MACHINING

Level - III

Learning Guide 5

Unit of Competence: **Perform Advanced Grinding Operations**

Module Title: **Performing Advanced Grinding Operations**

LG Code: **IND MAC3 05 0217**

Instruction Sheet	Learning Guide #1

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Set up work
- Perform advanced grinding operations
- Check components for conformance to specifications

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- selected and appropriate work holding devices are selected
- ***Grinding wheels*** are selected by its type, form and size, checked if it has cracked or not, balanced and dressed with compliance to standard.
- OHS measures and procedures are observed throughout the machining operations

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 20.
3. Read the information written in the information “Sheet.
4. Accomplish the “Self-check.
5. Do the “LAP test”.

MACHINE SET-UP FOR GRINDING

Cylindrical grinding and surface grinding typically utilize a single rotating “grinding” wheel; therefore, these two methods tend to be less critical than centerless grinding. Unacceptable finishes are more a symptom of the machine condition or set-up. As long as the plastic is properly held or fixtured in place, the grinder will make sure the rotating wheel does its job.

With a centerless grinder, set up is extremely important. This type of grinder uses two rotating wheels…a grinding wheel and a “regulating” wheel. The regulating wheel is non-abrasive and is strictly used to feed the rod or tube and apply force pushing it against the grinding wheel as it passes through. Proper set-up of the centerless grinder helps to ensure proper tolerance control and consistent circularity of the finished rod or tube. In this dual wheel grinder, the wheels are located in parallel, side-by-side. The spacing between these two wheels is adjustable and determines how much material is removed per pass. The position of the rod or tube being ground, as it passes between the wheels, is critical. This position is determined by the height of the “work-rest-blade”. This blade sits under and between the wheels and should be set such that the position of the material passing between the rotating wheels falls directly on-center with the wheels to no more than one sixteenth inch above center. When centerless grinding, as the rod or tube is ground and the outside diameter (OD) is reduced, you may need to continue adjusting the work-rest-blade to keep the center of the material positive versus the rotating wheels.

Grinding

To grind means to abrade, to wear away by friction, or to sharpen. In manufacturing it refers to the removal of metal by a rotating abrasive wheel. Wheel action is similar to a milling cutter. The cutting wheel is composed of many small grains bonded together, each one acting as a miniature cutting point.

Types of grinders

Cylindrical grinders

This machine is used primarily for grinding cylindrical surfaces, although tapered and simple format surfaces may also be ground. They may be further classified according to the method of supporting the work. Diagrams illustrating the essential difference in supporting the work between centers and centerless grinding are shown in figure below. In the centerless type the work is supported by the work rest the regulating wheel, and the grinding wheel itself. Both types use plain grinding wheels with the grinding face as the outside diameter.

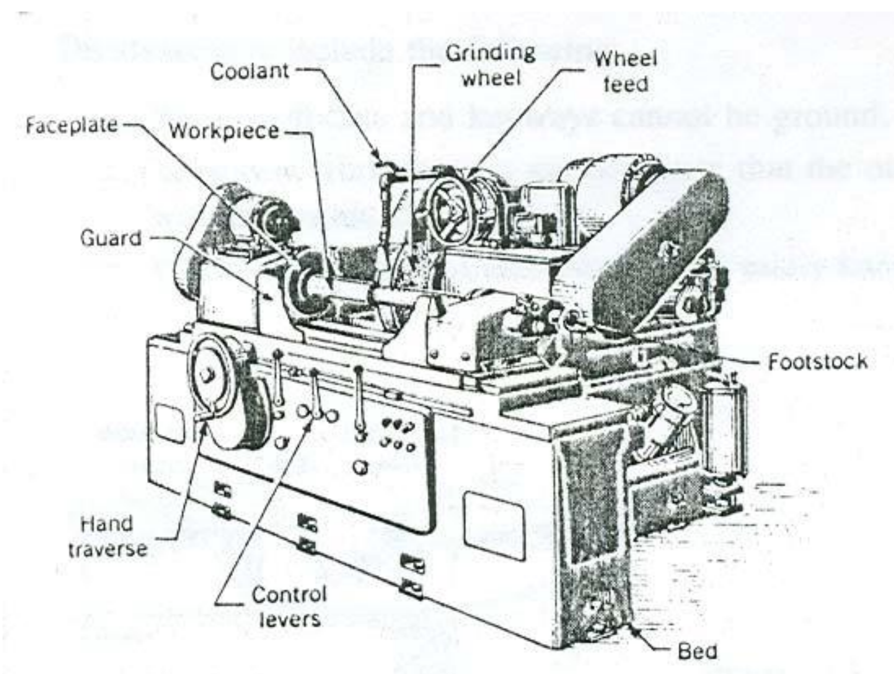


Fig. plain cylindrical grinder

The depth of cut is controlled by feeding the wheel into the work. Roughing cuts around 0.002 in(0.05 mm) per pass may be made but for finishing this should be reduce to about 0.0002 in (0.005 mm) per pass or less. In selecting the amount of in feed, consideration is given to the size and rigidity of the work, surface finish and the decision of whether or not to use a coolant.

Where the face of the wheel is wider than the part to be ground it is not necessary to traverse the work. This is known as plunge cut grinding. The grinding speed of the wheel is terms of surface feet per minute that is,

$V_c = \pi D_c x N$

Where

V_c=Cutting or grinding speed(m/min)

D_c=Diameter of grinding wheel(m)

N=Revolutions of the wheel per minute (rpm)

Centerless grinders

Centerless grinders are designed so that they support and feed the work by using two wheels and a work rest. The large wheel is the grinding wheel and the smaller one the pressure or regulating wheel. The regulating wheel is a rubber-bonded abrasive having the frictional characteristics ta rotate the work at is own rotational speed. The speed of this wheel, which may be controlled, varies from 50 to 200 ft/min(0.25-1.02 m/s). Both wheels are rotating the same direction. The rest assists in supporting the work while it is being ground, being extended on both sides to direct the work travel to and from the wheels.

The axial movement of the work past the grinding wheel is obtained by tilting the wheel at a slight angle from horizontal. An angular adjustment of 0^o to 10^o is provided in the machine for this purpose. The actual feed can be calculated by this formula.

$F = \pi d N \sin\alpha$
F=Feed (mm/min)

N=rpms

d=Diameter of regulating wheel(mm)

α=Angle inclination of regulating wheel

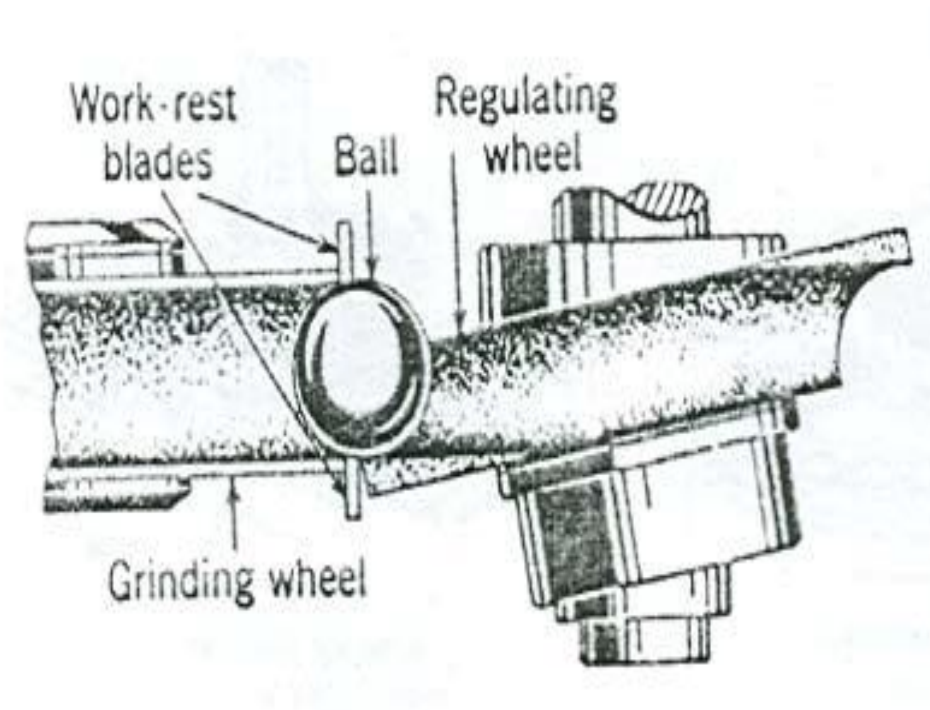


Fig. Centerless grinding of ball bearings

Internal grinders

The work done on an internal grinder is diagrammatically tapered holes or those having more than one diameter may be accurately finished in this manner. There are several types of internal grinders

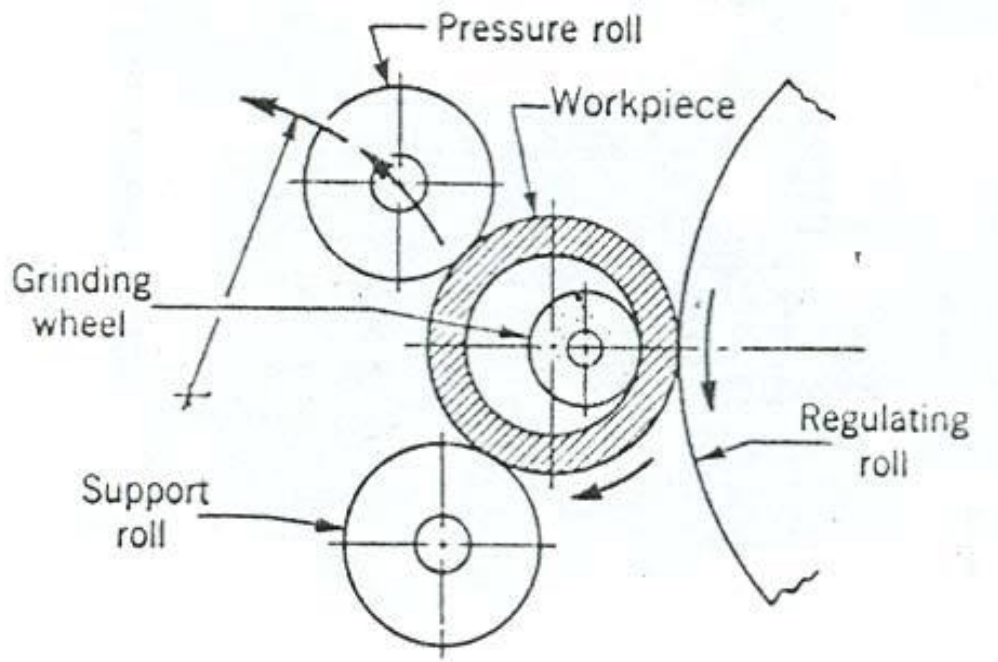


Fig. Centerless internal grinding

Surface grinding

Grinding flat or plane surfaces is known as surfaces grinding. Two general types of machines have been developed for this purpose; those of the planer type with a reciprocating table and those having a rotating worktable. Each machine has the possible variation of a horizontal or vertical positioned grinding wheel spindle. The four possibilities of construction are illustrated below figure.

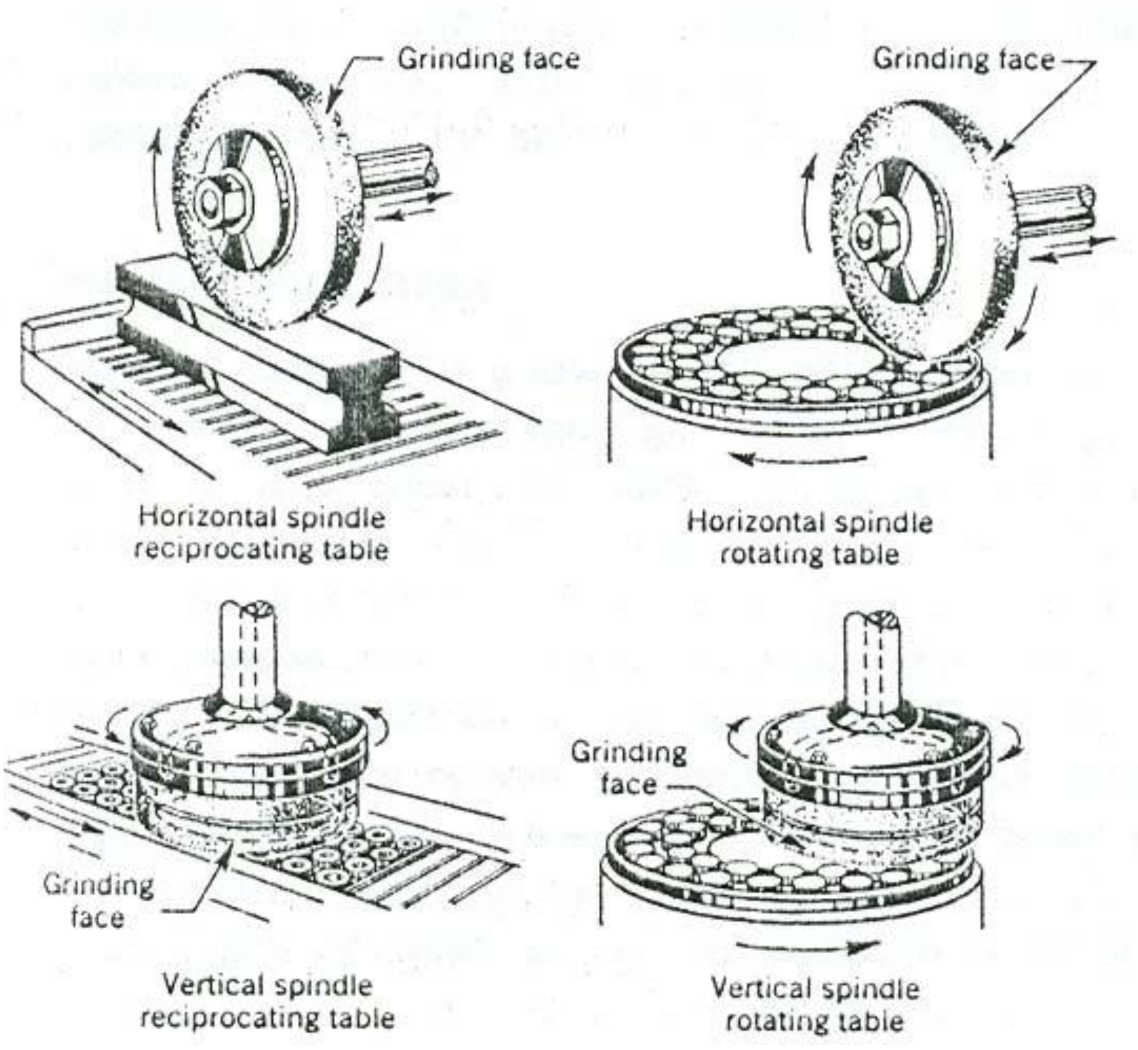


Fig. Types of surface grinding machines

Tool and cutter grinder

In grinding tools by hand a bench or pedestal type of grinder is used. The tool is hand held and moved across the face of the wheel continually to avoid excessive grinding in one spot. For sharpening miscellaneous cutters a universal type grinder is used.

Types of Grinding wheels

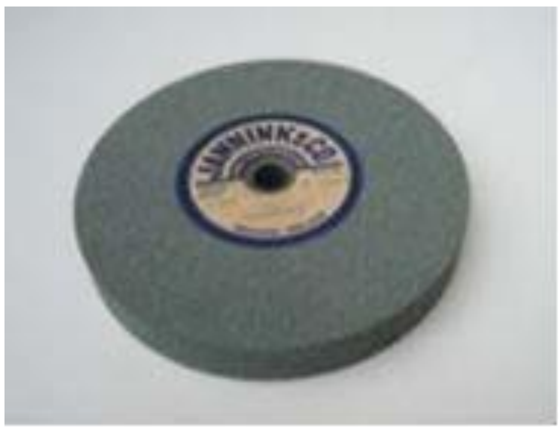


Fig. Grinding wheel

A **grinding wheel** is an expendable wheel that carries an abrasive compound on its periphery. These wheels are used in grinding machines.

The wheel is generally made from a matrix of coarse particles pressed and bonded together to form a solid, circular shape, various profiles and cross sections are available depending on the intended usage for the wheel. They may also be made from a solid steel or aluminum disc with particles bonded to the surface.

Materials used are generally silicon carbide and diamond with a vitrified bonding agent. In production grinding, a wide array of materials are used. Wheels with different abrasives, structure, bond, grade, and grain sizes are available. The abrasive is the actual cutting material, such as cubic boron nitride, zirconia aluminum oxide, manufactured diamonds, ceramic aluminum oxide, aluminum oxide, and others. The abrasive is selected based on the hardness of the material being cut. The structure of the wheel refers to the density of the wheel (bond and abrasive versus airspace). A less-dense wheel will cut freely, and has a large effect on surface finish. A less dense wheel is able to take a deeper or wider cut with less coolant, as the chip clearance on the wheel is greater. The grade of the wheel determines how tightly the bond holds the abrasive. Grade affects almost all considerations of grinding, such as wheel speed, coolant flow, maximum and minimum feed rates, and grinding depth. Grain size determines the physical abrasive size in the wheel. A larger grain will cut freely, allowing fast cutting but poor surface finish. Ultra-fine grain sizes are for precision finish work, where a fine surface finish is required. The wheel bonding agent determines how the wheel holds the abrasives. This affects finish, coolant, and minimum/maximum wheel speed.

The manufacture of these wheels is a precise and tightly controlled process, due not only to the inherent safety risks of a spinning disc, but also the composition and uniformity required to prevent that disc from exploding due to the high stresses produced on rotation.

Grinding wheels are self sharpening to a small degree, for optimal use they may be dressed and trued by the use of grinding dressers. **Dressing** the wheel refers to removing the current layer of abrasive, so that a fresh and sharp surface is exposed to the work surface. **Truing** the wheel makes the grinding surface parallel to the grinding table or other reference plane, so the entire grinding wheel is even and produces an accurate surface.

The wheel type (eg:- cup or plain wheel below) fit freely on their supporting arbors, the necessary clamping force to transfer the rotary motion being applied to the wheels side by identically sized flanges (metal discs). The paper blotter shown in the images is intended to distribute this clamping force evenly across the wheels surface.

Cup wheel

Fig. Cup wheel

A **cup wheel** as pictured to the right is predominantly used in Tool and Cutter grinders where orientation of the wheel and a slim profile are required. These wheels are used (and dressed) on the side face and have the advantage of producing a truly flat surface on the side of lathe tools. They are used in jig grinders to produce flat surfaces or counterbores.

Straight wheel

Fig. Straight wheel

To the left is an image of a **straight wheel**. These are by far the most common style of wheel and can be found on bench or pedestal grinders. They are used on the periphery only and therefore produce a slightly concave surface (*hollow ground*) on the part. This can be used to advantage on many tools such a chisels.

Cylinder wheel

Cylinder wheels provide a long, wide surface with no center mounting support (hollow). They can be very large, up to 12" in width. They are used only in vertical or horizontal spindle grinders.

Tapered wheel

A straight wheel that tapers outward towards the center of the wheel. This arrangement is stronger than straight wheels and can accept higher lateral loads.

Straight cup

Straight cup wheels are an alternative to cup wheels in tool and cutter grinders, where having an additional radial grinding surface is beneficial.

Dish cup

A very shallow cup-style grinding wheel. The thinness allows grinding in slots and cervices. It is used primarily in cutter grinding and jig grinding.

Saucer wheel

A special grinding profile that is used to grind milling cutters and twist drills. It is most common in non-machining areas, as saw filers use saucer wheels in the maintenance of sawblades.

Diamond wheel

Fig. Diamond wheel

Diamond wheels are grinding wheels with industrial diamonds bonded to the periphery.
They are used for grinding extremely hard materials such as carbide tips, gemstones or concrete. The saw pictured to the right is a slitting saw and is designed for slicing hard materials, typically gemstones.

Diamond Mandrels

Diamond mandrels are very similar to their counterpart, a diamond wheel. They are tiny diamond rasps for use in a jig grinder doing profiling work in hard material.

Cut off wheels

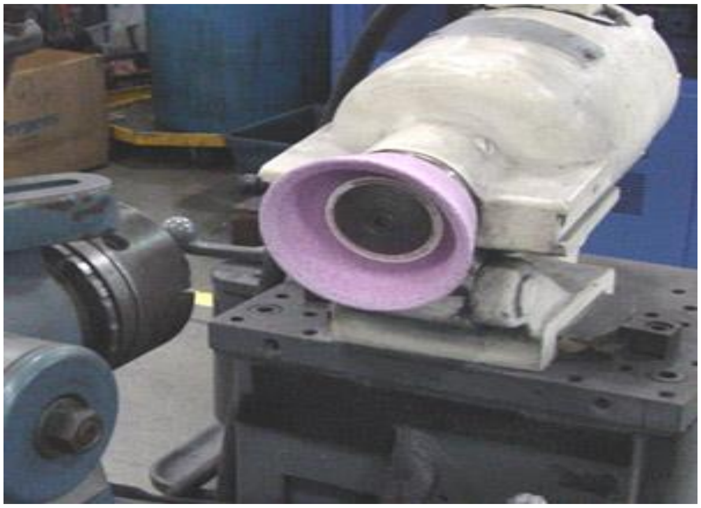
Cut off or **parting wheels** are self-sharpening wheels that are thin in width and often have radial fibers reinforcing them. They are often used in the construction industry for cutting reinforcement steel (rebar), protruding bolts or anything that needs quick removal or trimming. Most handymen would recognize an angle grinder and the discs they use.

Grinding wheel flanges clamping force

The clamping force of the grinding wheel flanges is an important safety parameter of a grinding operation:

- it must be high enough to drive the wheel without slippage under the most severe operating conditions of the machine.

- it must not apply to the wheel an excessive compression stress which could weaken the wheel.
- it must not distort the flanges.

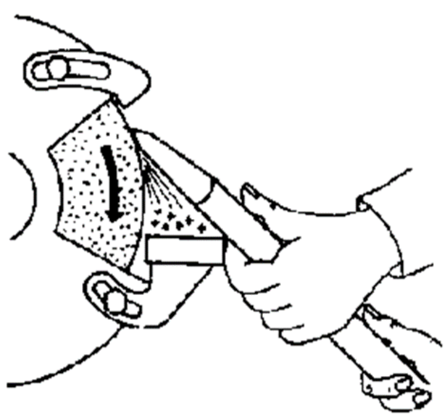


Purpose of grinding

Sharpening is grinding and whetting of tools after their manufacture in order to prepare the cutting edges for use, i.e. mainly in metal cutting processes.

Furthermore, dull, worn out tools are made serviceable again by this technique. There are two different techniques:

Off-hand sharpening and ***sharpening by means of fixtures or special grinding machines.***



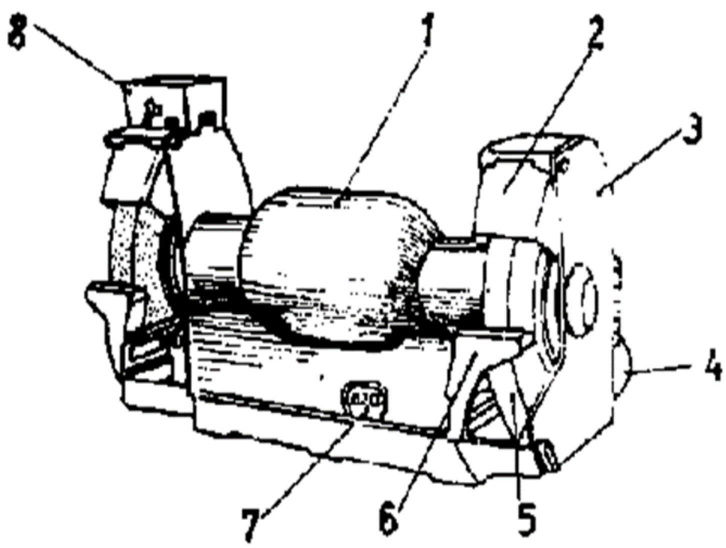
Off-hand sharpening

Off-hand sharpening can be done any time and without much preparations on any grinding machine as soon as a tool that was used has become dull. Therefore, this technique should be perfectly mastered. Permanent exercise and practice is required so that the technique is not unlearned. By off-hand sharpening, the following tools can be sharpened:

Steel scribers and scribers of beam trammels and scribing blocks; punches, chisels and drills of all kinds; screw drivers and scrapers.

Machines for grinding

In the fields of production and maintenance, bench and pedestal type grinding machines are used which are equipped with two grinding wheels, mostly of a different grain size.



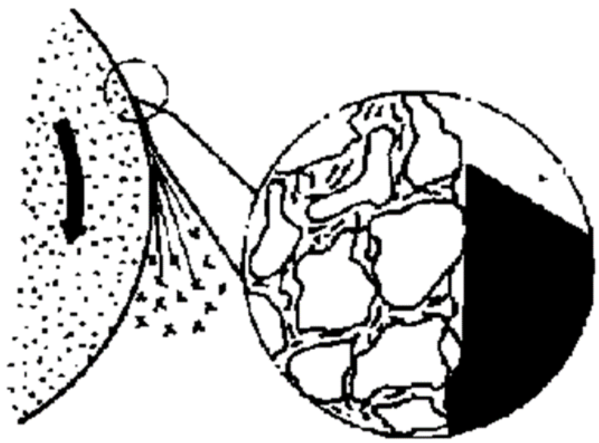
Bench-type grinding machine

1 - Motor in motor casing
2 - Spark killer
3 - Covering hood of the grinding wheel
4 - Pipe connection for exhauster
5 - Grinding wheel
6 - Grinding support
7 – Switch
8 - Water tank for wet grinding

Operation of grinding

When the workpiece is pressed against the grinding wheel which is rotating at a high speed (approximately 2800 rotations per minute), the abrasive grains by their irregular and sharp cutting edges scrape smallest chips from the workpiece.

After the abrasive grains have become dull they tear loose from the structure of the wheel making room for the next following sharp abrasive grains that continue the cutting operation.

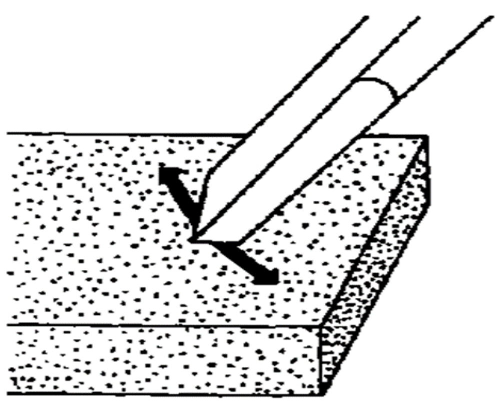


Effect of the abrasive grains

After sharpening a cutting edge of a tool, a burr is to be noted at the edge. This must be removed by whetting before the tool is used.

Operation of whetting

The flanks of the cutting edges of the tool are rubbed on a fine-grained whetstone moistened with water or oil. The flanks must be treated with the on both sides.



Whetting of a shear tool

By repeated changing of the side, the burr is bent several times because it always evades to the side opposite to the flank which is being ground.

The movement is made in an oblique direction towards the edge till the burr is removed.

If the burr is not removed, it breaks off when the tool is used tearing gaps in the cutting edge and making the tool dull and useless soon.'

Whetting increases the service life of the cutting edge.

Examples for off-hand sharpening with straight wheels

Punch and scriber

The operations are similar with sharpening of punches and scribers.

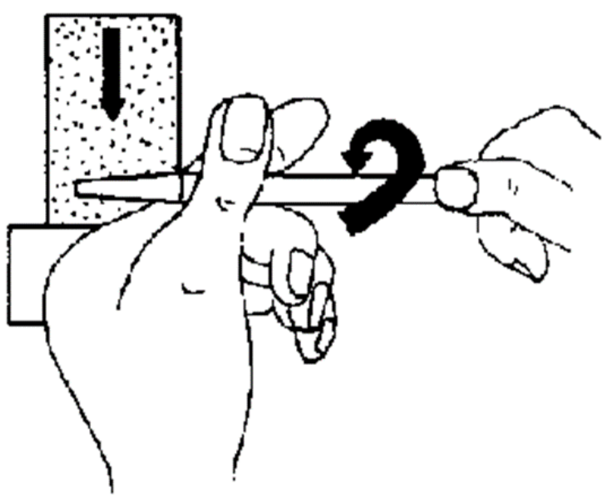
The left hand guides the tool at the grinding wheel, the right hand moves the tool.

Operation:

Grinding of the taper:

The left forefinger lies between grinding support and tool, the thumb is on the tool.

The right hand presses the tool against the wheel in horizontal position at the same time revolving it quickly around its own axis.

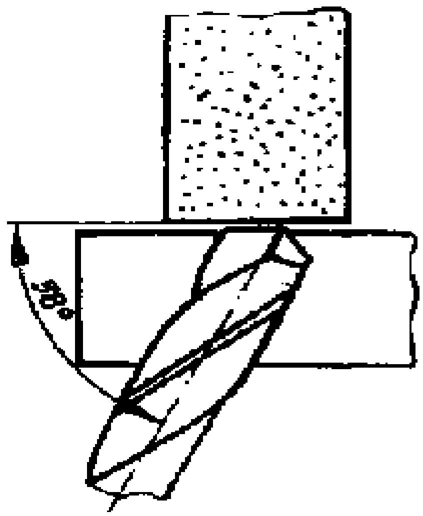


Position of the hands when grinding the taper of a scriber

Drills with standard drill point

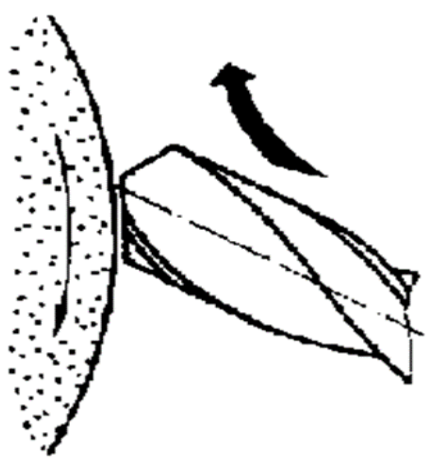
Grinding of the principal cutting edges:

The drill is held between the left forefinger and thumb and guided in such a way that the left principal cutting edge comes in a horizontal position in front of the grinding wheel, the drill itself lies horizontally at an angle of incidence of approximately 58° from the left.



Position of the drill

With slight pressure the drill is led by the right hand upwards from the wheel and, at the same time, slightly pushed to the right - it is lifted above.



Upward movement of the drill

Checking:

After every grinding operation the angle has to be checked by the grinding gauge, the evenness and cleanliness of the surface ground is judged by the eye.

Recommended values:

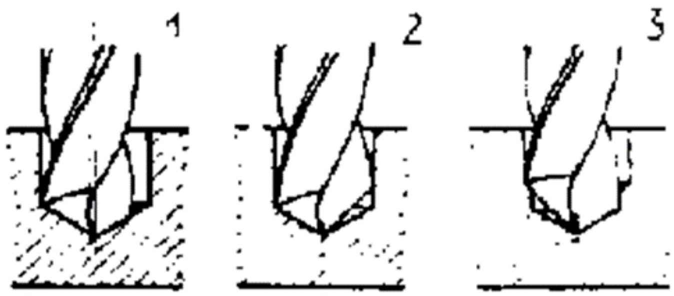
- Point angle between the principal edges by gauge (118º standard drill point)

- Chisel edge must be exactly in the middle and have an angle of 55°

- Flanks shall taper off at 4 - 6° behind the principal cutting edges

Grinding faults:

- Point angle, angle of clearance, complementary angle of the chisel edge angle too large or too small



Consequences of grinding faults (explanations 1,2,3 in the text

- Principal cutting edges (1) different in length (drill out of centre - bore hole too big)

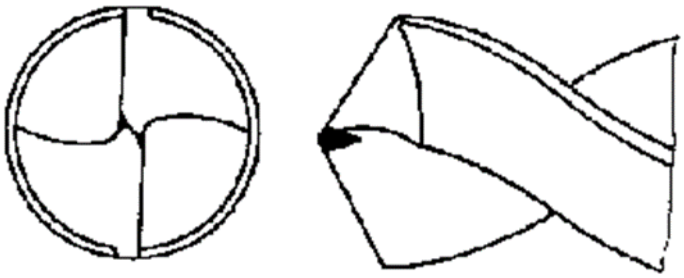
- Principal cutting edges at unequal (2) angles (shoulder in the bore hole)

- Principal cutting edges different in length and unequal angles of the principal cutting edges (3)

- Incompletely ground principal cutting edges (drill does not cut)

Pointing of the chisel edge:

With drills of a diameter of more than 10 mm the chisel edge is vertically ground at the right edge of the grinding wheel or at the dish wheel in order to reduce the squeezing negative effect of the chisel edge.



Pointed drill