it will be subjected.

The wheel should be a good locational fit on the spindle which should not be worn, damaged and must be burr free.

The spindle should be of sufficient length and threaded to ensure that when the wheel and flanges are mounted there will be a bearing for at least a full nut on the spindle.

Spindles should be properly lubricated to prevent them from becoming overheated during grinding.

**Mounting Flanges :**

The mounting flange is used to clamp the wheel to the machine and to transfer the driving forces from the machine spindle to the grinding wheel.

The design and type of the wheel flange varies according to the machine and type of grinding wheel. The flange should not be less than one-third of the diameter of the wheel used. The grinding machine manufacturer should clearly state the type of material to be used and the thickness of the flange.

Flanges should be of a matched pair and of equal diameter. They should have equal bearing surfaces and be properly recessed or undercut.

The area between the grinding wheel and the clamping flanges should be flat and free from all foreign matter. The flange should be fixed to the machine spindle.

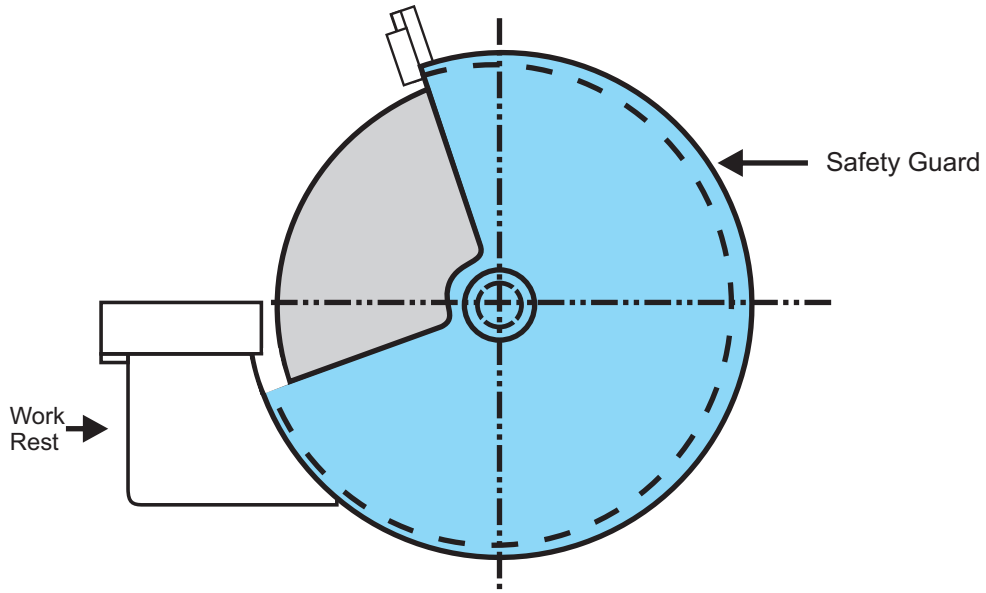
The screws or nuts used for clamping the flanges should be tightened uniformly in diametrical sequence and just sufficiently to hold the wheel firmly.

**Safety Guards :**

All grinding machines should be fitted with safety guards, designed specifically for the type of wheel and grinding application. These safety guards should conform to standard specifications and cover the entire wheel, except the area of grinding. Certain operations however, require even the working area to be guarded. Mainly, safety guards should be able to effectively contain wheel fragments and protect the operator, in the event of a wheel breakage. These guards should also be adjustable to allow for wheel wear.

**Work Rests :**

Work rests should be fitted with fixed grinding heads to help in the easy guidance of hand held work pieces. They should be strong and rigid and be adjustable to allow for wheel wear. Work rests should be placed on the horizontal centreline of the wheel at a distance of not more than 3 mm from the wheel.




**Wheel Balancing System :**

Grinding wheels are balanced for normal use. However, for certain grinding applications, closer limits of wheel balance are required. In such cases the machine manufacturer's instructions should be followed.

Using an out-of-balance wheel can result in damage both to the wheel and the spindle.

**Blotters :**

Blotters are very important in the operation of a grinding wheel. These are made of a flexible and compressible material, like cardboard or plastic of around 0.2 to 1.0 mm thickness and are placed between the flange and the grinding wheel.

Blotters of identical sizes are usually fixed to both sides of the wheel face or supplied loose with the wheel.

**The purpose of using blotters are :**

- To act as a cushion between the metal mounting plates and the abrasive surface of the grinding wheel
- To eliminate any distortion, between the wheel and the flange within the locating area.
- To minimise the risk of slippage between the wheel and the flanges.
- To distribute equally, the axial clamping force, when the nuts are tightened, over the entire flange locating area.
- To prevent any uneven wear of the mounting flanges.

**Wheel types for which blotters are not required :**

- Small wheels up to 20mm diameter.
- Type 27 depressed centre wheels
- Type 29, semi-flexible wheels
- Types 41 and 42, reinforced cutting off wheels, up to 230mm diameter
- Type 43 steel centred saws
- Type 4 taper sided wheels
- Type 6 and 11 straight and flared cup wheels, with centre nuts
- Type 35 and 36 cemented or nut inserted disc wheels
- Type 2 and 37 cemented cylinder and nut inserted cylinder wheels
- Type 31 segments
- Type 52 mounted wheels and points
- Types 16 to 19 plugs and cones with central thread insets
- Type 54 honing stones
- Type 90 hand stones
- Thin cutting and slitting wheels, up to 0.5mm thickness.
- Dove-tailed recessed wheels

**Dressers :**

Dressers are used for Truing and Dressing a grinding wheel. Truing a wheel is done to obtain the required geometry or form on the grinding face of the wheel.

Dressing a wheel changes the shape and cutting action of the grinding face. It restores the form and surface of a grinding wheel and also increases grinding efficiencies.

**Guidelines for dressing :**

- The dresser should be held as rigidly and as close as possible to the point of dressing to ensure vibration free operation.
- The diamond point of the dresser should be presented at an angle between 3° to 10° relative to the centre line of the wheel.
- To maintain the sharpness of the diamond point, the dresser should be rotated in the machine tool holder at an angle of 15° to 45°.
- Dressing should be carried out at normal speeds with copious amount of Metal working fluids.

**Grinding Fluid/Coolant :**

One of the most critical factors in achieving a good finish is the Grinding Fluid or Coolant. Grinding fluids are used to lubricate, reduce and dissipate the heat generated during a grinding operation.

Other functions of the coolant are as follows:

1. Dissipation of the heat generated during grinding thus keeping the work and wheel cool and reducing work distortion due to heat.
2. As a lubricant, it reduces the amount of friction between the cutting tool and the chip.
3. Influences the form of chip.
4. Reduces the diamond dressing tool while dressing.
5. Reduces loading to improve finish.
6. Assists in keeping work area clean.

**Types of Coolants**

Coolants can be classified as follows:

1. Neat Cutting Oils
2. Water based Cutting Fluids.

Water based fluids can be further classified as Synthetic, Emulsion and Semi - Synthetic.

**Synthetic**

Synthetic metal working fluids are fluids which are free from mineral oil. The constituents are finely distributed in water and form a transparent solution. The mineral oil free chemical solutions contain corrosion inhibitors and wetting agents. They have exceptional cooling and lubricating properties especially in very high speed cutting applications and hence are ideally suited for high speed CNC machines.

**Emulsion**

The most common form of water miscible metal working fluid is the emulsion. An emulsion is a dispense system which arises through mixing together of two liquids which are not soluble in each other. Emulsions basically contains higher proportion of mineral oil viz- 30 to 70% along with corrosion inhibitors and wetting agents. Product concentrates are diluted with water to form milky, opaque emulsions.

Some fluids in the above category contain synthetic lubricants and/or EP additives to extend their application range and enable the fluid to perform more difficult operations.

**Semi Synthetic**

Semi Synthetic are so called because they form in the main, clear emulsion combined with synthetic or natural emulsifiers. They contain 10 to 30% mineral oil, corrosion inhibitors and wetting agents. Product concentrates are dissolved in water to form stable, translucent mixes.

**Selection of Coolants**

Coolant type selection is based on the following factors:

- Application type & severity of operation, e.g. stock removal
- Nature of machine operation (cutting method)
- Water quality ( Soft, Hard, Chloride, Sulphate, Bi-carbonate %)
- Material to be machined
- Surface finish
- Filtration system in the machine tool

Good housekeeping is essential for effective and optimal use of grinding fluid. We would suggest selection and application of coolants for specific needs be discussed with your selected coolant supplier.

# STANDARD RECOMMENDATIONS GUIDE

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Agate** | | | | | |
| Off hand | C | 60 | P | 5 | V 13 |
| **Aluminium** | | | | | |
| Cylindrical | C | 46 | J | 8 | V 4 |
| Centreless | C | 46 | L | 5 | V 4 |
| Surfacing | C | 24 | K | 8 | V 4 |
| Internal | C | 36 | K | 8 | V 4 |
| Portable Grinders | C | 24 | O | 6 | B S |
| Cutting Off | C | 36 | P | 6 | B S |
| **Asbestos** | | | | | |
| Cutting Off | C | 24 | T | 8 | B S |
| **Axles** | | | | | |
| Centreless | A | 60 | J | 5 | V 15 |
| | A | 60 | L | 5 | V 15 |
| Cylindrical | A | 60 | J | 5 | V 15 |
| | A | 60 | L | 5 | V 15 |
| **Ball Bearings** | | | | | |
| Bearings O.D – Centreless | DA | 80-5 | K | 8 | V 18 N |
| Bearings O.D – Centreless | FSW | 60 | J | 7 | V C 8 |
| Grinding O.D – Centreless | A | 60 | J | 5 | V 15 |
| Grinding O.D – Centreless | A | 60 | L | 6 | V 15 |
| Grinding outer races (plunge cut) | A | 120 | L | 6 | V 15 |
| Grinding inter races (plunge cut) | DA | 180 | L | 8 | V 5 |
| Internal bore grinding | DA | 80 | M | 8 | V 5 |
| | WA | 80 | M | 8 | V 5 |
| | MCA | 80 | M | 8 | V 5 |
| **Billets (Alloy, H.S.S., Stainless)** | | | | | |
| Swing frame 7000-9500 s.f.p.m | A | 14-3 | T-R-Q | 3 | B S |
| **Billets (portable Grinder)** | | | | | |
| Portable Grinder 7000-9500 s.f.p.m | A | 16-3 | S | 3 | B S |
| **Bolts (screw)** | | | | | |
| Cylindrical | A | 60 | N | 5 | V 15 |
| | A | 60 | N | 5 | V C 10 |
| | A | 60 | N | 5 | V 18 N |
| Centreless | A | 80 | N | 5 | V 15 |
| | A | 80 | N | 5 | V C 10 |
| | A | 80 | N | 5 | V 18 N |
| **Brake Lining** | | | | | |
| Surfacing Discs | C | 24 | J | 8 | B S |
| Cutting Off (Dry) | C | 24 | Q | 6 | B S |
| **Brass & Bronze (Soft)** | | | | | |
| Centreless | C | 46 | M | 6 | V 4 |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Cylindrical | C | 46 | L | 6 | V 4 |
| Internal | C | 36 | K | 8 | V 4 |
| **Broaches** | | | | | |
| Sharpening | WA | 46 | I | 5 | V 18 N |
| **Bushings (hardened Steel)** | | | | | |
| Centreless | A | 60 | J | 5 | V 10 C |
| | A | 60 | J | 5 | V 15 |
| | A | 60 | J | 5 | V 18 N |
| | A | 60 | K | 5 | V 10 C |
| | A | 60 | K | 5 | V 15 |
| | A | 60 | K | 5 | V 18 N |
| Cylindrical | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |
| Internal | A | 60 | L | 8 | V C 10 |
| | A | 60 | L | 8 | V 15 |
| | A | 60 | L | 8 | V 18 N |
| **Cams (Auto) (hardened Steel)** | | | | | |
| Roughing | A | 46 | N | 5 | V 15 |
| | A | 46 | N | 5 | V 18 N |
| Finishing | A | 80 | P | 6 | B S |
| **Camshaft Bearing (Auto)** | | | | | |
| Cylindrical | A | 46 | N | 5 | V 15 |
| | A | 46 | N | 5 | V 18 N |
| **Cast Iron** | | | | | |
| Centreless | C | 46 | L | 5 | V 4 |
| Cylindrical | C | 36 | L | 8 | V 4 |
| Internal | C | 46 | J | 5 | V 4 |
| | A | 60 | L | 8 | V C 10 |
| | A | 60 | L | 8 | V 15 |
| | A | 60 | L | 8 | V 18 N |
| Surfacing (Cups & Cylinders) | C | 24 | H | 8 | V 4 |
| | WA | 36 | I | 8 | V C 8 |
| | WA | 36 | I | 8 | V 18 N |
| Surfacing (Segments) | WA | 36 | I | 8 | V 18 |
| | WA | 36 | I | 8 | V C 8 |
| Surfacing (Straight Wheels) | C | 36 | K | 8 | V 4 |
| Snagging (Floorstands) 5000-6500 s.f.p.m | C | 20 | S | 5 | V 1 |
| Snagging (Floorstands) 7000-9500 s.f.p.m | C | 20 | Q | 4 | B S |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Snagging (Swing Frame) | | | | | |
| 5000-6500 s.f.p.m | C | 20 | R | 5 | V 1 |
| Snagging (Swing Frame) | | | | | |
| 7000-9500 s.f.p.m | C | 16 | R | 5 | B S |
| Snagging (portable Grinder) | | | | | |
| 5000-6500 s.f.p.m | C | 24 | R | 5 | V 1 |
| Snagging (portable Grinder) | | | | | |
| 7000-9500 s.f.p.m | C | 20 | R | 5 | B S |
| **Cemented Carbides** | | | | | |
| SINGLE POINT TOOLS OFF HAND CUP OR PLATE MOUNTED WHEELS | | | | | |
| Roughing (Wet and Dry) | GC | 60 | J | 8 | V 4 |
| Semi Finishing | GC | 120 | I | 8 | V 4 |
| STRAIGHT WHEELS | | | | | |
| Roughing (wet & dry) | GC | 60 | K | 5 | V 4 |
| Semi finishing (wet & Dry) | GC | 120 | J | 5 | V 4 |
| SINGLE POINT TOOLS MACHINE GRINDING STRAIGHT WHEELS | | | | | |
| Roughing and finishing (Wet) | GC | 80 | K | 5 | V 4 |
| MILLING CUTTERS, reamers | | | | | |
| Roughing | GC | 60 | I | 8 | V 4 |
| SURFACE GRINDING STRAIGHT WHEELS | | | | | |
| Roughing (Wet) | GC | 60 | I | 8 | V 4 |
| Finishing (Wet) | GC | 120 | H | 8 | V 4 |
| CYLINDRICAL GRINDING | | | | | |
| Roughing (Wet) | GC | 60 | K | 5 | V 4 |
| Finishing (Wet) | GC | 120 | J | 7 | V 4 |
| **Chilled Iron** | | | | | |
| Snagging (Floorstands) 5000-6500 s.f.p.m | C | 20 | S | 5 | V 1 |
| Snagging (Floorstands) 7000-9500 s.f.p.m | C | 20 | R | 4 | B S |
| Surfacing Cups & Cylinders | C | 24 | H | 8 | V 4 |
| Surfacing (Straight Wheels) | C | 36 | I | 8 | V 4 |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Chromium Plating (Cylindrical)** | | | | | |
| Ordinary Finish | WA | 80 | L | 8 | V C 8 |
| | WA | 80 | L | 8 | V 18 N |
| Fine Finish | C | 280 | J | 10 | B S |
| **Crankshafts** | | | | | |
| Auto | A | 54 | M | 5 | V S C |
| | A | 54 | M | 5 | V C 10 |
| Diesel | A | 54 | N | 5 | V S C |
| | A | 54 | N | 5 | V C 10 |
| AUTOMOTIVE (PINS AND BEARINGS) | | | | | |
| Roughing – Heavy side removal | A | 36 | K | 5 | V C 10 |
| | A | 36 | K | 5 | V 15 |
| | A | 36 | K | 5 | V 18 N |
| – Light side removal | A | 54 | N | 5 | V C 10 |
| | A | 54 | N | 5 | V 15 |
| | A | 54 | N | 5 | V 18 N |
| Finishing | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |
| Roughing and Finishing | A | 54 | N | 5 | V C 10 |
| | A | 54 | N | 5 | V 15 |
| | A | 54 | N | 5 | V 18 N |
| Snagging – 5000-6500 s.f.p.m. | A | 20 | P | 5 | V 9 |
| Snagging – 7000-9500 s.f.p.m. | A | 16-3 | P | 4 | B S |
| Automotive (Regrinding) | A | 54 | N | 5 | V C 10 |
| | A | 54 | N | 5 | V 15 |
| | A | 54 | N | 5 | V 18 N |
| **Cutlery** | | | | | |
| OFFHAND | | | | | |
| Surfacing sides | WA | 120 | I | 8 | V C 8 |
| | WA | 120 | I | 8 | V 15 |
| | WA | 120 | I | 8 | V 18 N |
| Sharpening (Production) | WA | 120 | M | 8 | V C 8 |
| | WA | 120 | M | 8 | V 18 N |
| Snagging | A | 60 | Q | 5 | V 9 |
| **Cutters** | | | | | |
| Sharpening (Machine) | WA | 60 | K | 5 | V C 8 |
| | WA | 60 | K | 5 | V 18 N |
| Sharpening (Offhand) | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Cylinders, Cast Iron Auto (Internal)** | | | | | |
| Regrinding (Wheels) | C | 36 | I | 8 | V 4 |
| HONING (NEW CYLINDERS) STICKS | | | | | |
| Ordinary Finish | C | 120 | P | 8 | V 4 |
| Very Fine Finish | C | 280 | M | 8 | V 4 |
| **Cylinders (Aircraft) (Internal)** | | | | | |
| MOLYBDENUM STEEL | | | | | |
| Roughing | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| Finishing | WA | 60 | I | 8 | V C 8 |
| | WA | 60 | I | 8 | V 18 N |
| Regrinding | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| NITRIDED STEEL | | | | | |
| Before | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| After | C | 60 | I | 8 | V 4 |
| Regrinding | C | 60 | I | 8 | V 4 |
| **Dies (Forgings)** | | | | | |
| OFFHAND – PORTABLE GRINDING | | | | | |
| Mounted Points & Wheels (Coarse) | | COARSE | | | |
| Mounted Points & Wheels (Medium) | | MEDIUM | | | |
| Mounted Points & Wheels (Fine) | | FINE | | | |
| St. Wheels-Roughing | | | | | |
| 5000-6500 s.f.p.m. | A | 46 | P | 5 | V 9 |
| St. Wheels-Roughing | | | | | |
| 7000-9500 s.f.p.m. | A | 36 | R | 5 | B S |
| **Dies (Drawing)** | | | | | |
| SURFACING-HARDENED | | | | | |
| Straight Wheels (Dry) | WA | 60 | G | 8 | V C 8 |
| | WA | 60 | G | 8 | V 18 N |
| Straight Wheels (Fast Traverse, Wet) | WA | 60 | I | 8 | V C 8 |
| | WA | 60 | I | 8 | V 18 N |
| Cup Wheels (Wet) | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Discs | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Segments | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| SURFACING-ANNEALED | | | | | |
| Straight Wheels (Dry) | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Cup Wheels (Wet) | WA | 30 | H | 8 | V C 8 |
| | WA | 30 | H | 8 | V 18 N |
| Segments | WA | 24 | H | 8 | V C 8 |
| | WA | 24 | H | 8 | V 18 N |
| **Drill (Manufacturing)** | | | | | |
| Cutting off Soft (Wet) | A | 46 | R | 6 | B S |
| Cutting off Soft (Dry) | A | 24 | T | 8 | B S |
| Cutting off Hard (Wet) | A | 60 | Q | 6 | B S |
| Cutting off Hard (Dry) | A | 46 | P | 6 | B S |
| Cylindrical | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |
| Centreless (Soft) | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |
| Centreless (Hard) | A | 80 | L | 5 | V C 10 |
| | A | 80 | L | 5 | V 15 |
| | A | 80 | L | 5 | V 18 N |
| Precision Sharpening | WA | 46 | L | 5 | V C 8 |
| | WA | 46 | L | 5 | V 18 N |
| Pointing | WA | 60 | M | 5 | V C 8 |
| | WA | 60 | M | 5 | V 18 N |
| Grinding Relief | WA | 60 | M | 5 | V C 8 |
| | WA | 60 | M | 5 | V 18 N |
| Hertline Grinding Machine | A | 120 | V | 8 | B S |
| **Drills (Resharpening)** | | | | | |
| Machine | WA | 100 | J | 8 | V C 8 |
| | WA | 100 | J | 8 | V 18 N |
| Offhand | WA | 80 | L | 8 | V C 8 |
| | WA | 80 | L | 8 | V 18 N |
| **Ebonite** | | | | | |
| Cutting Off (Dry) | C | 24 | P | 6 | B S |
| **Fibreglass Insulating Board** | | | | | |
| Cutting Off | C | 24 | P | 6 | B S |
| **Fibre** | | | | | |
| Surfacing | C | 24 | J | 8 | B S |
| Cutting Off | C | 36 | P | 6 | B S |
| **Forgings** | | | | | |
| Centreless | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Cylindrical | DA | 46 | M | 5 | V C 10 |
| | DA | 46 | M | 5 | V 15 |
| | DA | 46 | M | 5 | V 18 N |
| Snagging-7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| Snagging-5000-6500 s.f.p.m. | A | 24 | R | 4 | B S |
| Surfacing – Discs | A | 24 | K | 8 | B S |
| **Gauges (Plug)** | | | | | |
| Cylindrical | WA | 80 | L | 8 | V C 10 |
| | WA | 80 | L | 8 | V 15 |
| | WA | 80 | L | 8 | V 18 N |
| Cylindrical (High Finish) | C | 280 | J | 10 | B S |
| **Gears (Cast Iron)** | | | | | |
| Cleaning Between teeth (offhand) | C | 24 | T | 4 | B S |
| **Gears (Hardend Steel)** | | | | | |
| Teeth-Form Precision Grinding | WA | 60 | K | 5 | V 18 N |
| | WA | 80 | J | 8 | V 18 N |
| Tooth Generating Precision Grinding | WA | 54 | K | 5 | V 18 N |
| | WA | 60 | L | 5 | V 18 N |
| Internal | WA | 60 | K | 8 | V 18 N |
| Surfacing (Cups and Cylinders) | WA | 36 | I | 8 | V 18 N |
| Surfacing (Segments) | A | 36 | I | 8 | V 18 N |
| Surfacing (Discs remove burrs) | WA | 36 | I | 8 | V 18 N |
| Surfacing (Straight Wheels) | WA | 36 | I | 8 | V 18 N |
| **Granite** | | | | | |
| Coping-solid type | C | 36 | M | 8 | B S |
| Surfacing (Planer Wheels) | C | 16 | O | 4 | B S |
| Surfacing (Portable) | C | 16 | O | 4 | B S |
| **Knives (Machines)** | | | | | |
| Cutting off (Dry) | A | 46 | R | 6 | B S |
| Cutting off (Wet) | WA | 60 | M | 8 | B S |
| Chipper and Barker, Sharpening | WA | 36 | I | 8 | V C 8 |
| | WA | 36 | I | 8 | V 18 N |
| Hog Sharpening | WA | 36 | I | 8 | V C 8 |
| | WA | 36 | I | 8 | V 18 N |
| Leather Fleshing, Sharpening (Bricks) | A | 36 | Q | 5 | V 9 |
| Leather Shaving, Sharpening-Cylindrical | A | 60 | P | 5 | V 9 |
| Leather Splitting, Sharpening | A | 36 | K | 8 | B S |
| Molding, Offhand, Sharpening | A | 46 | M | 5 | V C 10 |
| | A | 46 | M | 5 | V 15 |
| | A | 46 | M | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Machine Sharpening | WA | 60 | I | 8 | V C 8 |
| | WA | 60 | I | 8 | V 18 N |
| Paper, Sharpening | WA | 60 | I | 8 | V C 8 |
| | WA | 60 | I | 8 | V 18 N |
| Section Beveling | A | 46 | M | 5 | V C 10 |
| | A | 46 | M | 5 | V 15 |
| | A | 46 | M | 5 | V 18 N |
| Surfacing Backs | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Sugar Best, Routing | WA | 80 | N | 8 | V C 8 |
| | WA | 80 | N | 8 | V 18 N |
| Veneer Sharpening | WA | 60 | I | 8 | V C 8 |
| | WA | 60 | I | 8 | V 18 N |
| Veneer Surfacing | WA | 46 | J | 8 | V 18 N |
| | WA | 60 | I | 8 | V C 8 |
| **Magnesium** | | | | | |
| Snagging – 5000-6500 s.f.p.m. | C | 20 | P | 5 | V 13 |
| Snagging – 7000-9500 s.f.p.m. | A | 20 | O | 4 | B S |
| **Malleable Casting (Annealed)** | | | | | |
| Floor Stands 5000-6500 s.f.p.m. | A | 16/20 | R | 5 | V 9 |
| Floor Stands 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| Swing Frames 5000-6500 s.f.p.m. | A | 16/20 | R | 5 | V 9 |
| Swing Frames 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| Portable Grinders 5000-6500 s.f.p.m. | A | 24 | R | 5 | V 9 |
| Portable Grinders 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| **Malleable Casting (Unannealed)** | | | | | |
| Floor Stands 5000-6500 s.f.p.m. | C | 20 | R | 5 | V 1 |
| Floor Stands 7000-9500 s.f.p.m. | C | 20 | R | 4 | B S |
| Surfacing – Discs | A | 24 | K | 8 | B S |
| **Molybdenum** | | | | | |
| Cylindrical | WA | 60 | K | 5 | V C 8 |
| | WA | 60 | K | 5 | V 18 N |
| Surfacing | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| **Monel Metal** | | | | | |
| Cutting off (Dry) | A | 36 | Q | 6 | B S |
| Cutting off (Wet) | A | 46 | P | 6 | B S |
| Floor Stands 5000-6500 s.f.p.m. | A | 24 | R | 5 | V 9 |
| Floor Stands 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| Cylindrical | C | 60 | K | 7 | V 4 |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Needles :** | | | | | |
| Pointing | A | 80 | R | 7 | V 9 |
| **Nickel Rods And Bars** | | | | | |
| Cutting off (Dry) | A | 46 | R | 6 | B S |
| Cutting off (Wet) | A | 46 | P | 6 | B S |
| **Pipe (Cast Iron)** | | | | | |
| Cleaning-inside 5000-6500 s.f.p.m. | C | 20 | T | 5 | V 1 |
| Cleaning-inside 7000-9500 s.f.p.m. | A | 16/20 | T | 4 | B S |
| **Pipe (Soft Steel)** | | | | | |
| Cutting off (Wet) | A | 80 | P | 6 | B S |
| Cutting off (Dry) minimum burr | A | 60 | Q | 6 | B S |
| **Pistons (Aluminium)** | | | | | |
| Cylindrical | C | 46 | J | 8 | V 4 |
| Centreless | C | 46 | K | 7 | V 4 |
| Regrinding | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| **Pistons (Cast Iron)** | | | | | |
| Cylindrical | C | 46 | J | 6 | V 4 |
| | C | 36 | K | 8 | V 4 |
| Centreless | C | 46 | L | 6 | V 4 |
| Regrinding | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| **Pistons (Pins)** | | | | | |
| CENTRELESS MACHINE | | | | | |
| Roughing | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 15 |
| | A | 60 | M | 5 | V 18 N |
| Semi-Finishing | A | 80 | L | 5 | V C 10 |
| | A | 80 | L | 5 | V 15 |
| | A | 80 | L | 5 | V 18 N |
| Finishing | C | 240 | N | 10 | B S |
| Surfacing Ends (Discs) | A | 60 | I | 8 | B S |
| Lapping | C | 240 | M | 10 | B S |
| **Piston Rings (Cast Iron)** | | | | | |
| Surfacing Rough (Cylinders) | WA | 36 | I | 8 | V C 8 |
| | WA | 36 | I | 8 | V 18 N |
| **SURFACING (DISCS)** | | | | | |
| Roughing | C | 24 | J | 5 | B S |
| Semi-Finishing | C | 46 | I | 8 | B S |
| Finishing | C | 80 | H | 8 | B S |
| Surfacing (Straight Wheels) | WA | 80 | J | 8 | B S |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Lapping | C | 240 | K | 8 | V 4 |
| Internal (Snagging) | C | 30 | T | 5 | V 1 |
| **Piston Rods (Locomotive)** | | | | | |
| Cylindrical | A | 46 | M | 5 | V C 10 |
| | A | 46 | M | 5 | V 15 |
| | A | 46 | M | 5 | V 18 N |
| **Plastics** | | | | | |
| Cutting off (Dry) | C | 60 | K | 8 | B S |
| Cutting off (Wet) | C | 60 | M | 8 | B S |
| **Porcelain** | | | | | |
| Cutting off (Dry) Fired | C | 120 | M | 8 | B S |
| Cutting off (Low Speed) (Dry) Prefired | C | 36 | M | 8 | B S |
| Cylindrical | C | 60 | K | 7 | V 4 |
| Removing imperfection (Bricks) | WA | 80 | L | 8 | V C 8 |
| | WA | 80 | L | 8 | V 18 N |
| Centreless | C | 36 | K | 8 | V 4 |
| **Rails** | | | | | |
| Surfacing Welds 5000-6500 s.f.p.m. | A | 24 | R | 5 | V 9 |
| Surfacing Welds 7000-9500 s.f.p.m. | A | 16 | Q | 4 | B S |
| Cup Wheels | A | 16 | P | 4 | B S |
| Straight Wheels | A | 16 | Q | 4 | B S |
| Removing Corrugation | A | 24 | M | 5 | V 9 |
| | A | 16 | N | 5 | V 9 |
| Slotting after Welding | A | 24 | R | 6 | B S |
| **Razor Blade (Safety)** | | | | | |
| CARBON STEEL – Roughing | A | 220 | I | 8 | E F |
| Semi-Finishing | A | 400 | M | 8 | E F |
| STAINLESS-Roughing | C | 240 | M | 10 | E F |
| Finishing | C | 400 | M | 5 | E F |
| **Reamers** | | | | | |
| Backing off | WA | 80 | H | 12 | V C 8 |
| | WA | 80 | H | 12 | V 18 N |
| | WA | 60 | K | 5 | V C 8 |
| | WA | 60 | K | 5 | V 18 N |
| Cylindrical | DA | 80 | M | 5 | V C 10 |
| | DA | 80 | M | 5 | V 15 |
| | DA | 80 | M | 5 | V 18 N |
| **Roller Bearing Cups** | | | | | |
| Centreless O. D | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Internal | WA | 60 | M | 5 | V C 8 |
| | WA | 60 | M | 5 | V 18 N |
| Surfacing (Cylinders) | WA | 80 | G | 9 | V C 8 |
| | WA | 80 | G | 9 | V 18 N |
| **Rollers for Bearings** | | | | | |
| Centreless – Roughing | A | 80 | N | 5 | V 10 C |
| | A | 80 | N | 5 | V 18 N |
| Surfacing Ends (Discs) | A | 80 | L | 8 | B S |
| **Rolls, Aluminium Foil** | | | | | |
| FOR DARK REFLECTIVE FINISH : | | | | | |
| Roughing | A | 80 | K | 5 | V 15 |
| | A | 80 | K | 5 | V 18 N |
| Finishing | C | 220 | I | 10 | E F P |
| | C | 220 | I | 10 | B S |
| **Rolls (Brass or Copper)** | | | | | |
| Cylindrical-Roughing | C | 46 | L | 8 | B S |
| Finishing | C | 120 | I | 8 | B S |
| **Rolls (Granite)** | | | | | |
| New Rolls | C | 36 | I | 8 | B S |
| Regrinding | C | 60 | K | 8 | B S |
| **Rolls (Cast Iron)** | | | | | |
| Cylindricals (Roughing) | C | 36 | L | 6 | B S |
| Cylindricals (Finishing) | C | 80 | J | 6 | B S |
| **Rolls, Hot Mill (Chilled and Alloy)** | | | | | |
| Regrinding | C | 36 | K | 8 | B S |
| | C | 36 | M | 8 | B S |
| **NEW ROLLS** | | | | | |
| Roughing | CA | 24 | K | 8 | B S |
| Finishing | C | 36 | K | 8 | B S |
| **Rolls, Cold Mill (Hardened Steel)** | | | | | |
| REGRIND : | | | | | |
| First Stands | WA | 36 | I | 8 | B S |
| Other Stands | WA | 80 | H | 8 | B S |
| **Rolls Paper Mill (Two-Wheel Grinders)** | | | | | |
| REGRINDING : | | | | | |
| Cast Iron, Granite, Rubber-covered | | | | | |
| Press Rolls | C | 46 | J | 8 | B S |
| Steel | PA | 46 | L | 8 | B S |
| For Coarser Finish Papers | C | 46 | J | 8 | B S |
| All-purpose Wheel for all Rolls | C | 46 | H | 8 | B S |
| **Rolls, Rubber** | | | | | |
| Soft Rubber (Dry Grind) | C | 24 | G | 12 | V 4 |
| Hard Rubber | C | 36 | J | 8 | B S |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Rolls (High-Speed Tool Steel)** | | | | | |
| Roughing | A | 120 | I | 8 | V 15 |
| | A | 120 | I | 8 | V 18 N |
| Semi-Finishing | C | 280 | H | 10 | E F P |
| | C | 280 | H | 10 | B S |
| **Rolls, Scoring Bricks** | | | | | |
| Cold Mill Rolls | C | 80 | L | 6 | E F P |
| | C | 80 | L | 6 | B S |
| Hot Mill Rolls | C | 120 | K | 8 | V 4 |
| **Rotors Laminated (Cylindrical)** | | | | | |
| Roughing | WA | 120 | I | 8 | V C 8 |
| | WA | 120 | I | 8 | V 18 N |
| Finishing | WA | 240 | H | 10 | B S |
| **Rubber (Soft)** | | | | | |
| Cylindrical (Dry) | C | 24 | G | 8 | B S |
| **Rubber (Hard)** | | | | | |
| Cutting off | C | 36 | K | 8 | B S |
| Cylindrical | C | 30 | K | 8 | B S |
| **Rubber Hose** | | | | | |
| Cutting off (Dry) | C | 24 | R | 6 | B S |
| Cutting off (Dry) (Steel Mech) | A | 36 | S | 6 | B S |
| **Sand Cores** | | | | | |
| Cutting off (Dry) | C | 24 | R | 6 | B S |
| **Saws (Band and Circular)** | | | | | |
| Grinding | WA | 46 | M | 5 | V C 8 |
| | WA | 46 | M | 5 | V 18 N |
| **Saws (Metal Cutting)** | A | 60 | O | 5 | V 9 |
| | A | 80 | P | 6 | B S |
| **Shear Blades (Power Metal Shears)** | | | | | |
| Sharpening (Segments) | WA | 36 | G | 12 | V C 8 |
| | WA | 36 | G | 12 | V 18 |
| Sharpening (Cylinders) | WA | 36 | H | 12 | V C 8 |
| | WA | 36 | H | 12 | V 18 N |
| **Spring Coil** | | | | | |
| Squaring Ends (Discs) | A | 36 | M | 8 | B S |
| Small Gauge Wire | DA | 46 | M | 8 | V 9 |
| Medium Gauge Wire | DA | 36 | N | 8 | V 9 |
| Large Gauge Wire | DA | 24 | P | 8 | V 9 |
| **Spring End Grinding** | CG | 24 | K | 5 | BS |
| **Springs (Leaf)** | | | | | |
| Grinding Eyes | A | 24 | M | 8 | B S |
| Chamfering | A | 24 | P | 8 | V 9 |
| **Steatite (Ceramics)** | | | | | |
| Centreless | C | 60 | K | 7 | V 4 |
| Surfacing | C | 46 | J | 7 | V 4 |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Steel Castings (Low Carbon)** | | | | | |
| Swing Frames-5000-6500 s.f.p.m. | A | 20 | R | 5 | V 9 |
| Swing Frames-7000-9500 s.f.p.m. | A | 16 | R | 4 | B S |
| Floor Stands-5000-6500 s.f.p.m. | A | 20 | R | 5 | V 9 |
| Floor Stands-7000-9500 s.f.p.m. | A | 16 | Q | 4 | B S |
| Portable Grinders-7300-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| **Steel Castings (Manganese)** | | | | | |
| Swing Frames-5000-6500 s.f.p.m. | A | 20 | Q | 5 | V 9 |
| Swing Frames-7000-9500 s.f.p.m. | A | 16 | R | 4 | B S |
| Floor Stands-5000-6500 s.f.p.m. | A | 20 | Q | 5 | V 9 |
| Floor Stands-7000-9500 s.f.p.m. | A | 20 | P | 4 | B S |
| Portable Grinders-7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| **Steel (Hard)** | | | | | |
| Centreless (Com.Finish) | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |
| Centreless (Feed Wheel) | A | 120 | S | 8 | B S |
| Cylindrical (Smaller Wheel) | A | 60 | M | 5 | V C 10 |
| | A | 60 | M | 5 | V 18 N |
| Cylindrical (Larger Wheels) | DA | 60 | L | 5 | V C 8 |
| | DA | 60 | L | 5 | V 18 N |
| Internal | PA | 60 | M | 8 | V C 8 |
| | PA | 60 | M | 8 | V 18 N |
| | PA | 60 | K | 8 | V C 8 |
| | PA | 60 | K | 8 | V 18 N |
| Surfacing (Straight Wheels) | WA | 46 | I | 8 | V C 8 |
| | WA | 46 | I | 8 | V 18 N |
| | WA | 60 | H | 12 | V C 8 |
| | WA | 60 | H | 12 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Surfacing (Cup & Cylinders) | PA | 46 | H | 8 | V C 8 |
| | PA | 46 | H | 8 | V 18 N |
| Surfacing (Segments) | WA | 46 | I | 8 | V C 8 |
| | WA | 46 | I | 8 | V 48 N |
| Surfacing (Discs-Rough) | A | 24 | L | 8 | B S |
| Surfacing (Discs-Finish) | A | 46 | K | 8 | B S |
| Cutting Off (Wet)9000-12000 s.f.p.m. | A | 60 | O | 6 | B S |
| Cutting Off (Dry) 9000-12000 s.f.p.m. | A | 46 | P | 6 | B S |
| Billet Grinding 5000-6500 s.f.p.m | A | 20 | R | 5 | V 9 |
| Billet Grinding 7000-9500 s.f.p.m. | A | 14 | T` | 3 | B S |
| **Steel (Stainless)** | | | | | |
| Centreless | A | 46 | L | 5 | V 10 C |
| | A | 46 | L | 5 | V 18 N |
| Centreless (Com. Finish) | C | 60 | N | 6 | V4 |
| Centreless(Feed Wheel) | A | 120 | S | 8 | BS |
| Cylindrical | WA | 120 | L | 5 | V C 8 |
| | WA | 120 | L | 5 | V 18 N |
| Internal | WA | 46 | J | 8 | V C 8 |
| | WA | 46 | J | 8 | V 18 N |
| Surfacing (Straight Wheels) | WA | 46 | K | 8 | V C 8 |
| | WA | 46 | K | 8 | V 18 N |
| Surfacing (Cups and Cylinders) | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Surfacing (segment) | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Cutting Off (Dry) 12000-19000 s.f.p.m. | A | 36 | R | 6 | B S |
| **Steel (High Speed)** | | | | | |
| Centreless (Com. Finish) | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |
| Centreless (Fine Finish) | A | 120 | Q | 6 | B S |
| Centreless (Feed Wheel) | A | 120 | S | 6 | B S |
| Cylindrical (Smaller wheels) | DA | 60 | M | 5 | V C 10 |
| | DA | 60 | M | 5 | V 18 N |
| Cylindrical (larger Wheel) | DA | 60 | L | 5 | V C 10 |
| | DA | 60 | L | 5 | V 18 N |
| Internal | DA | 60 | L | 8 | V C 10 |
| | DA | 60 | L | 8 | V 18 N |
| | DA | 60 | M | 8 | V C 10 |
| | DA | 60 | M | 8 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Surfacing (Straight Wheels) | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| Surfacing (cups & Cylinders) | WA | 60 | G | 8 | V C 8 |
| | WA | 60 | G | 8 | V 18 N |
| Surfacing (segments) | WA | 46 | H | 8 | V C 8 |
| | WA | 46 | H | 8 | V 18 N |
| **BILLETS AND SLABS** | | | | | |
| Portable Grinder-7000-9500s.f.p.m. | A | 20 | T | 4 | B S |
| **Steel (Stainless- Hardneded)** | | | | | |
| Centreless (Commercial Finish) | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |
| Centreless (Fine Finish) | A | 120 | Q | 6 | B S |
| Cylindrical (Feed Wheel ) | A | 120 | S | 8 | B S |
| Cylindrical (Smaller Wheels) | DA | 60 | M | 5 | V C 10 |
| | DA | 60 | M | 5 | V 18 N |
| Cylindrical (Larger Wheel) | DA | 60 | L | 5 | V C 10 |
| | DA | 60 | L | 5 | V 18 N |
| Internal | PA | 60 | L | 8 | V C 8 |
| | PA | 60 | L | 8 | V 18 N |
| Surfacing (Straights Wheels) | WA | 36 | H | 8 | V C 8 |
| | WA | 36 | H | 8 | V 18 N |
| Surfacing (Segments) | WA | 36 | I | 8 | V 18 N |
| Surfacing (Cups & Cylinders) | WA | 36 | H | 8 | V C 8 |
| | WA | 36 | H | 8 | V 18 N |
| Cutting off (Dry) | A | 46 | R | 6 | B S |
| Cutting off (Wet) 9000-12000s.f.p.m | A | 60 | O | 6 | B S |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| HEMMING AND KLOTZ MACHINES: | | | | | |
| Cutlery-Small (Roughing) | WA | 60 | G | 8 | V C 8 |
| | WA | 60 | G | 8 | V 18 N |
| **Strove Parts (Cast Iron)** | | | | | |
| SNAGGING | C | 20 | S | 6 | V I |
| SURFACING TAPS | | | | | |
| AUTOMATIC MACHINE: | | | | | |
| Roughing | C | 36 | Q | 5 | V I |
| Finishing | C | 36 | Q | 6 | V I |
| Surfacing (Discs) | C | 24 | J | 8 | B S |
| **Taps** | | | | | |
| Fluting (Small Taps) | A | 60 | R | 5 | B S |
| (Large Taps) | WA | 46 | M | 5 | V C 8 |
| | WA | 46 | M | 5 | V 18 N |
| Grinding Relief | WA | 46 | M | 5 | V C 8 |
| | WA | 46 | M | 5 | V 18 N |
| Squaring Ends | A | 60 | O | 5 | V C 10 |
| | A | 60 | O | 5 | V 15 |
| | A | 60 | O | 5 | V 18 N |
| **Tubing Steel** | | | | | |
| Centreless | A | 60 | M | 5 | V 10 C |
| | A | 60 | M | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| **Tungsten** | | | | | |
| Centreless | C | 60 | K | 7 | V 4 |
| Surfacing - 2000 s.f.p.m. | WA | 46 | J | 8 | V C 8 |
| - 6000 s.f.p.m. | C | 46 | I | 8 | B S |
| Tungsten Carbide: | 3CG | 60 | J | 5 | V31 |
| **Valves (Automative)** | | | | | |
| Refacing | C | 80 | N | 6 | V 4 |
| | A | 80 | K | 8 | V C 10 |
| | A | 60 | M | 5 | V 18 N |
| STEMS : | | | | | |
| Cylindrical | DA | 60 | M | 5 | V C 10 |
| | DA | 60 | M | 5 | V 18 N |
| Centreless | A | 60 | N | 5 | V 10 C |
| | A | 60 | N | 5 | V 18 N |
| Cutting (Dry) | A | 36 | S | 6 | B S |
| Surfacing Ends (Discs) | WA | 36 | K | 5 | V C 8 |
| | WA | 36 | K | 5 | V 18 N |
| **Valves Seat inserts-Regrinding** | | | | | |
| Roughing : Cast Iron | C | 60 | M | 6 | V 4 |
| Alloy Steel | WA | 80 | N | 8 | V C 8 |
| | WA | 80 | N | 8 | V 18 N |
| Stellite | WA | 80 | L | 8 | V C 8 |
| | WA | 80 | L | 8 | V 18 N |
| FINISHING : | | | | | |
| All Seats | C | 120 | K | 8 | V 4 |
| **Valve Tappets** | | | | | |
| Centreless | A | 60 | O | 5 | V 10 C |
| | A | 60 | O | 5 | V 18 N |

| Work - Material - Operation | Abrasive | Grit Size | Grade | Structure | Bond |
|---|---|---|---|---|---|
| Cylindrical | DA | 60 | M | 5 | V 10 |
| **Walboard (Hard)** | | | | | |
| Cutting off (Dry) | C | 36 | T | 8 | B S |
| **Welds** | | | | | |
| CARBON ALLOY STEELS : | | | | | |
| Portable Grinders 5000-6500 s.f.p.m. | A | 24 | R | 5 | V 9 |
| Portable Grinders 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| **Stainless Steel** | | | | | |
| Portable Grinders 7000-9500 s.f.p.m. | A | 20 | R | 4 | B S |
| **Wrought Iron** | | | | | |
| Floor Stands 5000-6000 s.f.p.m. | A | 24 | R | 5 | V 9 |

# STORAGE

**Storage of Grinding Wheels :-**

Grinding wheels must be handled with extreme care and great importance should also be given to the method of storing them. A grinding wheel, if handled or stored badly, can cause serious problems when in operation.

Given below are a few basic guidelines in handling and storing of grinding wheels:

**On receipt of a wheel :-**

When you receive a grinding wheel, first check to see if the wheel shows any sign of damage, such as chipping, cracking or discolouration. If the wheel has any one of these problems, then it may be faulty and you should contact your supplier.

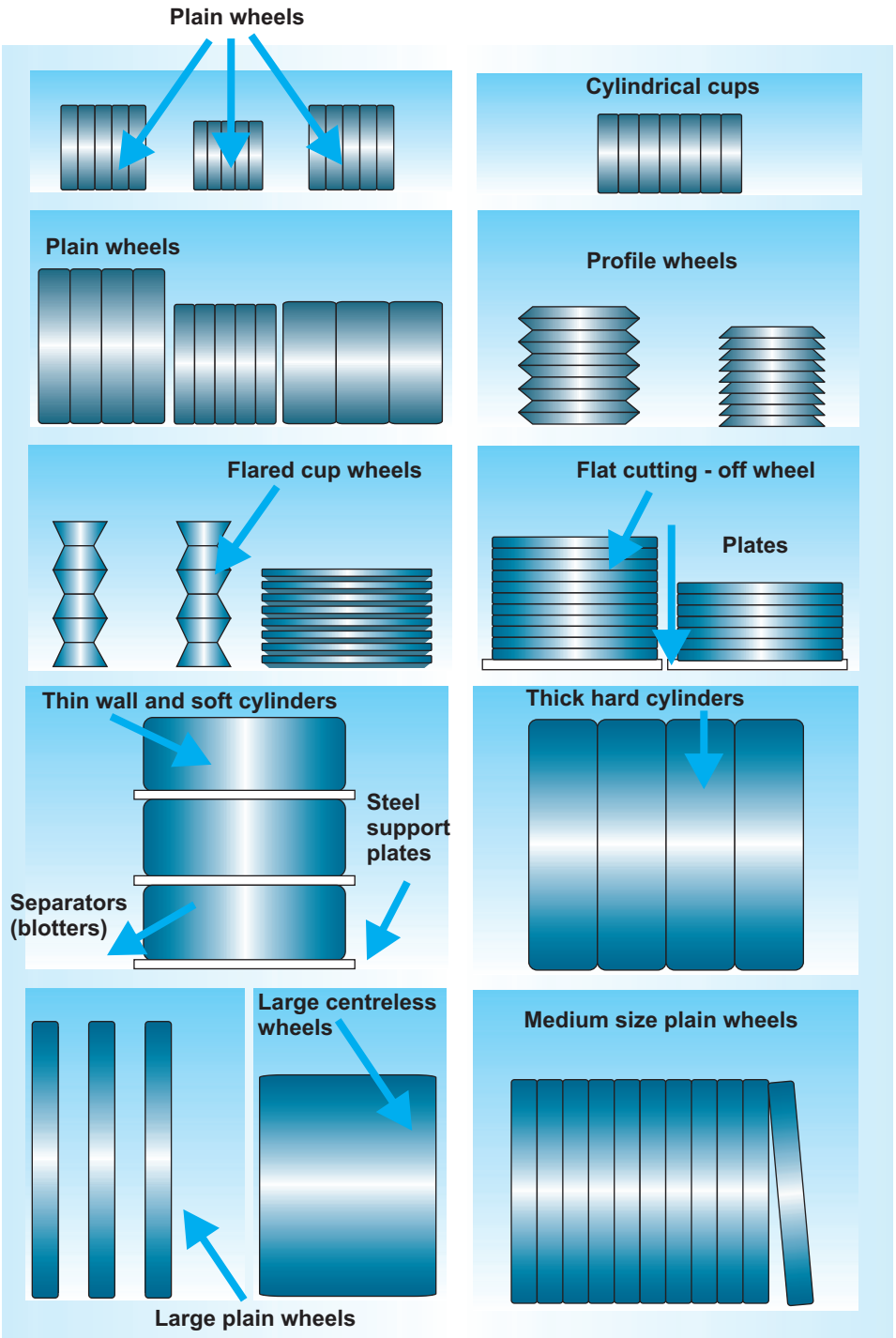
**Ring Test :-**

A ring test should always be conducted on receipt of a grinding wheel as well as before mounting it. This is mainly done to detect if there is any damage to the wheel. To conduct a ring test, small wheels should be held with the fore finger inside the bore while large wheels should be placed on a stand or support.

The wheel should be tapped lightly with a non metallic implement like a screw driver handle in case of small wheels or a wooden mallet in the case of heavier wheels.

While conducting the ring test, tap the wheel on either side at 45° of its vertical axis and at 1" or 2" from its periphery. Rotate the wheel again to 45° and repeat the test till the entire circumference of the wheel is covered. A good wheel will give a clear ring while a cracked or damaged wheel will produce a dull sound. The wheel giving a dull sound should not be used and you should contact your supplier.

A ring test should be held in a place where the 'ring' can easily be heard. It should be conducted only by a person qualified or skilled enough to interpret the result.




Rack design suitable for storing a wide variety of grinding wheels

# SAFETY

**Wheel Mounting Procedures :**

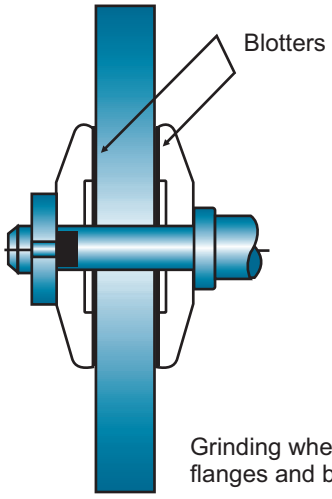
- The wheel must be mounted only by a trained and certified person, competent to carry out the job.
- Before mounting, a grinding wheel must first be checked for damage and a 'ring test' should be conducted to ensure that the wheel is in good condition.
- The wheel should be mounted only on the machine for which it is intended.
- The area surrounding a grinding machine should be free from obstruction. For wet grinding operations splash guards should be provided to prevent the floors surrounding the machine from becoming slippery.
- Wheel guards should be securely fitted before a wheel is run. This will protect the operator by containing or diverting the fragments of an accidentally broken wheel.
- Work rests should be adjusted as close as possible to the grinding wheel.

**Wheel Mounting Procedures :**

- The speed marked on the machine should not, under any circumstances, exceed the speed marked on the wheel blotter or any other document. Operating wheels beyond the maximum permissible speeds or 'MOS' indicated may cause them to break and lead to fatal accidents.

- The wheel should fit freely, but not loosely, on the spindle. The grinding wheel should be fixed to the spindle without applying force and then securely clamped to it.

- Flanges should be clamped firmly and run true to the spindle. Their bearing surfaces should be flat and free from burrs. Any foreign matter between the wheel and the flange can trigger local pressure or stress and cause the wheel to break.




Grinding wheel mounted with flanges and blotters

Blotters which are slightly larger than the flanges should be fixed without wrinkling, on bonded abrasive wheels.

**Wheel Mounting Procedures :**

- The bush, if used, should not project beyond the wheel and the blotters.
- After mounting, a wheel must be allowed to run freely, at its full operating speed, for at least 1 minute. This test run is applicable for both new wheels as well as old wheels re-mounted for grinding.
- Never grind material for which the wheel is not designed.
- Do not grind on the side of the wheel unless the wheel is specifically designed for that purpose.
- Since a grinding operation generates sparks and swarf, the operator should compulsorily wear safety goggles and face shields as required. Protective clothing like aprons, gloves and safety shoes should also be used to enable the operator to work safely and efficiently.
- In certain types of grinding where the swarf or dust generation is very high, operators should be provided with dust masks.
- Wheels should never be stopped by applying pressure or force to the periphery or face. Instead the wheel should be allowed to stop by itself.

# RIGHT MOUNTING FOR SAFE GRINDING

Though all grinding wheels are relatively fragile, they are safe operating tools if handled and used properly. However, if abused they can pose serious safety hazards.

The most common type of abuse is in the form of wrong mounting and studies have established that a high percentage of the total number of accidents on the shop floor are the result of incorrect mounting. In many countries regulations have been brought out to make training in the correct mounting of abrasive wheels mandatory.

Grinding wheels will withstand substantial compressive stresses but under tensile or bending stresses they give away easily. All major stresses that develop in a grinding wheel under operating conditions are at a maximum near the bore. Mounting flanges are designed in such a way that wheels are subjected only to compressive stresses and such stresses act on the wheel away from the bore. Most of the wheels are held between symmetrical flanges. These flanges are relieved near the bore and the bearing area is sufficiently away from the hole. The bearing area depends upon the size of the wheel and forces acting on the wheel. The flanges should be made from good quality mild steel or similar material and possess sufficient rigidity and resist deflection when they are tightened on to the wheel.

Refer Flange Selection table Nos. 1, 2, 3 & 4 which show the important dimensions of the various types of flanges commonly used for mounting grinding wheels.

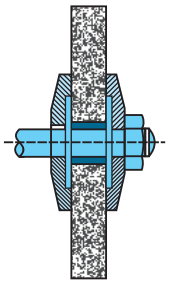
(For additional information please refer to the FEPA guidelines).

**Types of mounting**

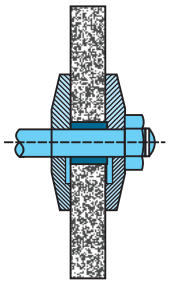
The manner of mounting wheels depends upon the size and shape of the wheel and the grinding operation.

**1. Straight Wheels with small holes**

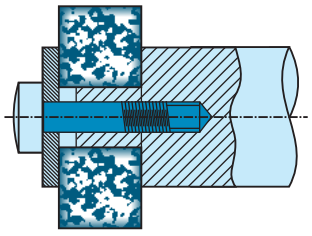
These wheels are generally used on Bench and Pedestal grinders (fig. 1)



A straight-sided wheel with a small hole, correctly mounted.
**Fig. 1**



An incorrectly mounted wheel. Flanges not recessed and washers not fitted.
**Fig. 2**



Method of mounting a small wheel used for internal grinding.
**Fig. 3**

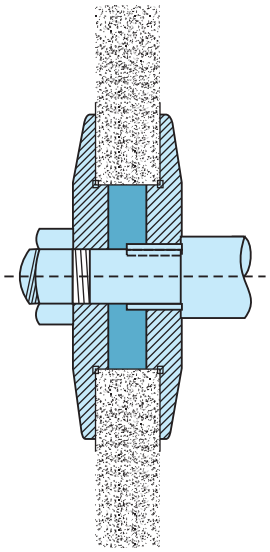
The wheel is held between 2 flanges having equal diameter. The driving flange is key to avoid slippage between the flange and the spindle. Both flanges are symmetrical in all other respects. The recesses shift the mounting stresses away from the hole. Fig. 2 shows a wheel which is incorrectly mounted. The flanges are not recessed and there is no blotter between the wheel face and flanges to provide a cushioning effect when the nut is tightened, with the result that the stresses concentrate at the bore region. This type of mounting can easily cause wheel breakage.

However, when the wheel diameter is very small as in the case of the internal grinding wheel, suitable mounting is shown in Fig. 3.

**2. Straight wheels with large holes**

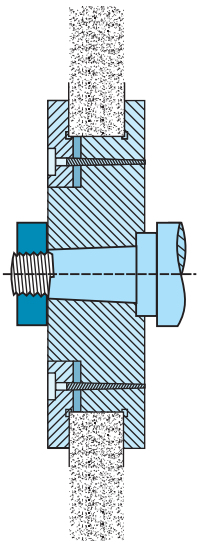
Straight wheel with large holes are commonly used for high speed snagging. Instead of mounting the wheel directly on the spindle, adaptor flanges are used (Fig. 4). These flanges are similar to the ones shown in fig. 1 in all other respects. The undercut at the corner facilitates proper location.

Large precision grinding wheels are mounted by means of sleeve flanges (Fig. 5 & 6). The wheel holder or collet is machined to form one of the flanges for gripping the wheel. The collet fits the tapered end of the spindle and is held in place by means of a lock nut. It is usual to keep wheels of different specifications mounted on the sleeve and kept ready so that the complete mounting can be replaced to save time.



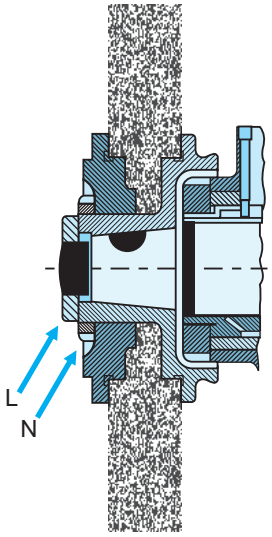
A flange assembly for a wheel with a large hole. The corners of the wheel seatings must be undercut as shown.

**Fig. 4**



A sleeve flange can be used on wheels with a large bore.

**Fig. 5**

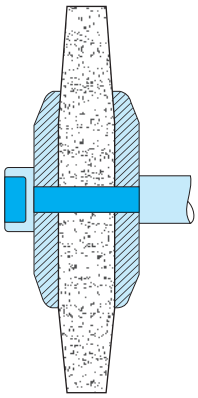



A method of mounting a precision wheel for external cylindrical grinding.

**Fig. 6**

### 3. Taper Wheels

Whenever it is impractical to fit the guards on the machine, the breakage risk can be reduced by using a taper wheel and protection flanges as shown in (Fig.7). The taper on the wheel prevents it from flying apart and causing injury to the operator in case of wheel breakage. However, this will not eliminate such risks.



Protection flanges used with a tapered wheel.
To be effective, the degree of taper of the flanges must correspond with that of the wheel

**Fig.7**

**CAUTION**

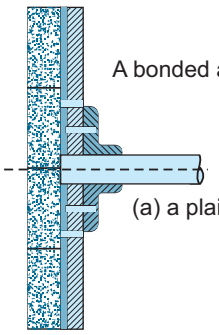
It has been proved that protection flanges can cause wheel breakage if the wheel face and bearing surface are not absolutely parallel. Such flanges will cause stress concentration, which may develop cracks in the wheel. Therefore, protection flanges should be used only if the guard cannot be used.

Protection flanges provide no protection if a portion of the wheel breaks up outside the flanges. For this reason minimum exposure of the wheel is important.

Table 4 specifies the minimum diameters of protection flanges for various diameters of taper wheels used on portable machines. Here also it can be seen that no blotters are used between the wheel face and protection flanges.

### 4. Cylinder Wheels and nut inserted discs.

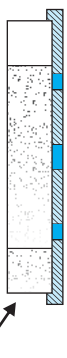
(a) **Cylinder Wheels** are mounted to a back plate or wheel head by means of mechanical clamps or by using cements. When mechanical clamps are used they should conform to the OD of the wheel and provide good gripping (Fig. 8, 9, 10).



A bonded abrasive disc cemented to

(a) a plain backplate and

**Fig. 8**



b) a lipped backplate

Cement

**Fig. 9**

A cylinder wheel mounted in a protection chuck. The chuck should be kept adjusted for minimum exposure of the wheel.

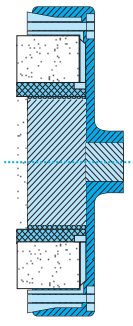
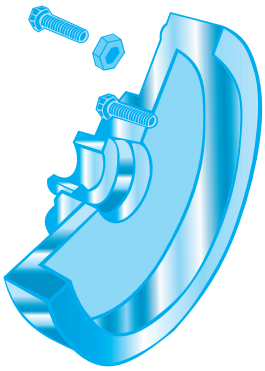


**Fig. 10**

(b) **Nut inserted discs.** These wheels are commonly used for disc grinding operations and are mounted by means of steel nuts embedded on the side. The hole on the face plate and nuts on the wheels should be accurately matched. The penetration of the screw should be less than the depth of the nut, otherwise the screw will pull the nut off the wheel. The face plate should be of adequate thickness and flat to provide even support over a large area of contact. Before mounting, the face plate should be thoroughly cleaned. The screws should be tightened uniformly in a diametrical sequence (Fig. 11).

Incorrect nut mounting for a cylinder wheel. The screws must not come into contact with the abrasive material.

**Fig.11**



A typical mounting for abrasive segments

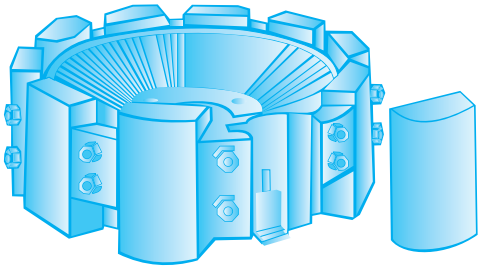


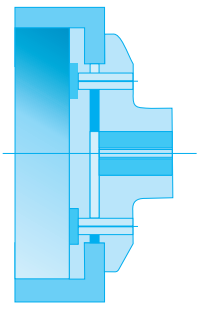
**Fig.12**

## 5. Grinding Segments

Fig. 12 shows typical arrangements for mounting segments. The segments are held in position by dovetailed wedges fitted on the periphery of the chuck. It is advisable to use blotters between the segments and the wedges. These wedges should be regularly checked to see that worn out wedges are not used for clamping. Such wedges will develop uneven mounting stresses and cause breakage. The overhang of the segment should not exceed its thickness.

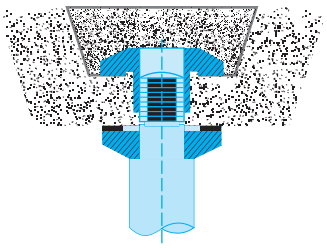
## 6. Cup Wheels

On fixed machine situations, cup wheels are commonly used on tool and cutter grinding machines, for sharpening cutting tools (Fig. 13). Flanges used for mounting cup wheels are similar to the sleeve type flanges described earlier.



A cup wheel mounting for a fixed machine.

**Fig.13**



An adaptor flange for an unthreaded-hole cup wheel. To provide proper support, the adaptor flange and back flange should be equal in outside diameter and diameter of recess.

**Fig.14**

On portable machine situations, cup wheels with plain or threaded holes are used. Plain wheels are mounted by means of adaptor flanges as shown in Fig. 14. Wheels with threaded holes are screwed on to the end of the machine spindle against the flange. The flange should be flat and not recessed (Fig. 15). Recessed flanges (Fig. 16) would tend to strain the threaded bushings. Blotters are not necessary.

A correctly mounted threaded-hole wheel.

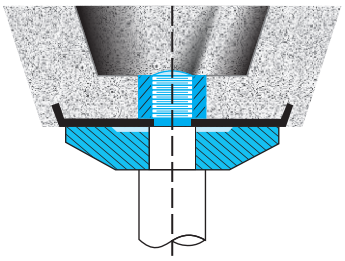


Fig. 15

An incorrectly mounted threaded-hole wheel.
The recessed flange does not provide proper support.

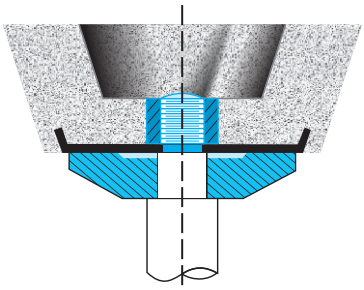
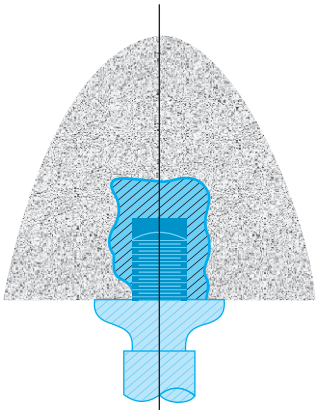


Fig. 16

## 7. Nut inserted cones

These are used on portable grinders in place of mounted points. Before mounting, the hole should be checked to see that it is free from foreign matter. Threaded spindles should be shorter than the depth of the nut but long enough for sufficient threaded engagement. Flanges should be flat and not recessed, otherwise the nut will be pulled out while tightening (Fig. 17 & 18).



A correctly mounted cone wheel

Fig. 17

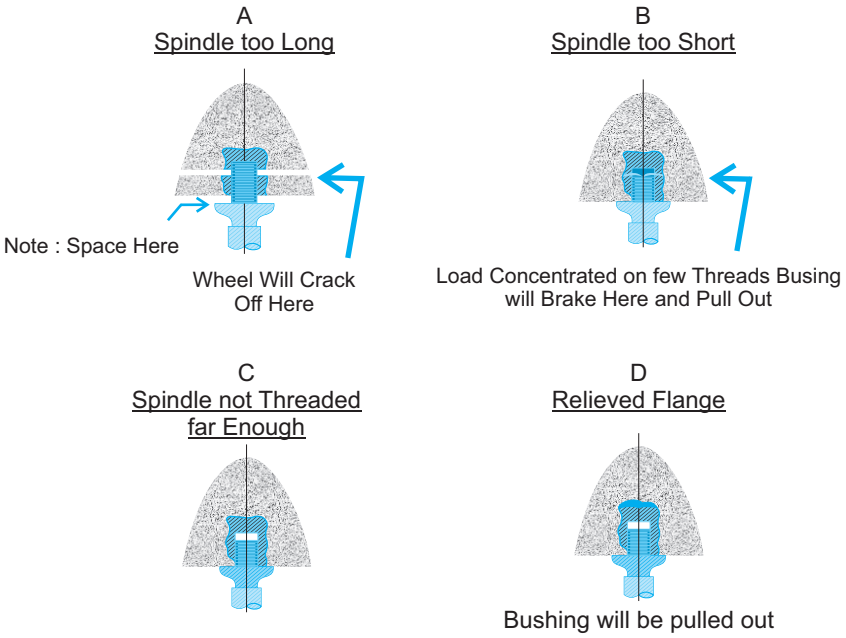



Fig. 18

# PROBLEM SOLVING

## CAUSES & CORRECTION OF COMMON GRINDING ERRORS

### CHATTER

| Indication | Cause | Methods of Correction |
|---|---|---|
| Chatter | Wheel out of balance | Re-balance wheel on mounting. Re-balance wheel after truing. Run wheel without coolant to remove excess water. After removing wheel from machine, store on side to prevent water from settling at lower edge of wheel. |
| | Wheel out of round | True before and after balancing. True sides to face. |
| | Wheel grading too hard | Select softer grade, more open bond or coarser grit. See “Wheel Grading”. |
| | Work centres or work rests not true or improperly lubricated | Check fit of centres and rests. Provide constant and even lubrication. |
| | Dressing | Use sharp diamond dresser rigidly held close to wheel. |

## SPIRALS ON WORK

| Indication | Cause | Methods of Correction |
|---|---|---|
| Spirals(traverse lines) same lead on work as rate of traverse | Mis-alignment | Check alignment of head and tail stocks, also wheel head to work. |
| | Truing | Have truing tool set on work wheel contact line, but pointed down $3^0$. Round off edges of wheel face. |

## WHEEL GRADING EFFECT

| Indication | Cause | Methods of Correction |
|---|---|---|
| Lack of cut, glazing, some loading; burning of work, chatter. | Wheel too hard in effect | Increase work and traverse speeds and wheel pressure(in feed).<br><br>Decrease spindle speed wheel diameter and width of wheel face.<br>Open up wheel by sharper dressing.<br>Review coolant.<br>Avoid dwelling at end of traverse.<br>Use coarser grain size and softer grade.<br>Check filtration system |
| Wheel marks, short wheel life, not holding cut, tapered work | Wheel too soft in effect | Decrease work and traverse speeds and wheel pressure(in feed).<br>Increase spindle speed, wheel diameter and width of wheel face.<br>Dress with slow traverse and slight penetration.<br>Review coolants.<br>Do not pass off work at end of traverse. |

## WHEEL LOADING

| Indication | Cause | Methods of Correction |
|---|---|---|
| Metal lodged on grains, or in wheel pores | Incorrect wheel | Use coarser grain size or more open bond to provide chip clearance.<br>Review coolant. |
| | Faulty dressing | Use sharper dresser. Dress faster.<br>Clean wheel after dressing. |
| | Faulty coolant | Review coolant. |
| | Faulty operation effect of wheel. | Manipulate operation to soften.<br>See" Wheel Grading Effect".<br>Use more in-feed. |

## WHEEL GLAZING

| Indication | Cause | Methods of Correction |
|---|---|---|
| Shiny appearance, smooth feel | Improper wheel | Use coarser grain size, softer grade. Manipulate operation to soften effect. See"Wheel Grading Effect". |
| | Improper dressing | Keep wheel sharp by using sharp dresser. Use faster dressing tool traverse. Allow more dressing tool penetration. |
| | Faulty coolant | Review coolant. |
| | Coolant contamination | Review coolant. |
| | Faulty operations | Use greater in-feed. See "Wheel Grading Effect" |

## INACCURACIES IN WORK

| Indication | Cause | Methods of Correction |
|---|---|---|
| Work out-of-round, out-of-parallel or tapered | Work centres or work rests not true or improperly lubricated. | Check fit of centres and rests. Provide constant and even lubrication. Provide adequate steady rests. |
| | Improper dressing | Make sure machine conditions are the same at dressing point as at point of grinding position. |
| | Improper operation | Do not permit wheel to pass off work at end of traverse, which causes taper at work ends. Decrease pressure, which springs work. Use harder wheel. |
| | Expansion of work | Reduce temperature of work by using more coolant & lighter cuts. |

## 'CHECKING' OF WORK

| Indication | Cause | Methods of Correction |
|---|---|---|
| Work Shows check marks | Improper wheel manipulation | Prevent wheel from acting too hard.<br>Do not force wheel into work.<br>See"wheel Grading Effect".<br>Use greater and even flow of coolant. |

## 'BURNING' OF WORK

| Indication | Cause | Methods of Correction |
|---|---|---|
| Work shows discolouration | Improper wheel | Use softer wheel or manipulate to get softer effect. See "Wheel Grading Effect". Prevent glazing & loading. Use more coolant. |
| | Faulty operation | Bring wheel to work more gradually, use less in-feed. Prevent stoppage of work while in contact with wheel. |

# SCRATCHING OF WORK

| Indication | Cause | Methods of Correction |
|---|---|---|
| Narrow and deep regular marks. | Wheel too coarse | Use finer grain size. |
| Wide irregular marks of varying depth. | Wheel too soft | Use harder grading. See "Wheel Grading Effect". |
| Widely spaced spots on works. | Oil spots or glazed areas on wheel face. | Balance and true wheel. Avoid getting oil on wheel face. |
| Fine spiral or thread on work | Faulty wheel dresser | Replace cracked or broken diamonds. Use slower dressing traverse. Set dressing tool at angle of $5^0$ down and $3^0$ side. Turn diamond every third dressing. |
| | | Tighten holder or diamond. Dress with less penetration. Do not allow tool to dwell in contact with wheel. Do not start dressing cuts on face-locate tool on face but start cuts from edge. Make final pass in dressing in opposite direction to grinding traverse. Traverse diamond evenly across wheel face. Round off wheel edges-just chamfering or dressing back is not enough. |
| | Faulty operation | Prevent penetration of advancing or following edge of wheel by being careful to dress wheel face parallel to work. Reduce wheel pressure. Provide additional steady rests. Reduce traverse in relation to work rotation. When making numerous passes, make slight change in traverse rate at each pass to break up pattern. |

# SCRATCHING OF WORK

| Indication | Causes | Methods of Correction |
|---|---|---|
| Wavy traverse lines | Ragged wheel edges | Round off wheel edges. |
| Isolated deep marks | Improper wheel dressing | Use sharper dressing tools. Brush wheel after dressing using a stiff bristle brush. |
| | Coarse grains or foreign matter in wheel face | Dress out. |
| | Bond disintegrates; grain pull out | Coolant too strong for some organic bonds. |
| Irregular marks | Loose dirt | Keep machine clean. |
| Irregular marks of varying length and width, scratches usually 'fishtail' | Dirty coolant | Clean tank frequently. Flush guards after dressing and when changing to finer wheels. |
| Deep Irregular marks | Loose wheel flanges | Tighten flanges, using blotters. |
| Grain marks | Wheel too coarse or too soft | Select finer grain size or harder grade wheel. |
| | Too much difference in grain size between roughing and finishing wheels | Use finer roughing wheel or finish out better with roughing wheel. |
| | Dressing too coarse | Less dresser penetration and slower dresser traverse. |
| | Improper cut from finishing wheel | Start with high work and traverse speeds, to cut away previous wheel marks; finish out with high work and slow traverse speeds, allowing wheel to spark out entirely. |

# WHEEL BREAKAGE

| Indication | Cause | Methods of Correction |
|---|---|---|
| Radial break, three or more pieces | Excess wheel speeds | Reduce wheel speed to rated speed. |
| | Improper mounting of wheel | Correct improper mounting such as lack of blotters, tight arbors, uneven flange pressure, dirt between flanges and wheel. |
| | Over heating | Prevent overheating by using sufficient amount of coolant. |
| | Excessive wheel pressure | Prevent excessive wheel pressure on work. |
| | Jamming of wheel | Do not allow wheel to become jammed on work. |
| Radial break, two pieces | Excessive side strain | Prevent excessive strain on the side of the wheel. |
| Irregular break | Wheel jamming | Do not allow wheel to become jammed on work. |
| | Wheel damage | Prevent blows on wheel. Do not use wheels that have been damaged in handling. Examine wheel before using. Check wheels for damage by 'ring test' or tapping. |
| General | Wheel arbor too tight | Do not use a wheel that is too tight on the arbor as wheel will break when started. |
| | Excessive wheel hammering | Prevent excessive hammering action on the wheel. |

# REFERENCE TABLES

## APPROXIMATE DIAMETER OF ABRASIVE GRAINS

### FEPA grain size (mesh) in mm and inches
### Average Grain Diameter

1/1000inch=25 microns
1 micron = 0.001 mm

| FEPA Designation | Average Dia. In mm | Average Dia. In inch |
|---|---|---|
| 8 | 2.40 | 0.096 |
| 10 | 2.00 | 0.080 |
| 12 | 1.70 | 0.068 |
| 14 | 1.40 | 0.056 |
| 16 | 1.20 | 0.048 |
| 20 | 1.00 | 0.040 |
| 24 | 0.71 | 0.028 |
| 30 | 0.59 | 0.024 |
| 36 | 0.50 | 0.020 |
| 40 | 0.42 | 0.017 |
| 46 | 0.35 | 0.014 |
| 54 | 0.30 | 0.012 |
| 60 | 0.25 | 0.010 |
| 70 | 0.21 | 0.008 |
| 80 | 0.18 | 0.007 |
| 90 | 0.15 | 0.006 |
| 100 | 0.13 | 0.005 |
| 120 | 0.10 | 0.004 |
| 150 | 0.08 | 0.003 |
| 180 | 0.07 | 0.0028 |
| 220 | 0.06 | 0.0024 |
| 240 | 0.05 | 0.0021 |
| 280 | 0.04 | 0.0017 |
| 320 | 0.03 | 0.0012 |
| 400 | 0.02 | 0.0008 |
| 500 | 0.014 | 0.0006 |
| 600 | 0.010 | 0.0004 |
| 850 | 0.007 | 0.0003 |
| 1200 | 0.004 | 0.0002 |

# SURFACE FINISH COMPARISON TABLE

| $R_a$ µm | $R_t$ µm | $R_z$ µm | RMS µinch | CLA µinch | PVA µinch | Roughness Class |
|---|---|---|---|---|---|---|
| 0.025 | 0.2 | 0.16 | 1.12 | 1 | 6 | |
| 0.05 | 0.4 | 0.32 | 2.2 | 2 | 12 | N1 |
| 0.06 | 0.5 | 0.38 | 2.7 | 2.4 | 16 | N2 |
| 0.08 | 0.6 | 0.5 | 3.6 | 3.2 | 20 | |
| 0.1 | 0.8 | 0.6 | 4.5 | 4 | 25 | |
| 0.12 | 1 | 0.75 | 5.3 | 5 | 32 | N3 |
| 0.16 | 1.25 | 1 | 7.1 | 6.3 | 40 | |
| 0.2 | 1.5 | 1.25 | 9 | 8 | 50 | |
| 0.25 | 2 | 1.6 | 11.2 | 7.1 | 63 | N4 |
| 0.31 | 2.5 | 2 | 14 | 12.5 | 80 | |
| 0.4 | 3.2 | 2.5 | 18 | 16 | 100 | |
| 0.5 | 4 | 3.2 | 22.4 | 20 | 125 | N5 |
| 0.6 | 5 | 4 | 28 | 25 | 160 | |
| 0.8 | 6.3 | 5 | 35.5 | 32 | 200 | |
| 1.0 | 8 | 6.3 | 45 | 40 | 250 | N6 |
| 1.25 | 10 | 8 | 56 | 50 | 320 | |
| 1.6 | 12.5 | 10 | 71 | 63 | 400 | |
| | | | | | | N7 |

$R_a$ = DIN Centre line Average

$R_t$ = Maximum Peak to Trough Height over the surface

RMS = Root Mean Square Avg. Height

CLA = Centre Line Average

PVA = Peak to Valley Avg. Height

$R_z$ = Average of fine absolute maximum peaks and troughs within the length of 1m.

**Calculation Basis :**

$1R_t \approx 8\ R_a$

$1R_z \approx 0.85\ R_t$

# CONVERSION CHART
# HARDNESS CONVERSION CHART

| Rockwell Scale (C) | VPN | Brinell Hardness | Tons/Sq. in. | Kgf/ sq. mm |
|---|---|---|---|---|
| 68.0 | 940 | | | |
| 67.5 | 920 | | | |
| 67.0 | 900 | | | |
| 66.5 | 883 | | | |
| 66.0 | 865 | | | |
| 65.5 | 848 | | | |
| 65.0 | 832 | | 150 | 237 |
| 64.5 | 817 | | 147 | 232 |
| 64.0 | 800 | | 145 | 229 |
| 63.5 | 787 | | 142 | 224 |
| 63.0 | 772 | | 140 | 221 |
| 62.5 | 759 | | 138 | 218 |
| 62.0 | 746 | | 137 | 216 |
| 61.5 | 733 | | 135 | 213 |
| 61.0 | 720 | | 133 | 210 |
| 60.0 | 697 | | 129 | 204 |
| 59.0 | 674 | | 126 | 109 |
| 58.0 | 653 | | 123 | 194 |
| 57.0 | 633 | | 120 | 189 |
| 56.0 | 613 | | 117 | 185 |
| 55.0 | 595 | | 114 | 180 |
| 54.0 | 577 | | 112 | 177 |
| 53.0 | 560 | 510 | 109 | 172 |
| 52.0 | 544 | 500 | 107 | 169 |
| 51.0 | 528 | 487 | 104 | 164 |
| 50.0 | 513 | 475 | 102 | 161 |
| 49.0 | 498 | 464 | 100 | 158 |
| 48.0 | 484 | 450 | 98 | 155 |
| 47.0 | 471 | 442 | 96 | 151 |
| 46.0 | 458 | 432 | 94 | 148 |
| 45.0 | 446 | 421 | 92 | 145 |
| 44.0 | 434 | 410 | 90 | 142 |
| 43.0 | 423 | 401 | 88 | 139 |
| 42.0 | 412 | 390 | 86 | 136 |
| 41.0 | 402 | 381 | 85 | 134 |
| 40.0 | 392 | 371 | 83 | 131 |
| 39.0 | 382 | 362 | 81 | 128 |
| 38.0 | 372 | 353 | 80 | 126 |
| 37.0 | 363 | 344 | 78 | 123 |
| 36.0 | 354 | 336 | 76 | 120 |
| 35.0 | 345 | 327 | 74 | 117 |
| 34.0 | 336 | 319 | 72 | 113 |
| 33.0 | 327 | 311 | 70 | 110 |
| 32.0 | 318 | 301 | 68 | 107 |
| 31.0 | 310 | 294 | 67 | 106 |
| 30.0 | 302 | 286 | 65 | 102 |

## HARDNESS CONVERSION CHART

| Rockwell Scale C | VPN | Brinell Hardness | Tons/Sq. in. | Kgf/ sq. mm |
|---|---|---|---|---|
| 29.0 | 294 | 279 | 64 | 101 |
| 28.0 | 286 | 273 | 62 | 98 |
| 27.0 | 279 | 267 | 61 | 96 |
| 26.0 | 272 | 261 | 59 | 93 |
| 25.0 | 266 | 258 | 58 | 91 |
| 24.0 | 260 | 253 | 57 | 90 |
| 23.0 | 254 | 248 | 55 | 87 |
| 22.0 | 248 | 243 | 54 | 85 |
| 21.0 | 243 | 239 | 53 | 83 |
| 20.0 | 238 | 235 | 52 | 82 |
| | 228 | 226 | 50 | 79 |
| | 217 | 216 | 47 | 74 |
| | 207 | 206 | 45 | 71 |
| | 196 | 195 | 43 | 68 |
| | 187 | 187 | 41 | 64 |
| | 176 | 176 | 39 | 61 |
| | 165 | 165 | 37 | 58 |
| | 145 | 145 | 33 | 52 |
| | 131 | 131 | 30 | 47 |

## BORE (H11) TOLERANCE CHART

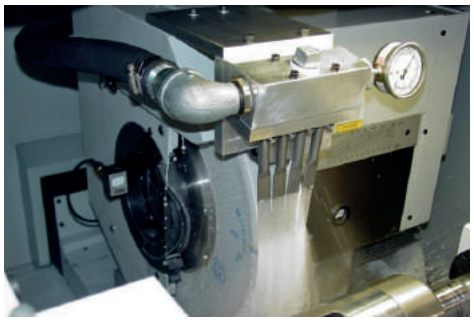
| Bore Diameter | | H11 Tolerance | | |
|---|---|---|---|---|
| Above (mm) | Up to and Including (mm) | Maximum (mm) | Maximum (inches) | Minimum |
| 3 | 6 | +0.075 | +0.0030 | 0 |
| 6 | 10 | +0.090 | +0.0035 | 0 |
| 10 | 18 | +0.110 | +0.0042 | 0 |
| 18 | 30 | +0.130 | +0.0050 | 0 |
| 30 | 50 | +0.160 | +0.0060 | 0 |
| 50 | 80 | +0.190 | +0.0075 | 0 |
| 80 | 120 | +0.220 | +0.0085 | 0 |
| 120 | 180 | +0.250 | +0.0100 | 0 |
| 180 | 250 | +0.290 | +0.0115 | 0 |
| 250 | 315 | +0320 | +0.0125 | 0 |
| 315 | 400 | +0.360 | +0.0145 | 0 |
| 400 | 500 | +0.400 | +0.0160 | 0 |

# CONVERSION TABLE-WHEEL SPEEDS

## Revolutions per minute for various diameters of grinding wheels to give peripheral speed in meters/sec. as indicated

| DIAMETER IN MM | PERIPHERAL SPEED IN METERS/SEC. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 m/s | 23 m/s | 25 m/s | 28 m/s | 30 m/s | 33 m/s | 35 m/s | 40 m/s | 42 m/s | 45 m/s | 48 m/s | 50 m/s | 55 m/s | 60 m/s | 70 m/s | 80 m/s |
| | REVOLUTIONS PER MINUTE (APPROX) | | | | | | | | | | | | | | | |
| 25 | 16800 | 17600 | 19100 | 21500 | 22900 | 25000 | 26500 | 30500 | 32000 | 34500 | 36500 | 38000 | 42000 | 46000 | - | - |
| 50 | 8400 | 8800 | 9500 | 10800 | 11500 | 12600 | 13400 | 15300 | 16100 | 17200 | 18300 | 19100 | 21100 | 23000 | - | - |
| 80 | 5200 | 5500 | 6000 | 6800 | 7100 | 7900 | 8400 | 9500 | 10100 | 10700 | 11400 | 12000 | 13200 | 14300 | - | - |
| 100 | 4200 | 4400 | 4750 | 5400 | 5700 | 6300 | 6700 | 7600 | 3100 | 8600 | 9200 | 9600 | 10600 | 11500 | - | - |
| 125 | 3350 | 3500 | 3800 | 4300 | 4600 | 5050 | 5600 | 6100 | 6500 | 6900 | 7300 | 7600 | 8400 | 9200 | - | - |
| 150 | 2800 | 2950 | 3200 | 3600 | 3800 | 4200 | 4450 | 5100 | 5400 | 5700 | 6100 | 6400 | 7000 | 7600 | - | - |
| 180 | 2330 | 2430 | 2650 | 3000 | 3200 | 3500 | 3800 | 4250 | 4450 | 4750 | 5100 | 5300 | 5900 | 6400 | 7400 | 8500 |
| 200 | 2070 | 2160 | 2350 | 2620 | 2820 | 3100 | 3300 | 3750 | 3950 | 4250 | 4500 | 4700 | 5200 | 5600 | 6600 | 7500 |
| 230 | 1820 | 1910 | 2070 | 2320 | 2490 | 2740 | 2900 | 3320 | 3490 | 3730 | 4000 | 4150 | 4670 | 4980 | 5820 | 6600 |
| 250 | 1650 | 1720 | 1880 | 2100 | 2230 | 2500 | 2650 | 3000 | 3150 | 3400 | 3600 | 3750 | 4150 | 4500 | 5300 | 6000 |
| 300 | 1370 | 1440 | 1570 | 1750 | 1880 | 2070 | 2190 | 2500 | 2600 | 2800 | 3000 | 3150 | 3450 | 3750 | 4400 | 5000 |
| 350 | 1180 | 1240 | 1350 | 1500 | 1610 | 1780 | 1890 | 2160 | 2250 | 2400 | 2600 | 2700 | 2950 | 3250 | 3750 | 4300 |
| 400 | 1030 | 1080 | 1180 | 1320 | 1410 | 1550 | 1650 | 1880 | 1970 | 2120 | 2260 | 2350 | 2600 | 2850 | 3300 | 3750 |
| 450 | 900 | 960 | 1050 | 1170 | 1250 | 1380 | 1470 | 1680 | 1760 | 1880 | 2010 | 2090 | 2300 | 2500 | 2950 | 3350 |
| 500 | 830 | 870 | 940 | 1050 | 1130 | 1240 | 1320 | 1500 | 1580 | 1700 | 1810 | 1880 | 2060 | 2260 | 2650 | 3000 |
| 550 | 750 | 790 | 860 | 960 | 1030 | 1130 | 1200 | 1370 | 1440 | 1550 | 1650 | 1710 | 1910 | 2085 | - | - |
| 600 | 690 | 720 | 780 | 880 | 940 | 1030 | 1090 | 1250 | 1320 | 1410 | 1500 | 1570 | 1750 | 1910 | - | - |
| 650 | 640 | 670 | 720 | 810 | 870 | 960 | 1020 | 1160 | 1210 | 1310 | 1390 | 1450 | 1615 | 1765 | - | - |
| 700 | 590 | 620 | 670 | 750 | 810 | 890 | 940 | 1080 | 1130 | 1210 | 1290 | 1350 | 1500 | 1640 | - | - |
| 750 | 550 | 580 | 630 | 700 | 750 | 830 | 880 | 1000 | 1050 | 1130 | 1210 | 1260 | 1400 | 1530 | - | - |
| 800 | 520 | 550 | 580 | 660 | 700 | 770 | 820 | 940 | 980 | 1060 | 1130 | 1170 | 1315 | 1435 | - | - |
| 900 | 460 | 480 | 520 | 580 | 630 | 690 | 730 | 840 | 880 | 940 | 1000 | 1050 | 1170 | 1275 | - | - |
| 1000 | 415 | 430 | 460 | 530 | 560 | 620 | 660 | 750 | 790 | 850 | 910 | 940 | 1050 | 1145 | - | - |
| 1060 | 395 | 415 | 450 | 505 | 540 | 595 | 630 | 720 | 760 | 810 | 865 | 900 | 990 | 1080 | - | - |
| 1100 | 380 | 400 | 430 | 490 | 520 | 570 | 610 | 690 | 730 | 780 | 830 | 870 | - | - | - | - |
| 1200 | 345 | 360 | 400 | 440 | 470 | 520 | 550 | 630 | 660 | 710 | 750 | 780 | - | - | - | - |

# Coolant Nozzles



To achieve optimum performance from your grinding process, it is important to ensure that all aspects of the application have been analysed and suitably addressed. After many years of offering abrasives and dressing solutions for industry, Master Abrasives now offers the complete solution to coolant nozzle design and application. Cool-Grind Technologies are expert in the development and application of coolant nozzles to ensure maximum efficiency of the grinding process and Master are the sole UK distributor for Cool-Grind Technologies.

# Dressing Tools

## Diamond Dressing Cups

This type of dressing tool is one of the most popular for the rotary dressing of small internal grinding wheels. There are basically three differing bond types available.

The electroplated type uses the plating process as described earlier to deposit a single layer of Diamond onto the steel body. This type is less expensive and very free cutting but wears relatively quickly so requires changing on a regular basis.

The metal bonded type is much more durable and provides longer life. The latest development in this field is the vitrified bonded Diamond cup. This utilises the latest vitrified bonding technology to produce a dressing tool that is as free cutting as electroplating but with the durability of the metal bonded cups.

Hybrid Diamond Dressing tools are customised high precision products with a unique and innovative bonding technology. The tools offer outstanding characteristics, producing a safe and controlled dressing operation with significantly improved economics. Thanks to the porous structure, these tools work in a self-sharpening mode, while the multilayered Diamond structure guarantees an extended lifetime.

## Diamond Dressing Discs

Diamond discs are becoming more popular especially with the development of CNC interpolation of forms. Here again the various bond systems can be utilised with metal bonding being the most popular. Once again Master is able to offer the complete range, including the latest technology of vitrified and hybrid bonded discs, to ensure complete process optimisation.

## Diamond Form Roller Dressers

To ensure Master is able to offer the complete package, we can also supply reverse, random, or hand set precision Diamond roller dressers for the forming and dressing of accurate profiles.

## General Diamond Tooling

To complete our range of dressing tools, Master also offers high quality and engineered single point and fliese type dressers. Master Abrasives offers the complete superabrasives package for industry.

Aerospace | Tooling | Fabrication | Power Generation | Medical | Heavy Engineering | Automotive | Bearing | Oil & Gas | Woodwork

# SOLUTIONS FOR INDUSTRY

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MA-190118