TVET CERTIFICATE IV in PRODUCTION TECHNOLOGY

BORING MACHINE OPERATION

PRTBM401

Operate Boring machines

Competence

REQF Level: 4

Learning hours: 100

Credits: 10

Sector: Mining and Manufacturing

Sub-sector: Production and Technology

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Purpose statement

This is a core module which describes the performance outcomes, skills knowledge and attitude required to perform boring machine operations for boring machine operator.

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Learning Unit 1- Analyze the work to be done

LO 1.1 – Identify the work

- Content/Topic 1: Type of materials to be bored

1.1. Metal

Metals are materials holding or possessing the characteristics of being shiny, hard, fusible, malleable, ductile, etc. Few examples of metals (materials) are – Gold, Silver, Aluminum, Copper, Iron, etc.
Examples of Material Properties of Metals: **Malleability, ductility, conductivity.**

Uses of Metals

- Metals are used for various purposes, from making wires and sheets. For example, Copper and aluminum wires in electrical equipment's, especially for conduction of electricity.
- Metals are also used in making automobiles, machinery, water boilers, industrial gadgets, etc.

1.2. Ferrous

Ferrous metals are those that contain iron as the base metal. The properties of ferrous metals may be changed by adding various alloying elements. The chemical and mechanical properties need to be combined to produce a metal to serve a specific purpose,
the materials to bored include the ferrous are follow:
Cast Iron, Wrought Iron , Steel, Low Carbon Steel, Medium Carbon Steel, High Carbon Steel, High-Speed Steel

1.3. Non-ferrous

When a metal is defined as non-ferrous it means that it does not have a significant amount of iron in its chemical composition. The common properties of non-ferrous metals simply because there is such a large variety of metals that fall into the non-ferrous category. Some non-ferrous metals are hard and brittle, some soft and ductile. There are a variety of non-ferrous metals to be bored: **Aluminum, copper, BRASS AND BRONZE.**

1.4. Non-Metal

Non – metals are materials not holding the characteristics of metals, means they are not shiny, hard, fusible, malleable, ductile, etc. Many materials like coal and Sulphur are very soft and dull in appearance. They break down into very fine thin powdery mass on tapping with the hammer. They are neither in – sonorous and also are a very poor conductor of heat and electricity. Few examples of non – metals are carbon, oxygen, Sulphur, etc. the non-metal (cannot be easily rolled, molded, extruded or pressed).

Uses of Non Metals

- Many non-metals like chlorine, Sulphur, iodine are very useful for medicinal purposes.
- Non-metal like oxygen is very essential for our life for respiration.
- We use nitrogen phosphorus in fertilizers for better plant growth and enhance the fertility of the soil.
- Non-metal like Sulphur is useful in crackers.
- Chlorine and Fluorine are useful for the water purification purpose.

1.5. Wood

Wood boring is a cutting operation to produce round holes in wood. Boring is either vertical, parallel or at an angle to the wood grain direction or panel plane.
Boring serves different purposes:

- Boring of through holes for mounting of screws, fitting or nails.
- Boring of holes of limited depth for end grain dowels or dowel joints.
- Pre-boring of wood screw holes.
- Boring of conical holes.

Bore bits are cutting tools to produce holes in wood. Normally the bore bit is rotated around its axis. During such rotation it advances in axial direction. The wood to be removed must not be squeezed off or torn off but be removed by a clean cut. A bore bit consists of various parts (see Fig.

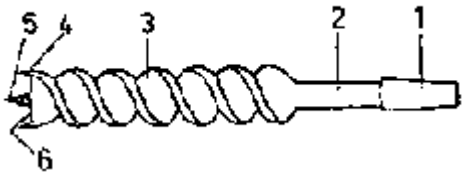


Figure 1.Bore bits

1 square tang, 2 shang, 3 chip-removing screw, 4 pre-cutters, 5 brad point, 6 cutting edge

1.6. Plastic

Plastics are the most common materials for producing end-use parts and products, for everything from consumer products to medical devices. Plastics are a versatile category of materials, with thousands of polymer options, each with their own specific mechanical properties. Boring plastic, it's may use drill bit, file, Hole saw, but plastic boring bits are expensive.

Figure 2.Plastic Cutting Boring Tools

1.7. Rubber

Rubber is used to prevent the entrance of dirt, water or air, and to prevent the loss of fluids, gases, or air. It is also used to absorb vibration, reduce noise and cushion impact loads. The term "Rubber" is as all-inclusive as the term "metal". It is used to include not only natural rubber, but all synthetic and silicone rubbers. Natural rubber has better processing and physical properties than synthetic or silicon rubber. These properties include: 1. Flexibility 2. Elasticity 3. Tensile strenght 4. Tear strenght 5. Low heat build-up due to flexing (hysteresis) (machining-handbook/chapter-2/page/, n.d.)
(chemistry/materials-metals-and-non-metals/metals-and-non-metals, n.d.)

- **Content/Topic 2 identify the work dimensions**

1. Diameter

a diameter of a circle is any straight line segment that passes through the center of the circle and whose endpoints lie on the circle. It can also be defined as the longest chord of the circle.

2. Width

Width is otherwise known as the breadth. It is the distance from one side to the other side which measures across a particular shape or object whose lengths are forming right angles with the sides as in the case of a rectangle

3. Lengt

Length refers to the distance between two ends of an object. It is the biggest distance from one side to the other and the greatest in the three dimensions of a body

4. Thickness

Thickness is the dimension through an object as opposed to its length or width

- **Content/Topic 2 Types of boring operations**

2.1. Counter boring

Counter boring: Counter boring is the operation of enlarging one end of an existing hole concentric with the original hole with square bottom. It is done to accommodate the heads of bolts, studs and pins. The cutting edges of the counter-bore (tool used for counter boring) may have straight or spiral teeth.

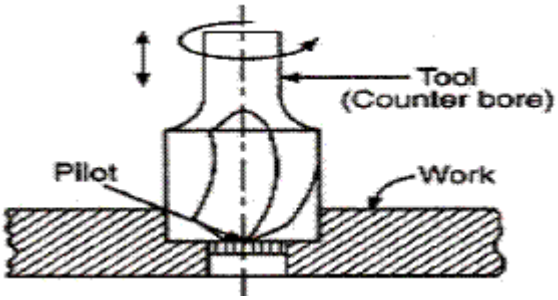


Figure 3.counter boring:

Counter sinking is the operation of making a cone shaped enlargement at the end of a hole to provide recess for a flat head screw or a countersunk rivet. The counter-sunks (tools used for counter sinking) carry included angles of 60°, 82° or 90° and the cutting edges of the tool are formed at the conical surface.

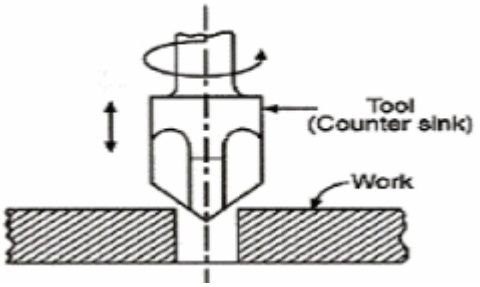


Figure 4.counter sinking

2.3. Facing

Facing is the process of removing metal from the end of a workpiece to produce a flat surface. Most often, the workpiece is cylindrical, but using a 4-jaw chuck you can face rectangular or odd-shaped work to form cubes and other non-cylindrical shapes.it is a turning operation in which the work piece is machined to its center. It involves moving the cutting tool perpendicular to the work piece's axis of rotation.

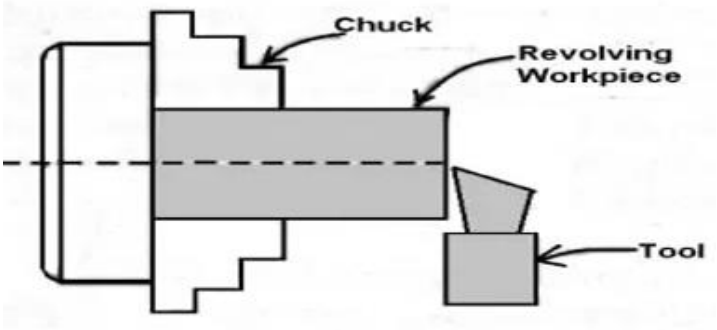


Figure 5.Facing

2.4. Under cuts

Undercutting is similar to grooving operation when performed inside a hole. It is the process of boring a groove or a large hole at a fixed distance from the end of a hole.

This is similar to the boring operation, except that a square nose parting is used. Undercutting is done at the end of an internal thread or a counter bore to provide clearance for the tool or any part.

2.5. Recessing

Recessing, sometimes called channeling or cambering, is the process of cutting a groove inside of a drilled, bored, or reamed hole. Recesses are usually machined to provide room for the tool runout needed for subsequent operations such as internal threading. To cut a recess, set up the lathe as in a boring operation. Reference the face of the tool bit to the face of the work; then move the tool bit forward the required distance to the recess by using the micrometer stop or by using the compound rest graduated collar.

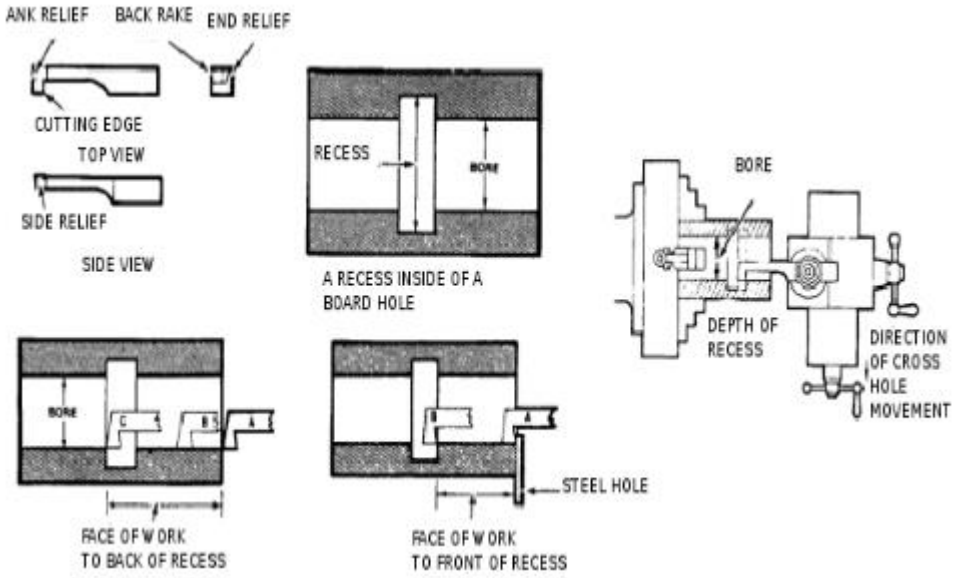


Figure 6.Recessing

L O 1.2 -Identify materials properties

- **Content/Topic 1Mechanical properties of metals**

1.1. Brittleness

It is the property of a material opposite to ductility. It is the property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads, snap off without giving any sensible elongation. Cast iron is a brittle material.

1.2. Ductility

It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percentage reduction in area. The ductile material commonly used in engineering practice (in order of diminishing ductility) are mild steel, copper, aluminium, nickel, zinc, tin and lead.

1.3. Stiffness

It is the ability of a material to resist deformation under stress. The modulus of elasticity is the measure of stiffness.

1.4. Hardness

It is a very important property of the metals and has a wide variety of meanings. It embraces many different properties such as resistance to wear, scratching, deformation and machinability etc. It also means the ability of a metal to cut another metal. The hardness is usually expressed in numbers which are dependent on the method of making the test.

The hardness of a metal may be determined by the following tests:

(a) Brinell hardness test
(b) Rockwell hardness test
(c) Vickers hardness (also called Diamond Pyramid) test, and
(d) Shore scleroscope.

1.5. Tensile:

Tensile properties indicate how the material will react to forces being applied in tension. A material's tensile strength indicates the maximum ability of a material to absorb energy and withstand stretching before it begins to crack or break. It has major significance when processing engineering materials and is a good indication of a material's ability to resist fracture or breaking up. Because of the variety of materials, the engineering stress is calculated by dividing the weight (load) applied to the metal, by the original cross-sectional area. Engineering strain is the displacement, (the amount the material has stretched), divided by the material's original length.

1.6. Machinability

It is the property of a material which refers to a relative case with which a material can be cut. The machinability of a material can be measured in a number of ways such as comparing the tool life for cutting different materials or thrust required to remove the material at some given rate or the energy required to remove a unit volume of the material. It may be noted that brass can be easily machined than steel.

1.7. Weld ability

Weld ability means that the welding process is intended to produce as homogenous properties as possible in the weld, i.e. that the materials affected by the weld must have at least the same strength, corrosion resistance, oxidation resistance etc. as the base material. The properties of the weld metal are determined largely by the choice of filler material, the type of base material, the welding method and the welding methodology, while the properties of the HAZ are determined primarily by the composition of the base material and the amount of thermal energy delivered during welding.(R.S. KHURMI J.K. GUPTA)**,**(Weman)

L O.1.3: Estimate cost

- **Content /Topic 1 Definition of BOQ**

Bill of Quantities also referred to as BOQ**,** is a document formulated in the construction industry to specify materials, labors, and their cost. It serves as a communication tool between client, consultant & the contractor. It is usually prepared by a cost consultant or a surveyor.

- **Content/Topic 2. Elements of Bill of Quantity (BOQ)**

2.1 Serial number

Serial Number Tracking

Serial Number tracking allows you to specify if a part is to be tracked. You have the ability to specify a formula for the construction of a serial number, this can be a global setting or based per part. From job management integrated through shipments serial number control is available and allows you to select the serial numbers used on the transaction. The packing slip and invoice can even be printed with or without showing serial numbers to ensure total traceability. The serial number explorer shows various information about the serial number including when it was created, what job or receipt created it, what job issue or shipment used it, and what the current status of the serial number is.

Change Requests

Engineering Change Requests can be managed and authorised for parts and jobs.

Find and Replace

Find and Replace allows you to replace all incidents of a part with another part in the part master file, allowing you quick and effective management of engineering changes.

Standard Cost Rollups

The standard cost roll-up wizard allows a part or product group costs to be updated in the inventory file with ease. All costs, labor, material and overhead costs can be rolled up and you can even update the selling prices with the click of a button all at the same time.

2.2 Items/Descriptions

The quantities described in the bill are measured in length, area, volume, weight, time or number. Preparation of the bill implies the completion of both design and specifications attributed to it. A contractor, guided by the bill's list of items, offers its price for each item.

BOQ descriptions for each module can consist of the following:

- ✓ Short description of the billable action
- ✓ Names of products, materials and their chemical make-up, if any
- ✓ Exclusions (e.g. actions that are not in the scope of work)
- ✓ Dimensions of the materials/items required (e.g. length, width, weight, diameter, percentages, ratios, etc.)
- ✓ Volume/area of size covered in the billable action
- ✓ Any additional tasks or tools required to complete billable action
- ✓ Regulations and/or standards required of your billable actions/materials
- ✓ Disposal, handling and/or maintenance information
- ✓ Limitations to scope of work
- ✓ Warranty periods, if any

Example table one

SECTION (12): ELECTRICAL WORKS							
ITEM	DESCRIPTION	UNIT	QTY	Unit price		Total cost	
				J.D	Fils	J.D	Fils
cont. 12/2	f- Solar Heater electrical point with 3x4 mm² wires in PVC conduits with all accessories needed.	No.	1				
	g-Hand Drayer electrical point with 3x4 mm² wires in PVC conduits with all accessories needed.	No.	1				
12/6	**Numbers:** Supply, install, connect &commission power socket outlets, including conduits, conduit fittings, pull boxes, accessories and circuit wiring or cables between socket outlet up to its sub-panel board as specified and as shown in drawings.						
	a- 13A, 3 Pin power single socket outlet, with switch.	No.	22				
	b- 13A, 3 Pin power double socket outlet, with switch.	No.	19				
	c- 13A single phase socket outlet, IP44 with cover..	No.	2				
	d- 13A, 3 Pin power double socket outlet, with switch connected to UPS panel	No.	20				

Example table two

S.N.	Description	Unit	Quantity	Rate per unit		Total Amount
				In Figure	In words	
1	E/w Excavation of soft clay & salty soil including disposal upto 10m lead & 1.5 m lift	cum	414.00	72.29	Seventy two and twinty nine paisa only	29,928.06
3	Structure back filling works 15 cm layer ways compaction two third of quantity	cum	136.17	118.75	One hundred eighteen and seventy Five paisa	16,170.19
5	Boulder solling works with supplying of materials	cum	1.20	1446.12	One thausand four hundred fouty six and	1,735.34
6	P.C.C. 1:3:6 work with materials all complete	cum	0.96	10438.95	Ten thausand four hundre	10,021.39
7	P.C.C. 1:2:4 work with materials all complete	cum	12.00	11935.64	Eleven thausand nine hundred thirty five and	143,227.68
8	Supply of form work with shuttering, staging etc. and erecting, fitting, fixing, centering etc all complete including dismantling as per drawing and specification	sq.m	121.00	715.82	Seven hundred fifteen and eight two paisa only	86,614.22
9	Renforcment steel work for curtoff wall with supllying ,cutting , bending , binding , placing all comlete	kg	594.33	91.77	Ninety one and Seventy seven paisa only	54,541.66
					Total = NRs.	**342,238.54**
					Payle Amount	**285,000.00**
					Contribution	57,238.54

2.3 Item specifications

Item specifications are one of the key requirements for a high-quality, legally defensible standards-based assessment. Item specifications help define important characteristics of the items (i.e., test questions) developed for each standard. These item specifications provide guidelines to help clarify the focus of what is to be assessed, what items may include, and what items may not include (i.e., assessment limits). Item specifications are used by item writers, item editors, and item reviewers as a common reference throughout the item-development process, from initial writing to final approval.

Example table of item specifications

Item	details	specification
steel frame	corner fitting	standard container fitting
	base frame	3.0mm steel plate
	secondary frame	2.5mm steel plate
	stand column	2.5mm steel plate
	roof frame	2.5mm steel plate
	Forklift slot	3.0mm steel plate
	strength plate	6mm steel plate
panel	wall panel	50mmEPS sandwich panel
	wall panel	50mmEPS sandwich panel
	ceiling plate	50mmEPS sandwich panel
	surface plate	0.5mm color steel plate
base	base floor	1220*2440 plywood floor
	surface floor	porcelain tiles with 20mm cement mortar (1:2) on top of the strong timber with appropriate adhesive material and 1" chicken mess
door and window	door	aluminum sandwich panel door
	window	aluminum sliding window 0.9m*1.2m

2.4 Unit Prices

unit price is the price for one item or measurement, such as a pound, a kilogram, or a pint, which can be used to compare the same type of goods sold in varying weights and amounts.

UNIT PRICE ANALYSIS						
Project : Project Code M27018351809 Location :						Works Item No. 3.4 Fill from within 30 metres
Work Item:	Fill from within 30 metres - excavation within the road corridor, spreading, watering, leveling and compacting (without haulage)					Unit - 1 M3
No	Description	Unit	Task Rate	Productivity	Unit Price (US$)	Amount (US$)
A	**LABOUR Cost for Leveling to form and forming camber**					
1	Skill labour for Setting Out (25%)	M^3	24	0.01042	9.0	0.094
2	Unskilled Labour - Excavation	M^3	1.2	0.83333	4.5	3.750
3	Semi Skilled labour(Gang Leader)	M^3	18	0.05556	7.0	0.389
	Sub Total					4.233
B	**TOOLS/EQUIPMENT Cost for Leveling to form and forming camber**					
1	Pedestrian Roller	M^3 per day	73.5	0.0136	$ 150	2.041
2	Water browser	M^3 per day	73.5	0.0136	$ 100	1.361
3	Hand Tool (5% of item A)	%				0.212
	Sub Total					3.401
C	**MATERIAL**					
	Sub Total					0.000
D	TOTAL DIRECT COST FOR 1 M3 OF LEVELING TO FORM CAMBER ACTIVITY IS					7.634

2.5 Total Prices

Total Price means the total sum payable by the debtor under a hire-purchase agreement or a conditional sale agreement, including any sum payable on the exercise of an option to purchase, but excluding any sum payable as a penalty or as compensation or damages for a breach of the agreement

Example

S/N	MATERIALS	DIMENSIONS	QUANTITY	UNIT PRICE (N)	TOTAL PRICE (N)
1	Transparent Glass	1250×900mm	1	2.400.00	2,400.00
2	Metal Sheet	850×750mm	1	2,000.00	2,000.00
3	Plywood (3/4" thick)	1000×1000mm	4	1,000.00	4,000.00
4	Wire Mesh	-	3yards	500.00	1,500.00
5	Nails	-	4kg	150.00	600.00

2.7 Labor cost 30% of material total price

Labor costs are those costs associated with employing labor including direct wages, food contributions, transport, and social costs, including payments for health and retirement. The cost of supervision may also be spread over the labor costs.

Industries started a new batch of paint on October 1. The new batch consists of 8,700 cans of paint, of which 7,500 was completed and transferred to finished goods. During October, the manufacturing process recorded the following expenses: direct materials of $10,353; direct labor of $17,970; and applied overhead of $9,000. The inventory still in process is 100% complete with respect to materials and 30% complete with respect to conversion. What is the cost of inventory transferred out and work in process? Assume that there is no beginning work in process inventory.

Solution

Units to account for	Units		
Beginning work in process	0		
Units started into production	8,700		
Total units to be account for	8,700		
	Materials	**Conversion**	**Total**
Work in process completion %	100%	30%	
Units accounted for			
Completed and transferred out	7,500	7,500	7,500
Ending work in process	1,200	360	1,200
Total units to account for	8,700	7,860	8,700
Costs to account for	**Materials**	**Conversion**	**Total**
Beginning work in process	0	0	0
Incurred during the period	$10,353	$26,970	$37,323
Total costs to account for	$10,353	$26,970	$37,323
Equivalent units	8,700	7,860	
Cost per equivalent unit	$ 1.19	$ 3.43	$ 4.62

2.8 Taxes

Many equipment owners must pay property taxes or some type of usage tax on equipment. Taxes, like interest, can be calculated by either using the estimated tax rate multiplied by the actual value of the equipment or by multiplying the tax rate by the average annual investment.

Taxes and Duties The contractor shall include all local taxes except VAT for the materials and services to be procured locally in his unit rate for various item of works included in the Bill of Quantities. The unit rate for materials, goods and equipment to be imported from overseas shall INCLUDE VAT and other import duties such as custom duties, cess, excise duty, etc. The Employer is not responsible to pay any VAT or custom duty for any imported items to be incorporated in the permanent works.

2.9 Grand total

Item	Description	Total (US$)
1.	**Total of Item # 1**	
2.	**Total of Item #2**	
	Grand Total (US$) – Not including Value Added Tax (VAT)	

Grand Total (in letters):----------

2.10 Contingencies

Contingency sum refers to an item that a bill of quantities includes. This term is used to describe additional unforeseen costs of items or services that may occur during the execution of work according to the project.

Contingency sum can be divided into two types. The first one describes a specific item that may become a subject to adjustments or when it requires additional services that are not accurately described in the bill of quantities (however, some work concerning this item should be envisaged). An example of this type of contingency sum may be 'additional alterations to services associated with the installation of kitchen appliances'. This type of contingency sum is normally estimated by the client's project quantity surveyor.

The second type of the contingency sum implies additional money that can be attributed to any item included in a bill of quantity. An example to illustrate this type is: 'additional work to be executed by the contractor when the contract administrator requires so'. Normally, the contractor's quantity surveyor or commercial manager approximates this type of contingency sum.

Example: Contingency or management reserve

Cost base line is the Sum of project cost estimate and contingency reserve; i.e.Cost Baseline Project Cost Estimate + Contingency Reserve Project budget is the sum of project cost base line and the management reserve; i.e. Project Budget = Cost Baseline + Management Reserve Therefore, Management Reserve is not a part of the cost baseline but it is a part of the project budget and Contingency Reserve is a part of cost baseline as well as project budget.(Bosco, 2014), (bill-of-quantities/, n.d.)

- **Content/Topic 2 Formats of BOQ**

The main sections included in the bill of quantities are Form of Tender, Information, Requirements, Pricing schedule, Provisional sums, and Day works

Item #	Description	Unit	Qty of Work	Rate in £	Total in £
	VERTICAL HOT WATER SUPPLY FOR BATH				
	1st Floor Suite				
1	Supply and install ¾" (19mm) copper pipe for hot water up to 8psi, complete as per specs	m	56	1,065	59,640
2	Supply and install ½" (12.7mm) copper pipe to supply to appliances (sink, shower)	m	23	865	19,895
	2nd Floor Suite				
3	Supply and install ¾" (19mm) copper pipe for hot water up to 8psi, complete as per specs	m	56	1,065	59,640

(BOQ) >>> Billing Of Quantity					
S/NO	Description	Unit	Qty	Unit Price	Total
1	Cement	Number	300	520	156000
2	Sand	CFT	1000	20	20000
3	Arregate	CFT	2000	18	36000
4	Door	Number	8	4000	32000
5	Window	Number	8	6500	52000
			Total Amount		296000

- **Content /Topic3 Definition of invoice**

An invoice is a document issued to customers by a seller asking for payment of goods or services. It is also known as a bill or tab. Invoice is a document presented to the customer before or after supplying the goods or services. It is a legal document that can be annulled with a credit note if issued incorrectly. If you are a seller, you are not allowed to simply remove an invoice from sales records. Your Businesses is probably registered for VAT (value added tax) and you need to issue invoices in line with specific regulatory requirements.

- **Content /Topic 4. Elements of an invoice**

4.1. Company information

If you are the payer, you want to be sure that your company's legal name, business address, business phone number and fax number (if applicable) are listed accurately and included near the top and bottom of the invoice. If you are the payee, you want to be sure to include the same information at the top and bottom of the invoice as well. You want to be sure to differentiate which company is the payer and which is the payee by labeling each.

As the one making the payment, you should label the payee as “Sold To”; this indicates who is responsible for making the payment.

4.2. Date

State the day the business invoice was created. This is especially important if your payment terms dictate that invoices be paid within 30, 60, or 90 days of the invoice date, for example.

4.3. Tin number

Giving each invoice its unique number or code helps both you and your customer stay organized. Use a unique identifier for each business invoice to differentiate between multiple customers or multiple invoices to the same customer. Most online invoice solutions will auto-generate a unique invoice number for you, though you can decide on the format you wish to use. For example, you can assign invoice numbers chronologically (like Invoice #0001, Invoice #0002, and so on) or use a specific format for each client (like Invoice #CustomerA0001, #CustomerB0002, and so forth).

Along with each company’s respective payer and payee information, you’ll want to include the date on which the invoice is issued and an invoice number or another unique identifier. You can structure your ID based on any system or stylistic preference, whether it’s a simple file number, unique billing code or date-based purchase order number. If you are the one sending the invoice to an organization and asking for payment, perhaps for freelance work, check with the organization to see if there are any unique company details they need included, such as an internal purchase order (PO) number or billing code. For many larger organizations, PO numbers and/or billing codes are the only way they can expediently deal with an invoice. Details like these can mean the difference between getting paid on time and getting paid next quarter.

4.4. Use of goods and services

This section of the invoice can be as detailed or generic as you like. The most important parts of the listing include:

- Name of the good or service provided
- Date the good or service was provided
- Rate for the good or service provided
- Quantity of the good or service provided

You may want to consider adding sub-sections for each item that includes price modifications, item descriptions or other information as needed.

4.5. Global itemized fees

If there are any taxes, handling fees or other charges that need to be levied, each of these should be listed as a separate line item. This is important for some organizations that need to apply these different fees to different budgets for their internal books to balance.

4.6. Total amount

While it may seem trivial, it’s worth mentioning: Make sure that the total amount due is prominently displayed on the invoice.

4.7. Adds on, Account Number, Delivery Date and Invoice number

While the previous seven items are really important to include on an invoice, there are a few other elements you can include if you choose, such as:

- **Message Field**: This can be used to say “thank you” to a client or make reference to something unique to the project.

- **Tax Identification Number**: Some businesses may file their invoices using their clients' TIN. Since it is a government-issued number that is unique to each business, it's worth including, especially if you handle a high volume of invoices.

While there are no legal guidelines for an invoice, including the elements listed above will help ensure your invoice is handled correctly and paid promptly.

Account number. An account number is a unique string of numbers and, sometimes, letters and other characters that identifies the owner of an account and grants access to it.

(Sullivan, February 18, 2015)

- **Content/Topic 5. Elements impacting the cost estimation**

5.1. Setup time

This takes into account the time required to prepare the machine for doing the job, together, with the time taken to study the blueprint. The time to prepare the machine, in turn, includes the time to install and adjust the tools in the machine, as well as to make the machine ready to start the work.

Time necessary to prepare the machine tool to be ready to start machining:

- Workholding device set –up
- Toolholding devive set-up
- Materials procurement
- Tool procurement

Time is closely related to cost. When calculating the length of time, the boring process will take, the speed, feed rate, retract rate and length of cut are the major variables to consider.

Boring Time = L/F

Retract Time = L/R

When, F= Feed rate (ipr)R= Retract rate (inches per minute- ipm) L= Length of cut

5.2. Load/unload time

Load/Unload time The time required to load the work piece into the boring machine and secure it to the fixture, as well as the time to unload the finished part. The load time can depend on the size, weight, and complexity of the work piece, as well as the type of fixture.

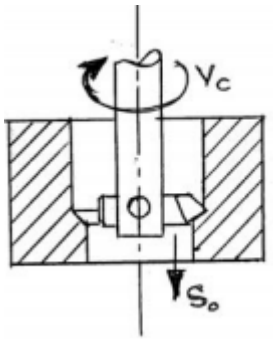
5.3. Idle time

Time during which workers or machines are not working, so there is no production

May be due fault in machine accident, mismanagement, job complete, next job not available. During idle time workers are paid .so the company loses money. the idle time in boring process which is the major issue faced in a manufacturing environment in modern days, idle time is one of the major reasons for reduced production, increased production costs, ineffective utility of machines, increase in manufacturing lead time and increased work in process, so in order to reduce the idle time a method of optimization the activities in manufacturing process and effective queuing up of activities involved in the manufacturing process is adopted.

Idle time: Also referred to as non-productive time, this is the time required for any tasks that occur during the process cycle that do not engage the work piece and therefore remove material. This idle time includes the tool approaching and retracting from the work piece, tool movements between features, adjusting machine settings, and changing tools. =

The basic principle and procedure of estimation of machining time in drilling and boring are almost same



The machining time, TC is estimated from,

$$T_C = \frac{L_C}{Ns_o}$$

where, $L_C' = L_h + A + O + C$

A, O = approach and over run

and $C = \frac{D}{2}\cot\rho$

D = diameter of the hole, i.e., drill

ρ = half of the drill point angle.

Speed, N and feed so are selected in the same way as it is done in case of turning. Therefore, the drilling time can be determined from,

$$T_C = \frac{\pi D(L_h + A + O + C)}{1000 V_C s_o}$$

In the same way TC is determined or estimated in boring also. Only the portion 'C' is not included. For blind hole, only over run, 'O' is excluded.

5.4. Cutting time

The time required for the cutting tool to make all the necessary cuts in the work piece for each operation. The cut time for any given operation is calculated by dividing the total cut length for that operation by the feed rate, which is the speed of the tool relative to the work piece.

5.5. Tool changing time

The time required to replace a tool that has exceeded its lifetime and therefore become to worn to cut effectively. This time is typically not performed in every cycle, but rather only after the lifetime of the tool has been reached. In determining the cycle time, the tool replacement time is adjusted for the production of a single part by multiplying by the frequency of a tool replacement, which is the cut time divided by the tool lifetime.

5.6. Tool costs

The tooling cost for machining is determined by the total number of cutting tools required and the unit price for each tool. The quantity of tools depends upon the number of unique tools required by the various operations to be performed and the amount of wear that each of those tools experience. If the tool wear exceeds the lifetime of a tool, then a replacement tool must be purchased. The lifetime of a tool is dependent upon the tool material,
cutting parameters such as cutting speed, and the total cut time. The unit price of a tool is affected by the tool type, size, and material.

5.7. Direct labor rate

Direct labor: The laborers who actually work and process the different materials manually or with the aid of machines are known as direct labor or productive labor. The nature of their duties is such that their wages can be directly charged to the job they are manufacturing. The wages of workers engaged to operate various production machines in machine shops, welding shops, pattern-making shops, electric winding shops, and assembly shops, etc., are known as direct labor.

5.8. Overhead rate

In a standard cost system, accountants apply the manufacturing overhead to the goods produced using a standard overhead rate. They set the rate prior to the start of the period by dividing the budgeted manufacturing overhead cost by a standard level of output or activity. Total budgeted manufacturing overhead varies at different levels of standard output, but since some overhead costs are fixed, total budgeted manufacturing overhead does not vary in direct proportion with output.

Overhead ratethe apportionment of overhead expenses is done by adopting suitable basis such as output, materials, prime cost, labor hours, machine hours etc. In order to determine the absorption of overhead in costs of jobs, products or process, a rate Is

calculated and it is called as overhead Absorption Rate or Overhead Rate. The overhead rate can be calculated as below

$$\text{Overhead Rate} = \frac{\text{Overhead Expenses}}{\text{Total Quantity or Value}}$$

(wu/turning, n.d.)(30473274/Absorption_of_Overhead, n.d.)

Learning unit 2-Identify tools, materials, equipment and machine

L O 2.1 Identify boring machine

- Content/Topic1: Introduction to boring machine

Introduction

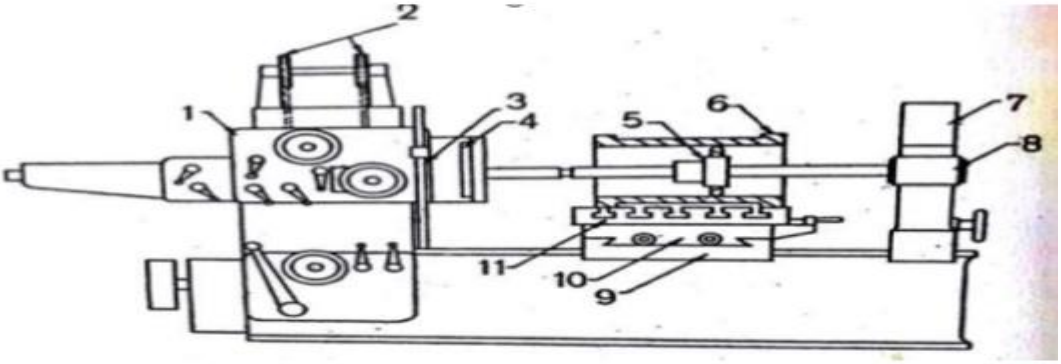
Boring is the method used to enlarge a hole that has already been cast or drilled via a single-point cutting tool or a boring head that contains multiple such tools. The hole created by a boring machine could be cylindrical or tapered. The bores may be made of steel cutting tips, diamond or cemented carbide. The bore could also be a tiny wheel for grinding. Solitary tools are gripped against boring heads and attached against rotating spindles. The rotating spindle moves in circular motions against the walls of existing holes. The diameter to the hole is swept by this boring tool. The tool is under the control of boring head. There are several kinds of boring processes including horizontal boring, line boring, and vertical boring. Horizontal boring machines bore holes with a spindle that is parallel to the work table. Line-boring machines have a boring bar that is supported on both ends. Vertical boring involves clamping down the part to be bored, and a machining tool being fed down into the part.

- Content /Topic2Types of boring machines

2.1. Horizontal

Horizontal Boring Machine:

The horizontal boring mill is also known as horizontal boring, drilling and milling machine, and is intended to perform operations on relatively large pieces which cannot be rotated easily, are irregular and unsymmetrical, and require operations on many surfaces. Fig. 1shows the main features of a horizontal boring machine. It also indicates the relative movements of its sliding and rotating elements. It may be noted that the main spindle can be rotated in either direction. It is possible to feed the main spindle axially. The work table can be traversed along and across the machine bed.



1. Headstock, 2. Pulley for counter balancing weight of headstock, 3. Headstock elevating screw, 4. Boring head, 5. Boring cutter on boring bar, 6. Work, 7. End supporting column, 8. Bearing block, 9. Saddle, 10 Cross-slide, 11. Table.

Figure 7.Horizontal Boring Machine

2.2. Vertical

Vertical fine boring machine is main used to bore high accurate holes of cylinder and engine sleeve and other accurate holes. Features: The table longitudinally and latitudinal moving device. The working fast centering device. Boring measuring device. Also provides optional digital read out for the tables moving.

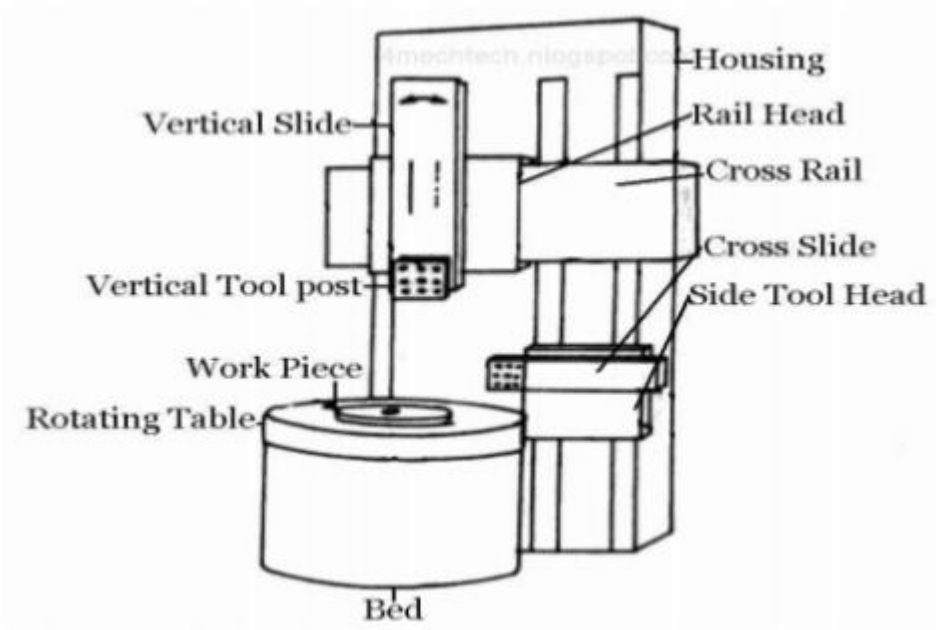


Figure 8.Vertical

2.3. Precision

Precision boring machines are planned for accuracy boring, facing and turning process. These machines are presented in a range of types. Configurations contain single or multiple spindles arranged horizontally, vertically or at any essential angle. Horizontal precision boring machine can have arranged as single end that is holes are machined as of one end just or it can have arranged as double end machine. The primary movement in precision boring machine is rotation of spindle by the tool. Advantages of precision boring machine are high geometrical correctness and high surface finish.

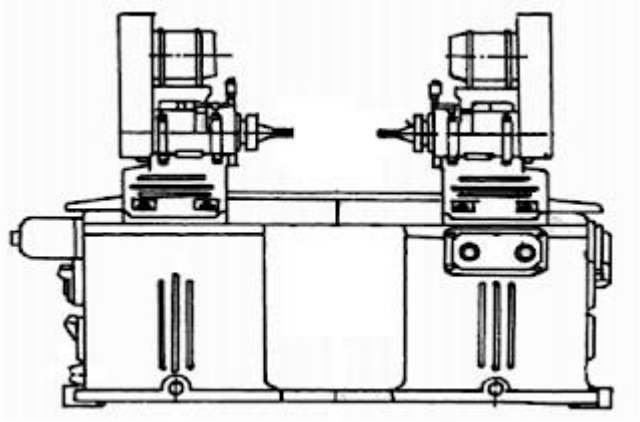


Figure 9.Precision boring machines

2.4. Jig

jig machine is used to produce products that require high levels of accuracy and precision. The exceptional levels of accuracy are achieved through low levels of thermal expansion high rigidity with the machine and accurate measurement of the space and location where holes are to be made. The jig machine cuts metals for slots, planes and holes finishing using accurate surface or center location without any special attachments used for alignment of tool. All parts of a jig machine are tremendously rigid in order to make sure there is minimal vibration and deflections. Spindles role in predetermined bearings

and in the process they resist friction. The jig machine needs a room with controlled temperature in order to operate effectively.

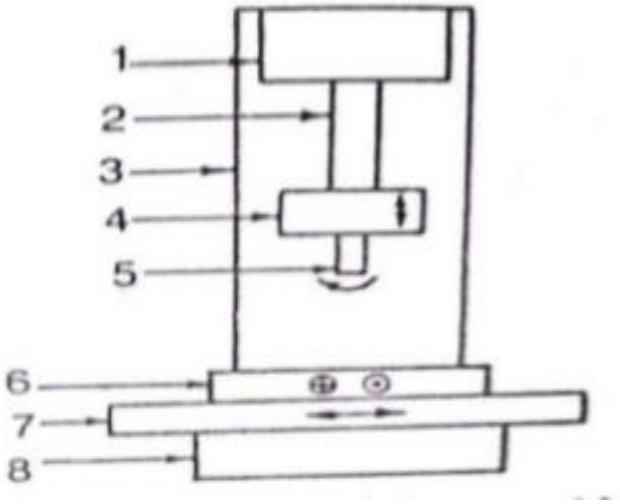


Figure 10.jig machine

1.spindle head,2. quill,3. column,4. spindle housing,5. spindle,6. table,7. saddle, 8.bed (salunke M.D and B.I.T.barshi),(precision-boring-machine.html, 2014)

L O 2.2 Identify boring tools

- **Content/Topic 1 Introduction to cutting tools**

Boring tool is a tool used to make holes or change the size or shape of hole. Boring tool include bits, drill, reams, and the device used to turn them.

- **Content/Topic 2 Types of boring tools**

2.1. Fine boring tools

Fine boring operations are performed to complete an existing hole to its final hole tolerance with quality surface finish. Our tool range offers product for dedicated as well as flexible diameters, large and small diameter as well as light weight boring.

Figure 11.Fine boring tools

2.2. Carbide insert boring bars

carbide boring bars, where a replaceable tungsten carbide insert is attached to a machined pocket in a steel or carbide boring bar shank. When the carbide insert chips, it can be easily and quickly rotated to

another corner (indexed) or replaced with another insert.

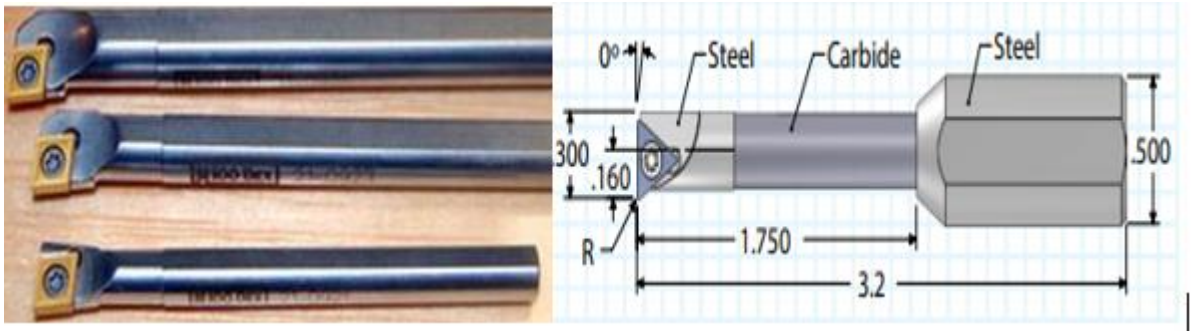


Figure 12.Carbide insert boring bars

2.3. ANSI/ISO – Cartridge Triangle Negative Rake – MTSNR/L

Many boring bars do not have alignment flats on them, so it is necessary to orient the top (flat) surface of the cutting edge parallel to the XZ plane of the lathe, as shown in figure below. The safest orientation is neutral (B) and if you elect to try a different orientation, be careful that adequate cutting tip clearance exists and that the tool tip is set on vertical spindle centerline. Positive rakes are used for cutting weaker materials like aluminum and plastics, and negative rakes are used for cutting stronger materials, like higher strength steels.

Figure 13.ANSI/ISO – Cartridge Triangle Negative Rake – MTSNR/

2.4. Triangle Right-Hand Step Bar

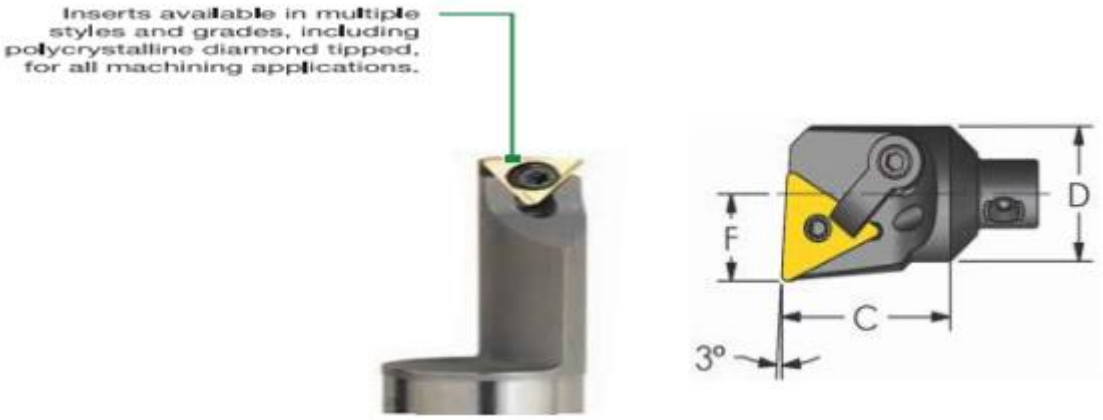


Figure 14.Triangle Right-Hand Step Bar

Negative triangle -3degree lead, TNM insert modular boring bar head ID1246

- ✓ Design for less obstruct and greater chip evacuation
- ✓ Positive rake geometry to bore hole
- ✓ Stocked in all grade including diamond tipped and barozon tipped styles.

- ✓ Stocked in shank as small

2.5. Boring bar tooling

Boring bar – used on a lathe to carry out boring operations along the axis of the workpiece, such as increasing the size of a drilled hole. The typical boring bar is shown in the figure. When boring with a rotating tool, size is controlled by changing the radial position of the tool slide, which hold the boring bar, with respect to the spindle axis of rotation. For finishing machining, the boring bar is additionally mounted in an adjustable boring head for more precise control of the bar radial position.

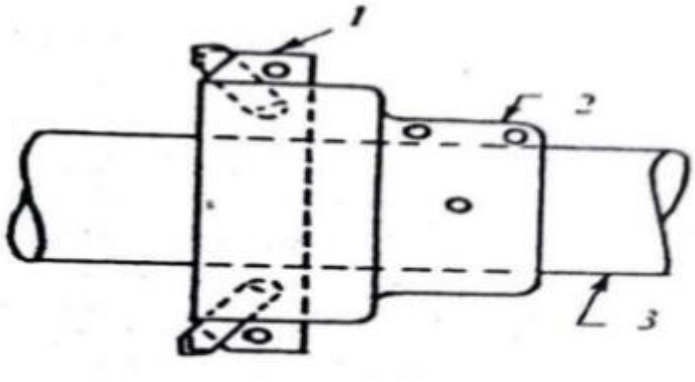


Figure 15.boring bar

L O 2. 3 Identify boring equipment

- **Content /Topic 1 Types of equipment**

1.1. Boring Quill Feed spindles (Manual)

QUILL

Quill "J", contains the spindle assembly and can be raised or lowered by using the quill feed handle "M".

SPINDLE

Spindle "K", performs the actual rotation and also retains the machine tooling.

QUILL LOCK

Quill Lock "L" is a friction lock for use when quill is in a stationary position such as a milling operation. It is recommended that this lock be used whenever quill movement is not desired.

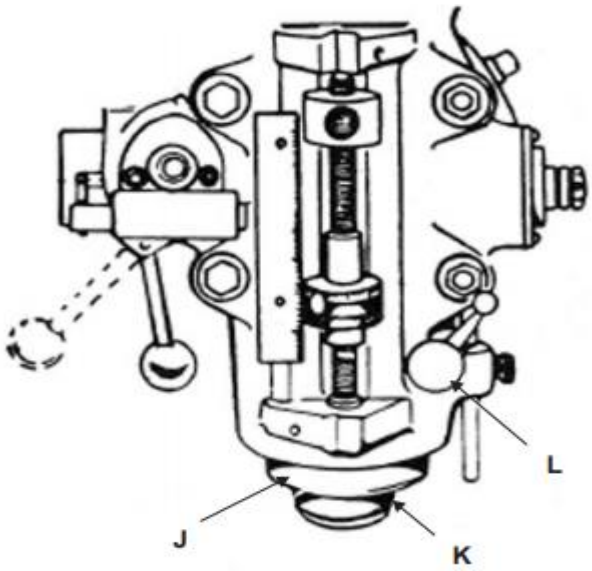


Figure 16.Boring Quill Feed spindles

Quill Feed Handle is used to raise and lower the quill manually. It is generally recommended that handle be engaged when using the power feed. It may be removed by simply pulling handle off.

Figure 17.Quill Feed Handle

1.2. Boring shanks

Boring heads are designed for precision production boring on machining centers, boring mills, transfer machines and high speed milling machines. Their fully enclosed, compact and rugged design allows reliable operation, even under extreme cutting conditions. A small boring bar is inserted into one of the holes. The head can be shifted left or right with fine gradation by a screw, adjusting the diameter of the circle that the cutting tip swings through, thus controlling the hole size.The boring head shank adapts our boring head to the mini mill with a Morse taper spindle, fits all heads with threaded back. Taper shanks are mounted directly to the machine spindle.

Figure 18.Boring shanks

1.2. Flanges

Boring consists of accurately machining the inner surface of a cylinder. boring machines are the right solution for applications such as machining bearing surfaces for sleeves on diesel and gas engines.
Boring Bar Attachment this makes it possible to carry out precision boring of components and is primarily designed for diesel engines and valve seat machining. The attachment fits onto external mount flange facing machine and uses a striker or optional geared feed.

Figure 19.boring flange equipment

1.3. Classic straight shanks

increase productivity on your boring operations with boring heads and boring head shanks, holders and adapters. Whether centering a tool for better accuracy or looking for a head with double edges for rougher operations, you'll find boring heads for securing the work piece and achieving the ideal hole every time.

Straight shanks are used for general purpose applications. The shank is smaller than the drill bit diameter. They are used with portable drills and drill presses on ferrous and non-ferrous materials.

Bright provides a smooth, polished finish on the tool. It increases chip flow in softer materials such as aluminum, wood and plastic.

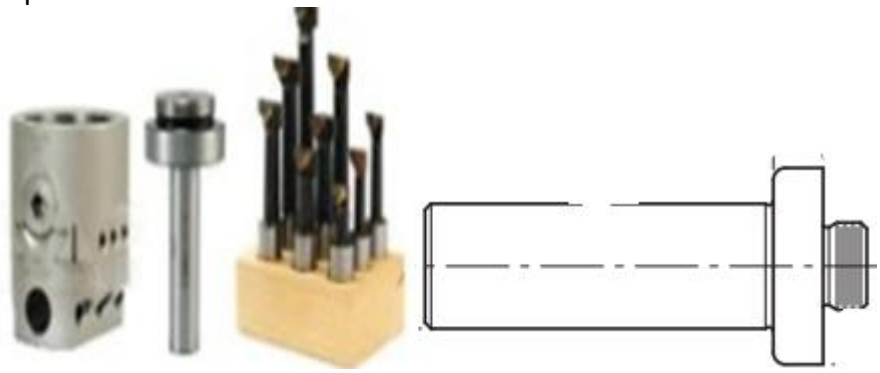


Figure 20.Classic straight shanks

1.5. boring head

Boring heads may be fastened by a shaft to the spindle of the machine or attached to the boring bar. The body of the boring head, which is kept from turning by a key, is fastened onto the boring bar with a nut; t he toolholder is shifted along guides in the body. Radial feed is

carried out by means of a screw that turns with each turn of the spindle. The screw is connected to a beve l gear drive by means of a sprocket, whose teeth strike a stop as the screw turns

Performs equally in heavy roughing cuts on turrets or fine finishing work on mills and jig borers. All bearing surfaces are ground after hardening for long life and trouble free operation.

Figure 21.boring head

1.7. Facing head

Facing heads are widely used on boring mills for facing and externally / internally turning, threading or boring on cylindrical, concial and other shaped surfaces with large diameters. Our facing heads can always custom made as per the relevant specifications on the spindle noses and headstocks on the boring mills
Boring and facing heads can be used in milling machines or drilling machines, which nowadays are replacing the horizontal borer machine. Facing with a boring and facing head has a stop bar to prevent the boring and facing head from spinning in the machine's spindle, the feed rate is selected to feed the boring bar or boring tool outwards at an even amount, until hitting a preset trip dog/stop to disengage the facing head.(boring-heads-with-integrated-shanks, n.d.),(Bridgeport.pdf, n.d.)

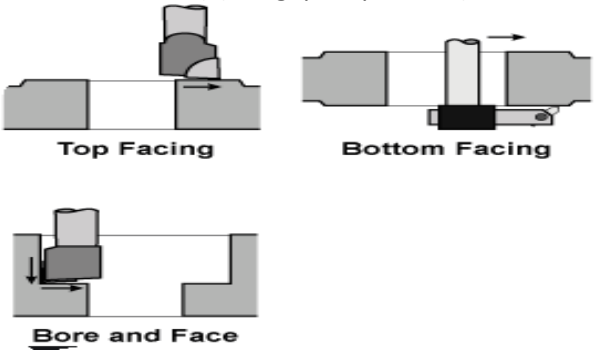


Figure 22.Facing head

- Content/Topic 2. Types of work holding devices

2.1. Step blocks

These holding devices are built like stairs to allow for height adjustments in mounting drilling jobs and are used with strap clamps and long T-slot bolts.

2.2. Clamping

Clamps are small, portable vises or plates which bear against the work piece and holding devices to steady the job. Clamps are made in numerous shapes to meet various work holding needs. Common types of clamps are the C-clamp, the parallel clamp, the machine strap clamp, the bent-tail machine clamp, the U-clamp, and the finger machine clamp

2.3. Dogs

Lathe Dogs

These are used in conjunction with the driving plate. The work to be inserted in the 'V' shaped hole of the carrier and then firmly secured in position by means of a screw, When a work piece is held and machined between centers, carriers are useful in trans- mitting the driving force of the spindle to the work by means of driving plates and catch plates. The work is held inside the eye of the carrier and tightened by a screw.

Lathe dogs have two types of tails:

(a) Straight tail

(b) Bent tail

Straight tail carrier is used to drive the work by means of the pin provided in the driving plate. The tail of the bent tail carrier fits into the slot of the catch plate to drive the work.

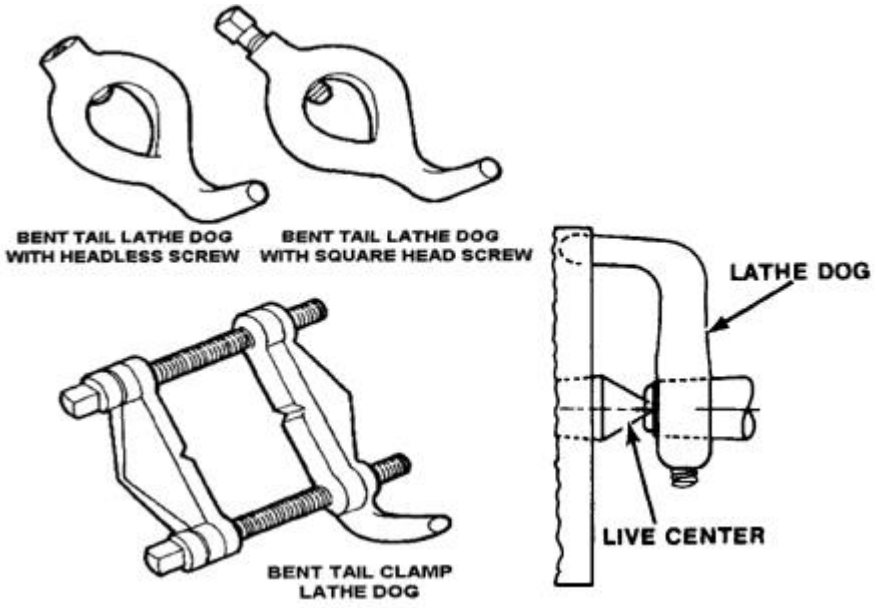


Figure 23.Dogs

2.4. Magnetic

Magnetic chucks are available in a variety of shapes. They can hold only ferrous work pieces unless intermediate mechanical work holders permit the holding of work pieces made of non-magnetic material. Magnetic chucks are suitable for light machining operations such as grinding.

Strongly magnetic materials and better utilization of magnetic force permit their use for heavier operations, such as light milling and turning.

Magnetic chucks can be operated by permanent magnets or electromagnets powered by direct current. The gripping power attainable depends on the strength of the magnets and the amount of magnetic flux directed through the work piece. a magnetic chuck is fast acting and, by holding a large surface of the work piece, causes a mini mum of distortion. Magnetic chucks are available in rectangular shapes, circular shapes as rotary chucks, and as V-blocks. Magnetic chucks impart some residual magnetism to work pieces. This must be removed by demagnetizing if it interferes with proper functioning of the work piece.

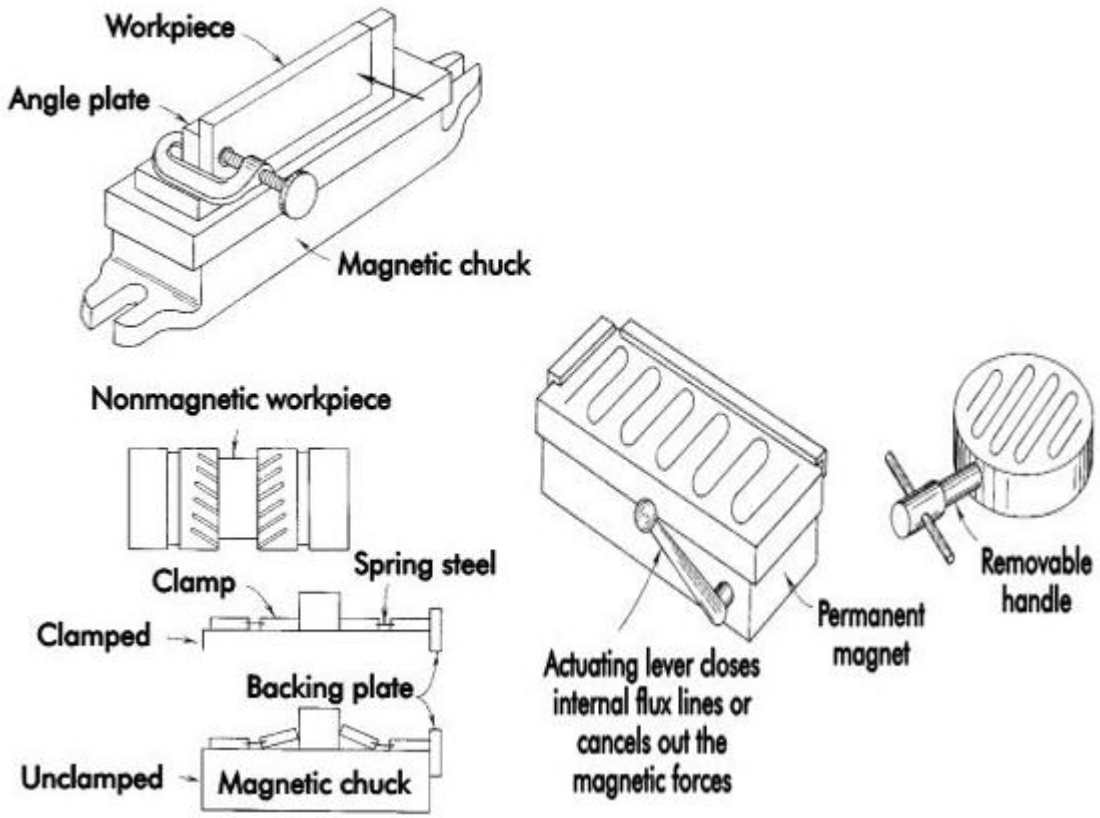


Figure 24.Magnetic

2.5. Jigs

Drill jigs are devices designed for production drilling jobs. The workplaces are clamped into the jig so that the holes will be drilled in the same location on each piece. The jig may guide the drill through a steel bushing to locate the holes accurately. Jig and Fixture are production Work holding devices used to manufacture duplicate parts accurately. They are special purpose tools used scale production by semi-skilled operator. They can also be used for small scale production when interchangeability is important by skilled machinist when the work piece is difficult to hold without special equipment

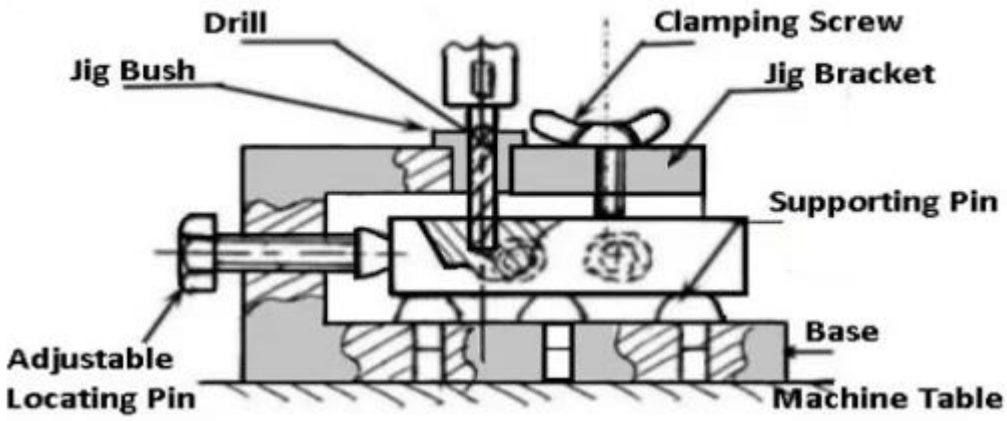


Figure 25.Jigs

2.6. Machine vices

A machine vice is a clamping device used to hold a workpiece securely when operating a machine tool, such as a drill press or milling machine.

2.7. Bore chuck

A **chuck** is a specialized type of clamp used to hold an object with radial symmetry, especially a cylinder. In drills and mills it holds the rotating tool whereas in lathes it holds the rotating work piece. On a bore chuck is mounted on the spindle which rotates within the headstock.

2.8. Collet

A collet is a form of chuck, but it is not identical. While a chuck is tightened around an object, a collet utilizes clamping pressure by forming a collar around the object being held, holding it securely in place. This clamping force is typing applied through a tapered design that uses a sleeve and inner cylindrical surface. While there are varying designs, all collet types operate by being pressed over the element to be held, resulting in both accurate alignment and static friction. While the collet is not suitable for every tool and operation, it does allow for self-centering, resistance against loosening, fast-chucking and steady clamping pressure.

Figure 26.Collet

2.9. Bore sleeve

Drill bits with Morse taper shank are available in various sizes and, therefore, adapters are needed in order to mount drill bits into different spindles of drilling machines. Drill sockets and drill sleeves are such adapters, used in order to add to or subtracts from the Morse taper so that the drill bit fits into the chuck spindle.

Drill sleeve

Used to adapt cutting tool shank to machine spindle if taper on tool is smaller than tapered hole in spindle

Figure 27.Drill sleeve

2.1.0. Bore socket

Drill socket

A drill too small for the machine spindle may be fitted into a socket or sleeve which has a taper hole of the proper size to hold the drill and a taper shank of the proper size to fit the drill spindle. Sometimes, more than one socket or sleeve is needed to build up the shank to tit into the drilling machine spindle. Sockets and sleeves may be obtained in a number of different sizes and hole shank taper combinations. Sockets, sleeves, and taper shank drills are mounted into the aligning slots of the spindle and lightly tapped with a soft hammer to seat in place.

Figure 28.Drill socket

- Used when hole in spindle of drill press too small for taper shank of drill
- Used also as extension socket

2.1.1.V-block

V' – blocks are used for holding cylindrical work pieces. The work may be supported on two or three 'V' – blocks according to the length of the work. The work is held on the 'V' groove and is clamped by straps and bolts. They are made of cast iron or steel and are accurately machined. Operations like keyway cutting, slot cutting and machining flat surfaces can be performed on the cylindrical work pieces held on a 'V' block.

2.1.2. T-slot bolt

The work pieces can be held directly on the machine table by means of 'T' – bolts and clamps. The top of the machine table has 'T' – slots into which 'T' – bolts may be fitted. The bolts of diameter 15 to 20mm are used. The clamps are made of mild steel. 'T' – bolts pass through a central hole on the clamp. The clamp is made to rest horizontally on the work surface by placing a suitable step block at the other end of the work. A heavy duty washer and nut are used with the T-bolt to secure the work.(collet-types-and-sizes/, 2019/02/19)

Learning unit 3- Select tools, materials, equipment and machine

L O 3.1: Select boring machine

- **Content/Topic 1 Factors influencing the selection of boring machines**

1.1. Machine capacity

Horizontal boring machines equipped with a 110-130 mm boring bar and hydrostatic rotary table with a maximum 8 ton capacity.
This horizontal boring machine is a very productive solution at a very competitive price.
It stands out for its high dynamics (30 m/min rapid feeds).

- ✓ Ideal option for boring operations
- ✓ Quick return on investment
- ✓ Optimum vibration damping
- ✓ Electro-welded structure filled with polymeric cement

- ✓ Twin motor hydrostatic rotary table

Head

Boring bar diameter mm 110–130
Power kW 22/37
Torque Nm 1100-1800
Rotation speed min^{-1}3000–3500

Rotary table

Table/pallet size mm 1000×1000 / 1200×1200 / 1200×1500 / 1500×1500

Max. tool size

Diameter mm
Length mm
Weight Kg
Tool change time sec

1.2. Hole diameter

a hole is a cylindrical feature that is cut from the work piece by a rotating cutting tool that enters the work piece axially. The hole will have the same diameter of the cutting tool and match the geometry (which may include a pointed end).

Diameter - Holes can be machined in a wide variety of diameters, determined by the selected tool. The cutting tools used for hole-making are available in standard sizes that can be as small as 0.0019 inches and as large as 3 inches. Several standards exist including fractional sizes, letter sizes, number sizes, and metric sizes.

A custom tool can be created to machine a non-standard diameter, but it is more cost effective to use the closest standard sized tool.

1.3. Multiple spindle

This machine can be fitted with multiple spindle boring head and offers fast and efficient multiple borings. The boring head can be tilted to The machine can do horizontal as well A foot switch equipped for easy control The boring head can be up and down and a mechanical digital meter is equipped for accurate adjustment. Spindle boring machine major components and machine body made from high grade cast-iron. Conventional belt tension adjustment. Hydraulic control system. Multiple spindle can be easily adjusted for various boring positions. Easy operation and minimum maintenance

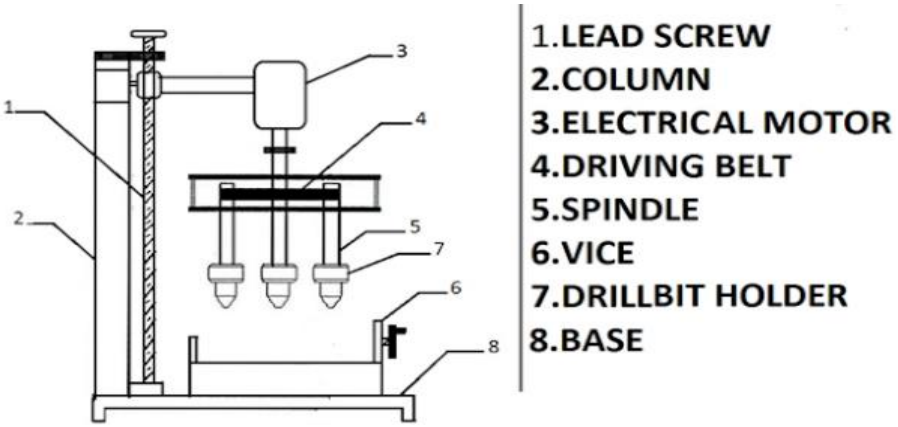


Figure 29.Multiple spindle

1.4. Length of column

Boring is ensuring correct location of a hole by making it concentric with the axis of rotation and increase diameters of holes, to enlarge previously drilled hole and make holes of sizes for which drill tool is not available

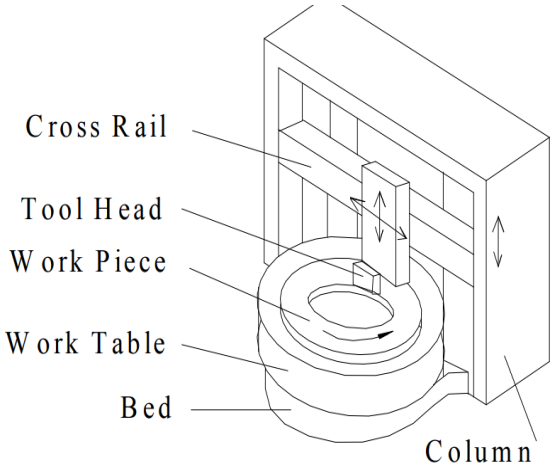


Figure 30.Length of column

1.5. Cutting speed

Machining time in boring operation is calculated by the same formula as for calculating the machining time in turning operation,

$$\text{Time required} = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}} \text{ minutes.}$$

The length of cut in this case is the depth of hole to be bored. Cutting speeds and feeds for boring are same as for turning.

Example:

A 10 mm drilled hole in a casting of 10 mm thickness is to be brought in alignment by boring. Calculate the time taken in boring operation, assuming cutting speed 30 metres/minute and feed 0.13 mm/rev.

$$\text{R.P.M} \quad 'N' = \frac{1000 \times \text{Cutting speed}}{\pi \times \text{Diameter}}$$

$$= \frac{1000 \times 30}{\pi \times 0.13} = 955 \text{ r.p.m.}$$

$$\text{Time taken in boring} = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}}$$

$$= \frac{10}{255 \times 0.13} \text{ minutes}$$

$$= \frac{10 \times 60}{955 \times 0.13} = 4.83 \text{ seconds.}$$

1.5. Feed per tooth

The feed per tooth is the depth of material removed by each tooth and measured parallel to the direction of feed motion

Feed per tooth(f) f= $\frac{f}{sxn}$

S=spindle speed

F=feed

N=number of flute

1.7. Spindle speed

$$Cutting\ speed, v_c = \frac{\pi \cdot D \cdot n}{1000} \quad (m/min)$$

$$Spindle\ speed, n = \frac{1000 \cdot v_c}{\pi \cdot D} \quad (rev/min)$$

$$Feed\ speed, v_f = f \cdot n \quad (mm/min)$$

$$Feed\ per\ rev, f = \frac{v_f}{n} \quad (mm/rev)$$

Legend

- v_c = Cutting speed (m/min)
- n = Spindle speed (rev/min)
- v_f = Feed speed (mm/min)
- D = Drill diameter (mm)
- f = Feed per rev (mm/rev)

1.8. Table feed Inch (feed) per revolution

Metric Formulas for Turning and Boring

a_p= Depth of cut (DOC)	mm	k_c= Specific cutting force	Nm
D_m= Diameter of part (DIA)	mm	n= Spindle speed (RPM)	Rev/Min
f_n= Feed per revolution (FEED)	mm/Rev	v_c= Cutting speed (SFM)	m/Min
l_m= Machined length (LEN)	mm	T_c= Cutting time (TIM)	Min
Q= Metal removal rate (MMR)	mm^3/ Min	R_{max}= Profile depth	µm
P_c= Power requirements (POW)	kW	r_ε= Insert nose radius	mm

Cutting Speed Surface Meters Per Minute

$$vc = \frac{\pi \times Dm \times n}{1000}$$

EX: Determine the cutting speed (v_c) required for turning a 50mm diameter part with a spindle speed of 600 RPM.

$$v_c = \frac{\pi \times 50 \times 600}{1000} = 94{,}25\ m/Min$$

Spindle Speed Revolution Per Minute

$$n = \frac{Vc \times 1000}{\pi \times Dm}$$

EX: Determine the spindle speed (n) required for turning a 32mm diameter part with a cutting speed of 100 m/Min.

$$n = \frac{100 \times 1000}{\pi \times 32} = 994{,}72\ Rev/Min$$

Metal Removal Rate mm^3/Min

$$Q = vc \times a_p \times f_n \times 1000$$

EX: Determine the metal removal rate (Q) required for cutting with a depth of 1,5 with a cutting speed of 200 m/ Min and feed rate of 0,4 mmPR.

$Q = 200 \times 1{,}5 \times 0{,}4 \times 1000 = 120.000\ mm^3/min$

Power Requirement Killowatts

$$P_c = \frac{v_c \times a_p \times f_n \times k_c}{1.460.000}$$

EX: Determine the power requirement (P_c) for turning a material with a specific cutting force of 20.500, a depth of 1,5, a cutting speed of 200 m/Min, and feed rate of 0,4 mmPR.

$$P_c = \frac{200 \times 1{,}5 \times 0{,}4 \times 20.500}{1.460.000} = 1{,}68\ kW$$

Cutting Time Minute

$$Tc = \frac{lm}{f_n \times n}$$

EX: Determine the amount of time required to machine a 200mm long part with a spindle speed of 600 RPM and feed rate of 0,4 mmPR.

$$T_c = \frac{200}{0{,}4 \times 600} = ,83\ Min\ (50\ Sec)$$

Profile Depth (µm)

$$R_{max} = \frac{f_n^2 \times 10^6}{8 r_\varepsilon}$$

EX: Determine the profile depth (R_{max}) of a surface machined using an insert with a nose radius of 0,8 and a feed rate of 0,4 mmPR.

$$R_{max} = \frac{0{,}4^2 \times 10^6}{8 \times 0{,}8} = 25\ \mu m$$

1.9. Metal removal cubic in/min

Metal removal means how much material that can be removed in a certain time frame and is strongly related to the productivity for roughing.

Cutting Speed:	SFM = D x 0.26 x RPM
Feed per Tooth:	IPT = IPM ÷ Z ÷ RPM
Spindle Speed:	RPM = SFM x 3.82 ÷ D
Table Feed:	IPM = IPT x Z x RPM
Inch (Feed) per Revolution:	IPR (FR) = IPM ÷ RPM
Metal Removal cubic in/min:	MR = IPM x RDC x ADC

D:	Diameter of Tool.
Z:	Number of Flutes.
FR:	Feed per Revolution.
IPM:	Table Feed.
IPR:	Inch per Revolution.
IPT:	Feed per Tooth.
SFM:	Cutting Speed.
RPM:	Spindle Speed.
ADC:	Axial depth-of-cut (Length).
HP:	Actual Horsepower available at running RPM.
PC:	Power constants for HP (HP/CI-MR).
RDC:	Radial depth-of-cut (Width).
MR:	Metal Removal Rate (Cubic inches per minute).

Power is calculated using unit power and material removal rate:
Machine hp = unit power x removal rate (in^3 / min)
Unit power is based on high speed steel (HSS) and carbide tools
(boring-machines/boring-machines-features-types-and-tools-industrial-engineering, n.d.)

L O 3.2 Select boring tools and equipment

- **Content/Topic 1Types of boring equipment**

2.1. Drift

The drift is inserted through a slot in the spindle. Drift are flat, tapered keys with one rounded edged that are designed to fit into a spindle chucks slot to force a tapered shank drill loose, it's used to remove tapered shank drills or accessories from drill press spindle, always place rounded edge up so this edge will against round slot in spindle. Used hammer to tap drill drift and loosen tapered drill shank.

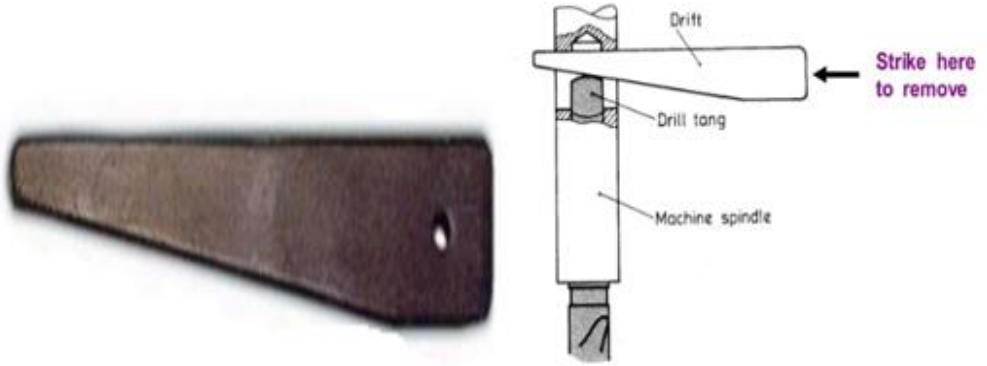


Figure 31.Drift

2.2. Morse taper

Boring head on Morse taper shank. A small boring bar is inserted into one of the holes. The head can be shifted left or right with fine gradation by a screw, adjusting the diameter of the circle that the cutting tip swings through, thus controlling the hole size, even down to within 10 micrometres if all machining conditions are good.

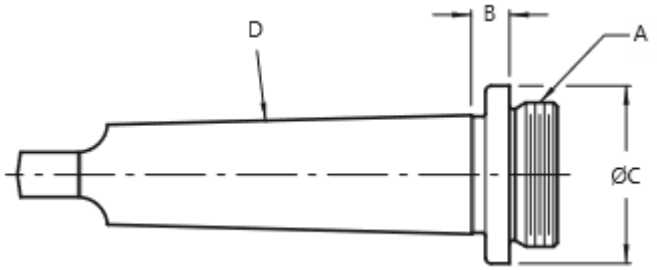


Figure 32.Morse taper

2.3. Drill chuck

Drills and similar tools with parallel shanks are held in a drill chuck. By rotating the outer sleeve, the jaws can be opened and closed. To ensure maximum grip, the chuck should be tightened using the correct size of chuck key. This prevents the drill from spinning during use and chewing up the drill shank.

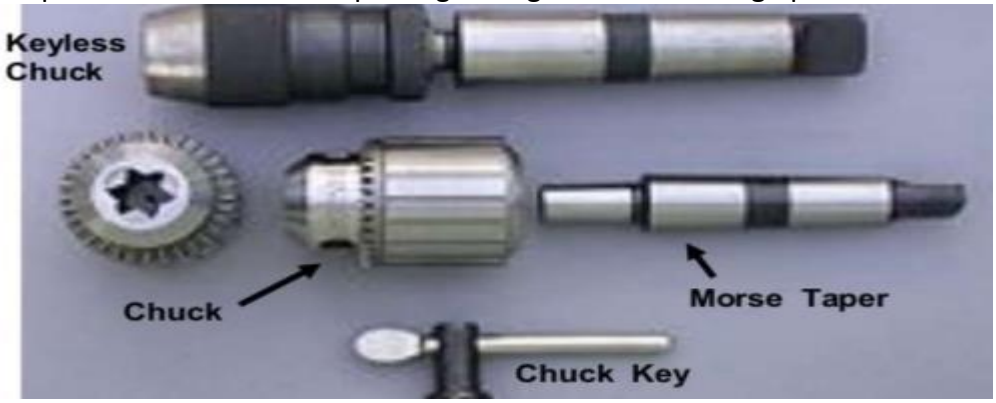


Figure 33.Drill chuck

Those Types of boring equipment are getting explanations above. Check page from 32 to 41.

2.4**.** Step blocks
2.5. Boring Quill Feed spindles
2.6. Boring shanks
2.7. Flanges
2.8. Classic straight shanks
2.9. Boring heads
2.10. Step blocks
2.11. Clamping
2.12. Dogs
2.13. Magnetic table
2.14. Jigs
2.15. Machine vices
2.16. Bore chuck
2.17. Collet
2.18. Bore sleeve
2.19. Bore socket
2.20. V-block
2.21. T-slot bolt
2.22. Facing head

L O 3.3. Select materials

- **Content /Topic1Types of materials to be bored**

1.1 Non-metals:

1.1.1 Wood

Boring is one of the key operations for working in the wood processing sector; it is a fundamental process within the furnishing, in order to ensure that the various components of a piece of furniture fit together perfectly: creating holes, slots and housings for hinges, locks or shelves requires the use of appropriate machinery. compared to other materials such as metal, wood and its derivatives are much softer, and for this reason, wood boring is a simpler, faster process than that required for machining other materials. The precision with which the holes are made determines the stability and durability of an item of furniture

There are two main types of hole:

- ✓ Blind hole
- ✓ Through hole
- ✓ Holes for hinges
- ✓ Holes with countersink

cutting tools to produce holes in wood. Normally the bore bit is rotated around its axis. During such rotation it advances in axial direction, the wood to be removed must not be squeezed off or torn off but be removed by a clean cut The quality of the holes and the performance depend on the sharpness of the cutting edges and on the state of the boring tools and boring appliances. forces are required for the rotary motion of the bit brace and for the feed motion in the in the direction of the bore hole depth. The part to be bored is to be clamped,

Boring tool used in wood

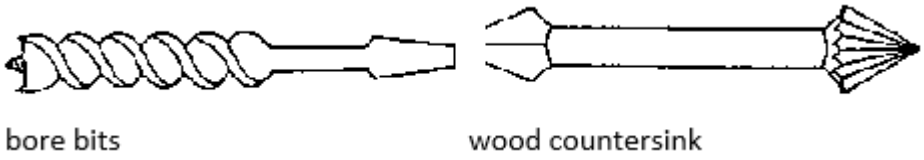


Figure 34.Boring tool used in wood

Boring is to be carried out as follows:

- ✓ If it is not possible to clamp the workpiece, assistance by a second worker is required.
- ✓ The face to be bored must be horizontal to permit the bit to cut vertically from top to bottom. In that case less feed force is required.
- ✓ Before boring the scribe-marked centre of the hole (pencil or scriber marking) should be punched to prevent the bit from running off centre.
- ✓ During boring the position of the bit with the boring appliance is to be constantly checked from all sides to make sure that the hole is produced in the correct position.
- ✓ A boring fixture should be used

1.1.2 Plastic

Boring holes in plastic may seem like an easy task, but plastic is a brittle material and is prone to crack and splinter if you aren't careful.

When boring plastic, the larger the hole, the slower bore speed you should use since high speeds can melt the plastic. Also, always reduce the bore speed as the boring tool exits the material. Before boring, it's best to clamp down the plastic securely to a solid surface and back up the piece you are boring with a spare piece of plywood underneath. This way the boring tool enters the plywood when it exits the plastic and avoids chipping the surface on the bottom. let's look first at the two main types of plastic: thermoplastics and thermosets.

1.1.3 Thermoplastics

Thermoplastics are the most commonly used type of plastic. The main feature that sets them apart from thermosets is their ability to go through numerous melt and solidification cycles without significant degradation.

Common types of thermoplastic materials

- ✓ Acrylic (PMMA)
- ✓ Acrylonitrile butadiene styrene (ABS)
- ✓ Polyamide (PA)
- ✓ Polylactic acid (PLA)
- ✓ Polycarbonate (PC)
- ✓ Polyether ether ketone (PEEK)
- ✓ Polyethylene (PE)
- ✓ Polypropylene (PP)
- ✓ Polyvinyl chloride (PVC

1.1.4 Thermosetting Plastics

In contrast with thermoplastics, thermosetting plastics (also referred to as thermosets) remain in a permanent solid state after curing. Polymers in thermosetting materials cross-link during a curing process that is induced by heat, light, or suitable radiation.

Common types of thermoplastic materials:

- ✓ Cyanate ester
- ✓ Epoxy

- ✓ Polyester
- ✓ Polyurethane
- ✓ Silicone
- ✓ Vulcanized rubber

1.1.5 Concrete

Concrete is a mixture of cement, sand, gravel, and water. The composition and specific hardness vary, but basically, concrete is very, very hard. Concrete boring is the action of boring or drilling a cured concrete form with a powered concrete auger or drill. Holes in concrete slabs, walls or floors are often required for the passage of electrical, plumbing. Builders once routinely used star drills to bore holes in concrete, masonry and stone. Star drills are straight, forged-iron shafts with star shaped chisels on one end.
The best way to do it is by boring holes with a coring bit, which looks like an oversize hole saw minus the teeth and pilot bit. In place of the teeth is a smooth or segmented edge studded with tiny industrial diamonds that cut concrete and rebar by means of abrasion.

Figure 35Concrete boring

1.1.6 Ceramics

ceramic materials used for engineering applications can be divided into two groups: traditional ceramics, and engineering ceramics. Typically, traditional components: clay, silica (flint) and feldspar. For example, bricks, tiles and porcelain articles. However, engineering ceramics consist of highly pure compounds of aluminum oxide (Al_2O_3), silicon carbide (SiC) and silicon nitride (Si_3N_4).
Set yourtool to a low speed and apply a modest amount of pressure to the surface.
Allow the tool to work slowly rather than pushing through and causing damage to the tile.
Applying too much pressure can cause the tile to blow out and crack on the back side, this blow out creates a weak spot in the tile, and can also make a much larger hole than you initially required.

1.2 Metals:

1.2.1. Ferrous

Ferrous metals are those that contain iron as the base metal. The properties of ferrous metals may be changed by adding various alloying elements.

- ✓ **CAST IRON**

Cast iron is a metal that is widely. used. It is a hard, brittle metal that has good wear resistance.

- ✓ **WROUGHT IRON**

Wrought iron is an iron that has had most of its carbon removed. It is tough; however, it can be bent or twisted very easily

- ✓ **STEEL**

Steel is an alloy of iron and carbon or other alloying elements. When the alloying element is carbon, the steel is referred to as carbon steel.

- ✓ **High Carbon Steel**

This steel is used in the manufacture of drills, taps, dies, springs, and other machine tools and hand tools that are heat-treated after fabrication to develop the hard structure necessary to withstand high shear stress and wear.

- ✓ **High-Speed Steel**

High-speed steel is a self-hardening steel alloy that can withstand high temperatures without becoming soft. High speed steel is ideal for cutting tools because of its ability to take deeper cuts at higher speeds than tools made from carbon steel.

- ✓ **Tungsten Carbide**

Tungsten carbide is the hardest man-made metal. It is almost as hard as a diamond. The metal is molded from tungsten and carbon powders under heat and pressure. Tools made from this metal can cut other metals many times faster than high speed steel tools.

- ✓ **Alloy Steels**

Steel is manufactured to meet a wide variety of specifications for hardness, toughness, machinability, and so forth.

1.2.2. Non-ferrous

There are many metals that do not have iron as their base metal. These metals, known as nonferrous metals

- ➢ **ALUMINUM**

Aluminum and its alloys are produced and used in many shapes and forms. The common forms are castings, sheet, plate, bar, rod, channels, and forgings. Aluminum alloys have many desirable qualities. They are lighter than most other metals and do not rust or corrode under most conditions

- ➢ **MAGNESIUM**

Magnesium alloys are produced and used in many shapes and forms, for example, castings, bars, rods, tubing, sheets and plates, and forgings. Their inherent strength, light weight, and shock and vibration resistance are factors which make their use advantageous.

- ➢ **COPPER**

Copper is a reddish metal, very ductile and malleable, and has high electrical and heat conductivity. Copper can be forged, cast, and cold worked. It also can be welded, but its machinability is only fair.

- ➢ **BRASS AND BRONZE**

Brass, an alloy of copper and zinc (has a low melting point and high heat conductivity. There are several types of brass such as naval, red, admiralty, yellow, and commercial. All differ in copper and zinc content. All may be alloyed with other elements such as lead, tin, manganese, or iron, and all have good machinability and can be welded.

Learning Unit 4- Perform sharpening of cutting tool

L O 4.1: Mount the grinding wheel

- **Content/Topic 1 Factors influencing the selection of grinding wheel**

2.7 Abrasive grain

This choice of right abrasive is to some extent determined by the type of material only to be ground, which will decide whether the abrasive is Silicon Carbide (SiC) or Aluminium Oxide (A1203) as these are

most commonly used abrasives in different varieties. Sic is the best suited abrasive for brittle and hard materials like grey cast iron castings, chilled iron, tungsten carbide hard steels, stone, porcelain and other ceramic substances SC is also recommended for low tensile strength material such as non-ferrous metals, bronze, brass, copper, aluminium and plastic materials, Al 203 is better for tough materials having high tensile strength like mild steel, alloy steel, high speed annealed malleable iron, tough bronze, wrought iron, etc

1.2 Grain size

For softer materials, it is a general practice to use coarse grain size and for harder materials, fine grains. Coarser grain is used for high rate of stock removal Fine grain is used if the work size or the work surface finish is important Grain Size is determined by the mesh number by which it is retained when passed through a series of meshes in a vibrating sieve.

1.3 Wheel grade

The hard materials and materials having high strength offer more resistance to wheel while grinding operation is performed. Thus if hard grade of wheel is used then wheel will get blunt soon and the grinding will not be good Therefore, for better results on such materials, the abrasive particles should break and fall quickly so that new sharp faces of the particles do the work and they never get blunt

For softer materials, high or harder grade, i.e. good bond is used. The grading is done by capital alphabets, the first alphabets being used for softer grade and last ones for harder grade

The grade of the bond can be classified in three categories.

Soft: **A B C D E F G H**

Medium: **I J K L M N O P**

Hard **R S T U V W X Y Z**

1.5. Grain spacing

Spacing or structure, from 1 (densest) to 17 (least dense). Density is the ratio of bond and abrasive to air space. A less-dense wheel will cut freely, and has a large effect on surface finish. It is also able to take a deeper or wider cut with less coolant, as the chip clearance on the wheel is greater.

1.6. Wheel bond

The bond material holds the abrasive particles in the form of a wheel. When these particles become blunt or break down completely, the bond material releases the blunt grains and thereby exposes new, sharp particles to continue the work. This action occurs because of the increase in grinding pressures resulting from the particles of grit becoming dull. The principal bond types are vitrified, shellac, resinoid and rubber.

How the wheel holds the abrasives; affects finish, coolant, and minimum/maximum wheel speed.(supura),(Gardne, 1965)

Bond name	Bond symbol	Bond description
Vitrified	V	Glass-based; made via vitrification of clays and feldspars
Resinoid	B	Resin-based; made from plants or petroleum distillates
Silicate	S	Silicate-based
Shellac	E	Shellac-based
Rubber	R	Made from natural rubber or synthetic rubber
Metal	M	Made from various alloys
Oxychloride	O	Made from an oxohalide
Plated	P	Made by Electro / Electroless bonding of metal to hold abrasive

- **Content/Topic 2Mounting procedure**

Great care must be taken in mounting the grinding wheels on the spindle because of high cutting speeds. The following points are important in connection with mounting of grinding wheel. Fig. shows mounting of a grinding wheel.

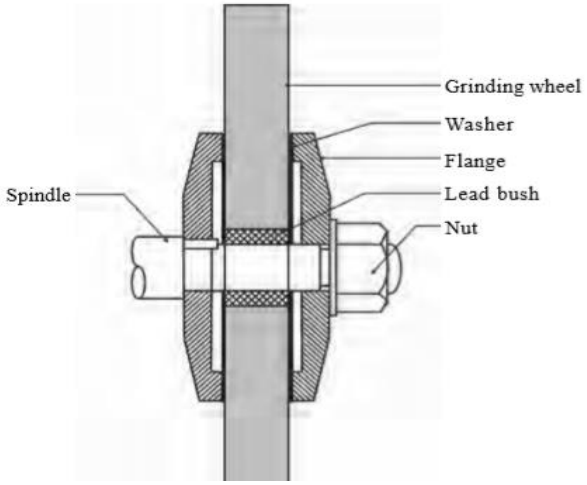


Figure 36.Mounting of a grinding wheel

1. All wheels should be inspected before mounting to make sure that they have not been damaged. The wheel is put on an arbor and is subjected to slight hammer blows. A clear, ringing, vibrating sound must be heard.
2. The wheel should not be forced on and they should have an easy fit on the spindle.
3. The hole of grinding wheel is mostly lined with lead. The lead liner bushes should not project beyond the side of wheels.
4. There must be a flange on each side of the wheel. The flange must be large enough to hold the wheel properly, at least the flange diameter must be equal to the half of the grinding wheel diameter. Both the flanges should be of same diameter.
5. The sides of the wheel and the flanges should be flat. Flanges contact the wheel only with the annular clamping area.
6. Washers of compressible materials such as cardboard, leather, rubber etc., not over 1.5 mm thick should be fitted between the wheel and its flanges. The diameter of washers may be normally equal to the diameter of the flanges.
7. The inner flange should be keyed to the spindle, whereas the outer flange should have an easy sliding fit on the spindle so that it can adjust itself tightly to give a uniform bearing on the wheel and the compressible washers.
8. the nut should be tightened to hold the wheel firmly. Undue tightness is unnecessary and undesirable as excessive clamping strain is liable to damage the wheel.
9. The wheel guard should be placed and tightened before the machine is started.(Dr. R. RAJKUMAR, Government of Tamilnadu, 2011)

L O 4.2: Grind the boring tool

- **Content /Topic1Cutting tool angle**

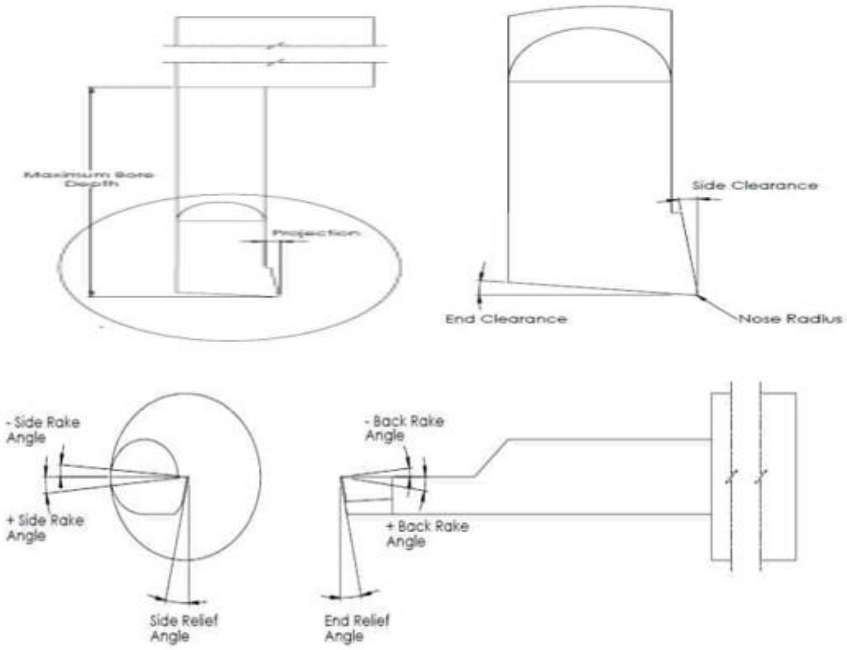


Figure 37.Cutting tool angle

2.7 Side Rake angle

The angle measuring the sideways tilt of the side face of the tool**,** the side rake angle and the side relief angle combine to form the wedge angle (or lip angle) of the tool bit that provides for the cutting action

2.8 End cutting edge angle

The main purpose of the end cutting angle is for clearance when cutting in the positive Z direction (moving into the hole). This clearance allows the nose radius to be the main point of contact between the tool and the work piece. Increasing the end cutting edge angle in the positive direction decreases the strength of the tip, but also decreases feed force. This is another situation where balance of tip strength and cutting force reduction must be found. It is also important to note that the angle may need to be changed depending on the type of boring one is performing.

1.3 Back rake angle

Sometimes called the top rake angle, the back rake angle for solid carbide boring bars is ground to help control the flow of chips cut on the end portion of the tool. This feature cannot have too sharp of a positive angle as it decreases the tools strength.

1.4 Side Relief Angles

Like the end cutting edge angle, the main purpose of the side and end relief angles are to provide clearance so that the tools non-cutting portion doesn't rub against the workpiece. If the angles are too small then there is a risk of abrasion between the tool and the workpiece. This friction leads to increased tool wear, vibration and poor surface finish. The angle measurements will generally be between 0° and 20°.

Side relief is the angle ground into the tool bit, under the side of the cutting edge, to provide clearance in the direction of tool bit travel.

1.5 Side cutting edge angle

Side and cutting edge angles are the angles formed by the cutting edge with the end of the tool bit (the end cutting edge angle), or with the side of the tool bit (the side cutting edge angle). The side cutting edge angle reduces the pressure on the tool bit as it begins to cut.

Side Relief Angle: The angle measuring how far the bottom face is tilted away from the work piece

1.6 End relief angle

The angle measuring the tilt of the end face relative to the line running perpendicular to the center axis of the tool

End relief is the angle ground into the tool bit to provide front clearance to keep the tool bit heel from rubbing. The end relief angle is supplemented by the tool holder angle and makes up the effective relief angle for the end of the tool bit.(in-the-loupe/how-boring-bar-geometries-impact-cutting-operations, n.d.)

- **Content/Topic 2.Use of wheel dresser**

Wheel dressing abrasive wheels on an off-hand grinder can be carried out using a star-wheel dresser, comprising a handle, at the end of which is fitted a series of star-shaped wheels and two lugs on the underside as shown in Fig.

Figure 38.Star-wheel dresser

Dressing

If the grinding wheels are loaded or gone out of shape, they can be corrected by dressing or truing of the wheels. Dressing is the process of breaking away the glazed surface so that sharp particles are again presented to the work. The common types of wheel dressers known as “Star” -dressers or diamond tool dressers are used for this purpose.

A star dresser consists of a number of hardened steel wheels on its periphery. The dresser is held against the face of the revolving wheel and moved across the face to dress the wheel surface. This type of dresser is used particularly for coarse and rough grinding wheels. **Fig. shows dressing by a star wheel dresser.**

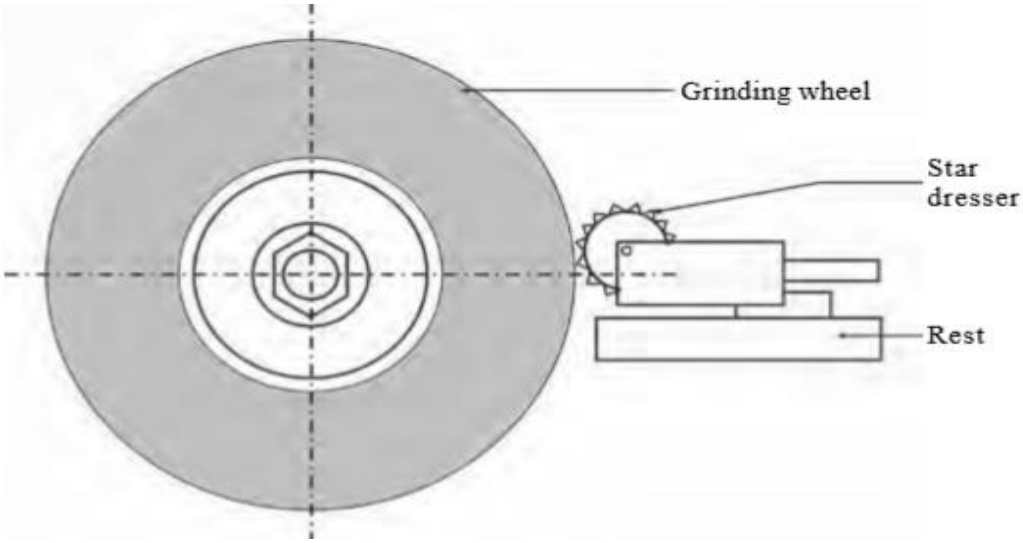


Figure 39.Dressing of a grinding wheel (Star wheel method

L O4.3: Use coolant during sharpening

- **Content/Topic 1 types of coolants**

1.1. Water soluble chemical fluids

Soluble Oils are metalworking fluid concentrates containing a high percentage of oil (usually greater than 50%). When mixed with water, they form an emulsion that has a milky appearance. The high oil content provides excellent physical lubricity for the cutting operation as well as protection for the machine tool.

1.2. Water soluble oils

Water is the cheapest cooling medium, but it is unsuitable by itself, mainly because it rusts ferrous metals. In soluble oils, or more correctly emulsifiable oils, the excellent cooling property of water is combined with the lubricating and protective qualities of mineral oil. Oil is, of course, not soluble in water, but with the aid of an agent known as an emulsifier it can be broken down and dispersed as fine particles throughout the water to form an emulsion. These are often referred to as 'suds' or coolant. Other ingredients are mixed with the oil to give better protection against corrosion, resistance to foaming and attack by bacteria, and prevention of skin irritations. Under severe cutting conditions where cutting forces are high, extreme-pressure (EP) additives are incorporated which do not break down under these extreme conditions but prevent the chip welding to the tool face.

1.3. Synthetic oil:

Sometimes called chemical solutions, these fluids contain no oil but are a mixture of chemicals dissolved in water to give lubricating and anticorrosion properties. They form a clear transparent solution with water, and are sometimes artificially colored. They are very useful in grinding operations, where, being non-oily, they minimize clogging of the grinding wheel and are used at dilutions up to 1 in 80. As they are transparent, the operator can see the work, which is also important during grinding operations. They are easily mixed with water and do not smoke during cutting. No slippery film is left on the work, machine or floor. They give excellent rust control and do not go rancid.

1.4. Petroleum-based oils:

Petroleum-based oil describes a broad range of natural hydrocarbon-based substances and refined petroleum products, each having a different chemical composition. As a result, each type of crude oil and refined product has distinct physical properties. These properties effect the way oil spreads and breaks down, the hazard it may pose to marine and human life, and the likelihood that it will pose a threat to natural and man-made resources.

The rate at which an oil spill spreads will determine its effect on the environment. Most oils tend to spread horizontally into a smooth and slippery surface, called a *slick*, on top of the water. Factors which affect the ability of an oil spill to spread include:

- ✓ **Surface tension** - the measure of attraction between the surface molecules of a liquid. The higher the oil's surface tension, the more likely a spill will remain in place. If the surface tension of the oil is low, the oil will spread even without help from wind and water currents. Because increased temperatures can reduce a liquid's surface tension, oil is more likely to spread in warmer waters than in very cold waters.
- ✓ **Specific gravity** - the density of a substance compared to the density of water. Since most oils are lighter than water, they lie flat on top of it. However, the specific gravity of an oil spill can increase if the lighter substances within the oil evaporate.
- ✓ **Viscosity** - the measure of a liquid's resistance to flow. The higher the viscosity of the oil, the greater the tendency for it to stay in one place.(bruce j.brack)

Learning unity 5- Select the machine

L O 5.1: Set the machine

- **Content /Topic1 Boring machine parameters setting**

1.1. Depth of cut

Depth of Cut: Depth of cut is practically self-explanatory. It is the thickness of the layer being removed (in a single pass) from the work piece or the distance from the uncut surface of the work to the cut surface, expressed in mm. It is important to note, though, that the diameter of the work piece is reduced by two times the depth of cut because this layer is being removed from both sides of the work.

$$dcut = \frac{D-d}{2} \text{ mm}$$

1.2. . Cutting speed, v_c

The boring tool rotates with a certain number of revolutions (n) per minute, generating a certain diameter (DC). This gives a specific cutting speed vc measured in m/min at the cutting edge. Cutting speed has a direct influence on tool life.

1.3. Feed, f_n

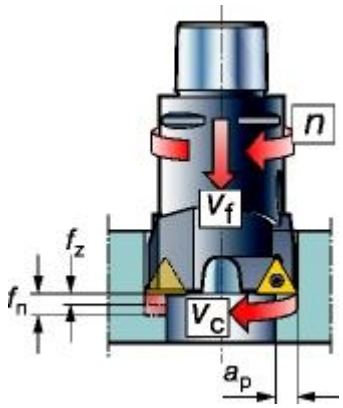


Figure 40.Feed,

The axial tool movement is called feed rate and is measured in mm/revolutions. The feed rate is obtained by multiplying the feed per tooth (fz) by the effective number of teeth (number of teeth generating final surface). The feed rate is the key value in determining the quality of the surface being machined and for ensuring that the chip formation is within the scope of the insert geometry.

1.4. Penetration rate, v_f

The penetration rate means the speed of the axial movement and is strongly related to the productivity.

Metal removal rate, Q

Metal removal rate means how much material that can be removed in a certain time frame and is strongly related to the productivity for roughing.

1.6. Cutting depth, a_p

The cutting depth is the difference between the uncut and the cut hole radius.

1.7. Entering angle, k_r (º)

The cutting edge approach to the workpiece is expressed through the entering angle as the angle between the main cutting edge and the direction of feed.

Net power, P_c

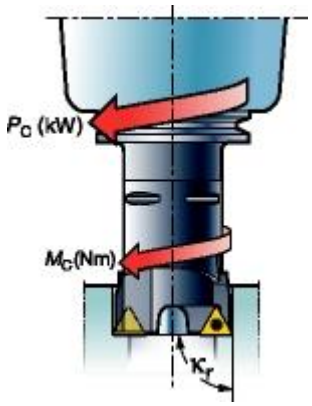


Figure 41.Entering angle

The power the machine must be able to provide to the cutting edges in order to drive the cutting action. The mechanical and electrical efficiency of the machine must be taken into consideration when selecting cutting data.

Torque, M_c

The torque value produced by the boring tool during cutting action, which the machine must be able to provide.(Pradeep M. Borade1 , Prof. M. J. Deshmukh2)

Metric

Cutting speed/vc(m/min

$$v_c = \frac{\pi \times D_m \times n}{1000}$$

Spindle speed/n(r/min)

$$n = \frac{v_c \times 1000}{\pi \times D_m}$$

Machining time tc/min

$$T_c = \frac{l_m}{f_n \times n}$$

Metal remove rate Q cm^3/min

$$Q = v_c \times a_p \times f_n$$

Penetration rate v_f mm/min

$$v_f = f_n \times n$$

Feed per revolution f_n mm/rev

$$f_n = z_c \times f_z$$

Net power p_c kw

$$P_c = \frac{v_c \times a_p \times f_n \times k_c}{60 \times 10^3}\left(1 - \frac{a_p}{D_c}\right)$$

Torque p_c n/m

$$M_c = \frac{P_c \times 30 \times 10^3}{\pi \times n}$$

L O5.2: Fix the cutter in the boring spindle

- **Content/Topic 2 Methods of fixing the boring cutter**

2.1 Arbor mounting

1.Engage arbor in machine spindle

2. Engage cutter on arbor

(a) Unscrew locking screw from arbor.

(b) Clean mating parts of cutter and arbor.

(c) Slide bore of cutter on arbor spigot, rotating cutter to align drive dogs to cutter slots.

(d) Feel drive dogs engage in slots and faces flat together.

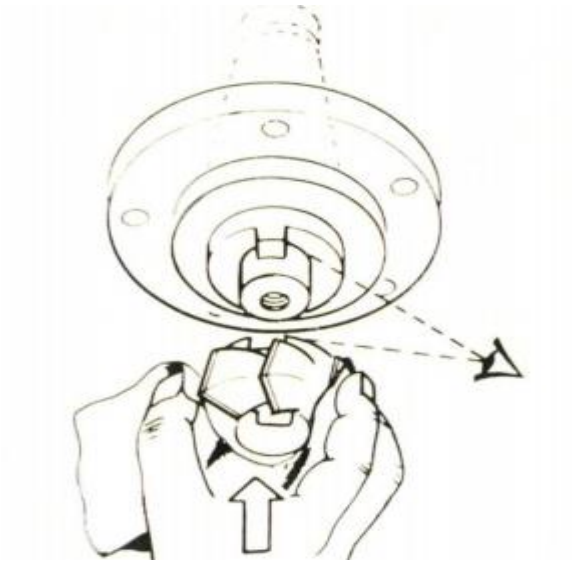


Figure 42.Arbor mounting

3. **Tighten cutter on arbor**
(a) Hold cutter in position on arbor and screw
(b) locking screw into arbor finger tight.
4. Final tighten locking screw
(a) Check that dogs of key and slots of screw head are not worn.
(b) Engage dogs of key in slots of screw head.
(c) Apply upward pressure to keep key engaged in slots and tighten screw.

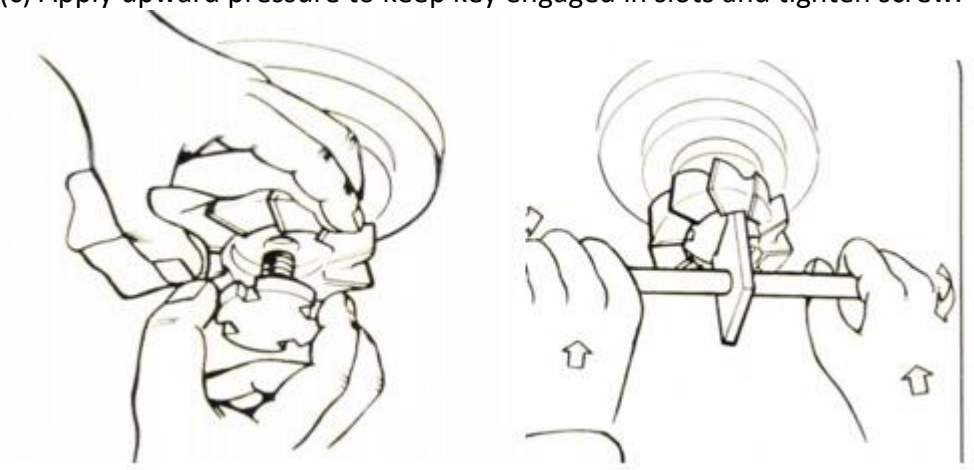


Figure 43.Tighten cutter on arbor

2.2 Spindle

Boring Tools Mountings for Horizontal Boring: various mounting equipment/tools used for cutters in a horizontal boring machine are: 1. Boring bar 2. Boring head or cutter head 3. Facing head. Boring Bar: Ordinary boring operations are carried out with tools mounted on a bar held in spindle having Morse taper hole. The maximum diameter of the bar is normally not larger than the spindle diameter, and the length is sufficient to reach the end column support. To reduce bending or vibration, a boring bar should be of maximum diameter and minimum length and it may be supported in various ways to match with different types of work pieces. (knowledge/machining-formulas-definitions/pages/boring.aspx, n.d.)

L O 5.3: Fix the work piece

- **Content/Topic 3 Clamping the work piece**

2.7 Vice clamping

Loose vice clamping for quickly fixing the workpiece's central positions in single-piece production or at low cutting pressure. Firm vice clamping with determination of fixed position in series production or at high cutting pressure.

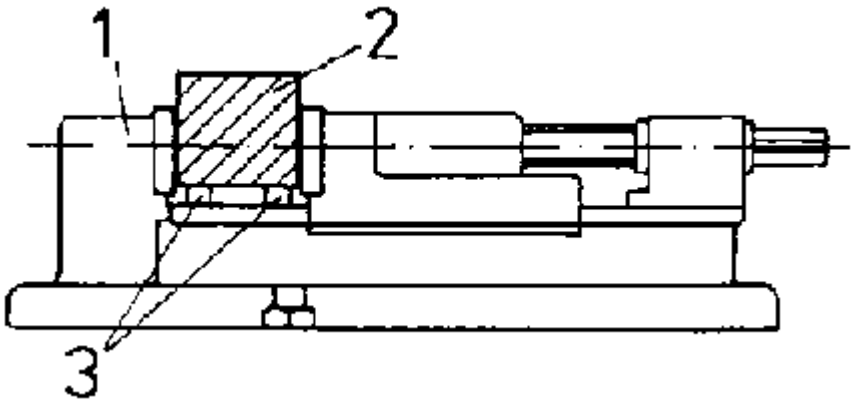


Figure 44.Vice clamping

1 vice, 2 workpiece, 3 parallels

3.2 Chucking

jaw chucks which are mounted at the spindle nose and firmly hold job in centre lathes. Premachined round bars are quickly and coaxially mounted by simultaneously moving the three jaws radially by rotating the scroll (disc with radial threads) by a key as can be seen in the diagram (a)

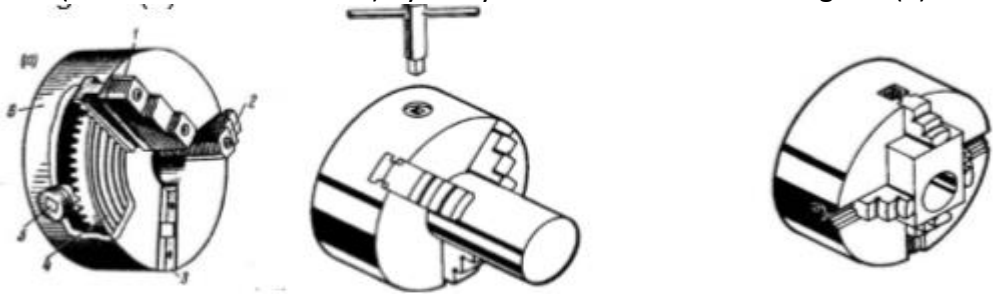


Figure 45.jaw chucks

The four jaw chucks, available in varying sizes, are generally used for essentially more strongly holding non-circular bars like square, rectangular, hexagonal and even more odd sectional jobs in addition to cylindrical bars, both with and without pre-machining at the gripping portion. The jaws are moved radially independently by rotating the corresponding screws which push the rack provided on the back side of each jaw.

o for turning, facing, boring, threading and similar operations, jobs of odd shape and size are usually mounted on large face plate (instead of chuck) being fitted on the spindle nose The job may be (b) directly clamped on the face plate or (c) in case of batch or small lot production, in a fixture which is clamped on the face plate.

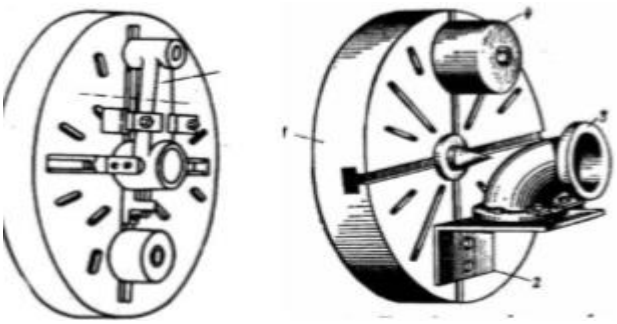


Figure 46.face plate

3.3 Clamping in fixtures

for clamping work pieces which due to their geometrical shape cannot or only with considerable effort be clamped with usual clamping equipment such as vice, stop and clamp. This is the safest kind of clamping ensuring high quality. It is, however, dependent on the specific workpiece and construction of the fixture.

Direct clamping of job or clamping of the vice and jig on the drilling bed are done with the help of clamp plates, T-bolts etc., as indicated in Fig1 a. (b) shows the type of vices; plain, swivelling and universal type being used for holding small jobs in drilling machines. Fig2. also typically shows how a job is fitted in a jig for drilling in batch production

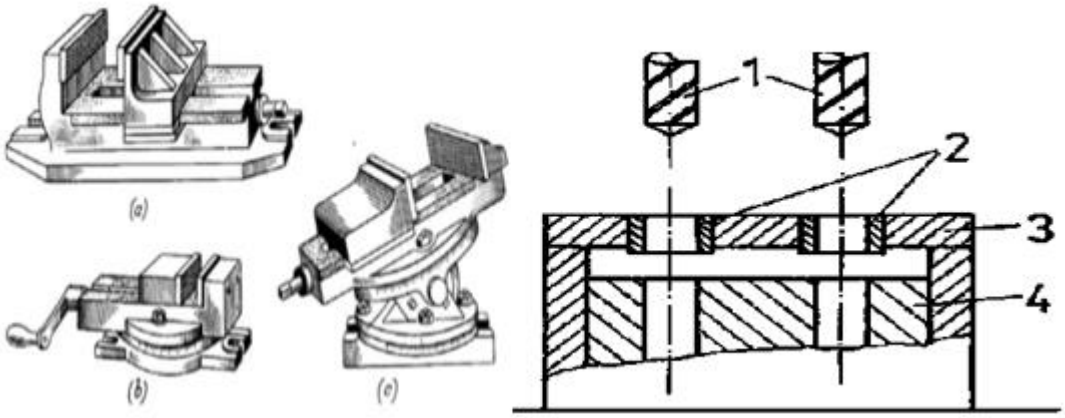


Figure 47.Vices to hold jobs and Mounting of Fixture

1 tools, 2 drill bushes, 3 fixtures, 4 work piece

3.4 Magnetic

Magnetic chucks use the magnetic force from a permanent magnet, electromagnet, or electro-permanent magnetic material to achieve chucking or holding action. Magnetic chucks use magnetic force to hold a work piece in place while it is being worked on. The magnets work by inducing polarity into the ferrous work material that connects across its north and south poles. When a work piece is placed across the poles of the magnet, the flux flows into it. The ferrous components have poles that are opposite the polarity of the magnet so they attract each other. Amplifying and controlling this flux is the key to applying magnets in a metalworking operation.(Kharagpur)

Figure 48.Magnetic

Learning unity 6- Carry out boring process

L O 6.1: Bore a work piece

- **Content /Topic1 Steps of boring**

1.1. Roughing

Rough boring operations are performed to open up an existing hole to prepare for finishing. Boring operations are applied to machine holes that have been made through methods such as pre-machining, casting, forging, extrusion.

Cut the first groove to the depth of the first roughing cutting diameter. The feed the insert toward the other side of the work piece. Cut till the end, then retract the insert at the 45° away from the wall. Repeat the operation, till the roughing operation is complete.

1.2. Finishing

Fine boring operations are performed to complete an existing hole to achieve a close hole tolerance, correct positioning and high quality surface finish. Machining is carried out with small cutting depths. Face-Off at finish dimension, one side of the groove to the finished diameter. Retract the insert at 45° away from the wall and move to the other side of the groove. Face-Off to the finish diameter and continue to cut till the other wall is reached, then retract the insert at 45°.

- **Content /Topic2 Types of boring operations**

1.1. Boring

Boring is the operation of enlarging the hole which is already drilled, punched or forged. It cannot produce a hole. Boring is similar to the external turning operation and can be performed in a lathe. In this operation, the work piece is revolved in a chuck or a faceplate and the tools which are fitted to the tool post is fed into the work.

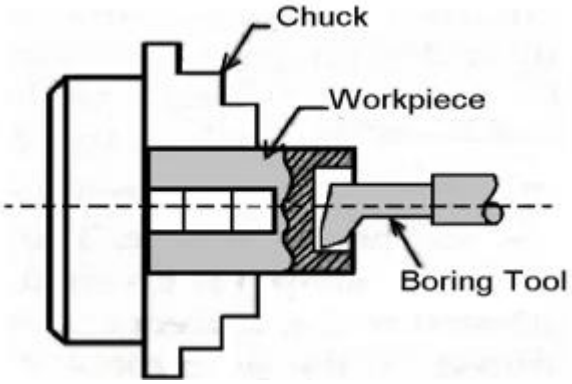


Figure 49.Boring

1.2 . Facing

Facing is machining the ends and shoulders of a piece of stock smooth. flat, and perpendicular to axis. It's used to cut work to the desired length and to produce a surface from which accurate measurements may be taken.

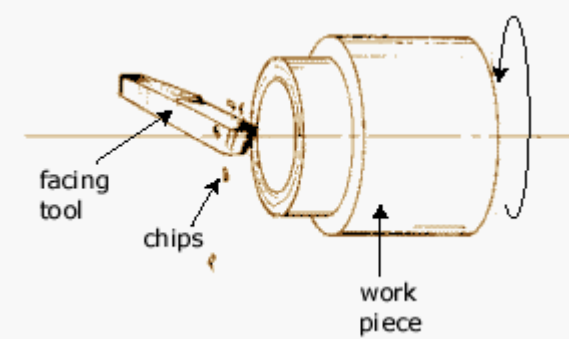


Figure 50.Facing

1.3 . Drilling

Drilling is the operation of producing a cylindrical hole in a workpiece. It is done by a rotating tool, the rotating side of the cutter, known as drilling drill. In this operation, the workpiece is revolving in a chuck or a faceplate and the drill is held in the tailstock drill holder or drill chuck.The feeding is adopted is affected by the movement of the tailstock spindle. This method is adopted for the drilling regular-shaped workpiece.

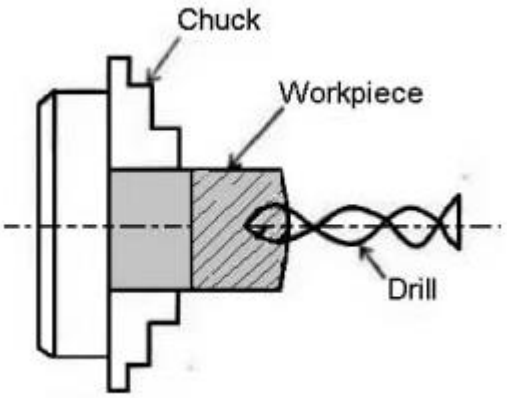


Figure 51.Drilling

1.4. Reaming

Reaming is the operation of finishing and sizing a hole which has been already drilled or bored. The tool is used is called the reamer, which has multi-plate cutting edges. The reamer is held on the tailstock spindle, either directly or through a drill chuck and is held stationary while the work is revolved at a very slow speed.

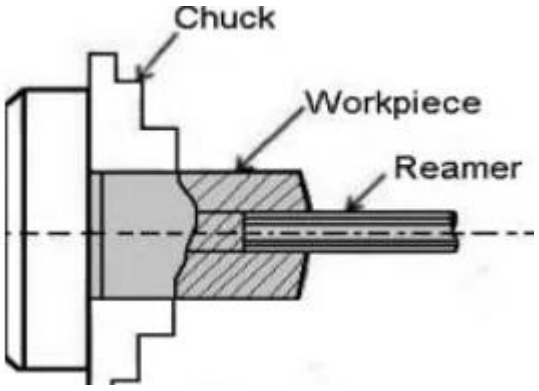


Figure 52.Reaming

1.5. Forming

It is the process of turning a convex, concave or of any irregular shape. Form-turning may be accomplished by the following method:

1. Using a forming tool.
2. Combining cross and longitudinal feed.
3. Tracing or copying a template.

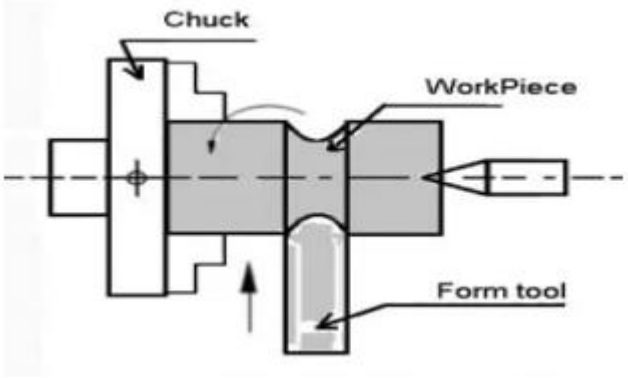


Figure 53.forming

1.6. Recessing

Recess is usually narrow; the cutting edge is kept narrow. The tool is relieved by 10to20 on each side towards the shank. The side are relieved to make the tool free cutting

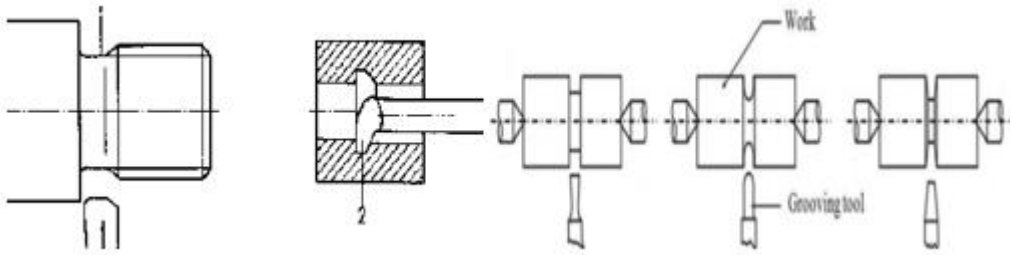


Figure 54.Recessing

1.7. Countersinking

Countersinking is the tapering or beveling of the end of a hole with a conical cutter called a machine countersink. Often a hole is slightly countersunk to guide pins which are to be driven into the work piece; but more commonly, countersinking is used to form recesses for flathead screws (Figure) and is similar to counter boring.

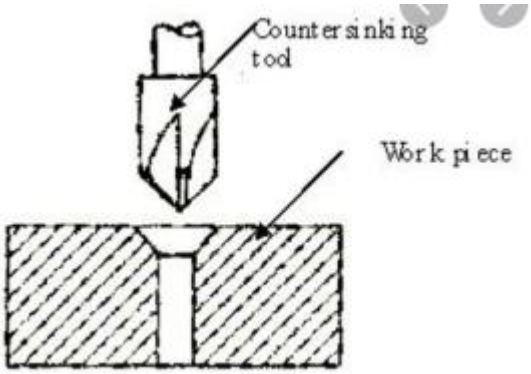


Figure 55.Countersinking

Counter sinking is performed after drilling to provide space for the head of a fastener such as screw, when placed in the hole, to sit flush with or below the surface of the surrounding materials.

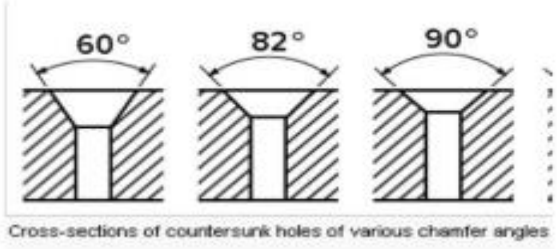


Figure 56.Countersinking angle

1.8. Counter boring

Counter boring is the operation of enlarging the end of the hole through a certain distance. It is similar to a shoulder work in external turning.

The operation is similar to boring and plain boring tools or a counter bore may be used. The tool is used called a counter bore. The speed is slightly less than drilling.

1.9. Taping

Tapping is the operation of cutting internal threads of small diameter using a multipoint cutting tool called the tap. In a lathe, the work is mounted on a chuck or on a faceplate and revolved at a very slow speed. A tap of required size held on a special fixture is mounted on the tailstock spindle.

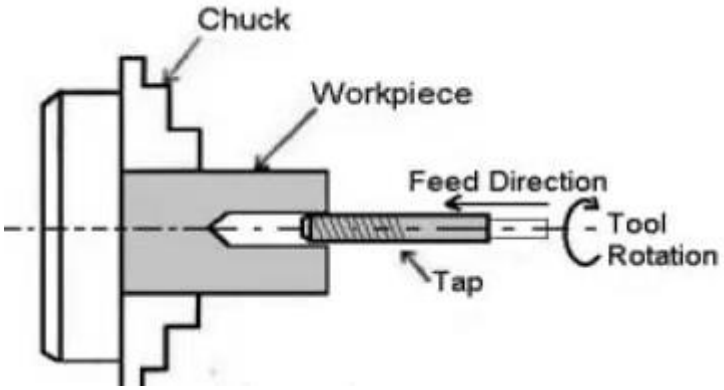


Figure 57.Taping

1.0 Threading

It is the important operation in the lathe to obtain the continuous ”helical grooves” or ” threads’‘.

When the threads or helical grooves are formed on the out surface of the workpiece is called external thread cutting. When the threads or helical grooves are formed on the inner surface of the workpiece is called internal thread cutting. The workpiece is rotating between the two centres i.e., live centre and dead centre os the lathe.

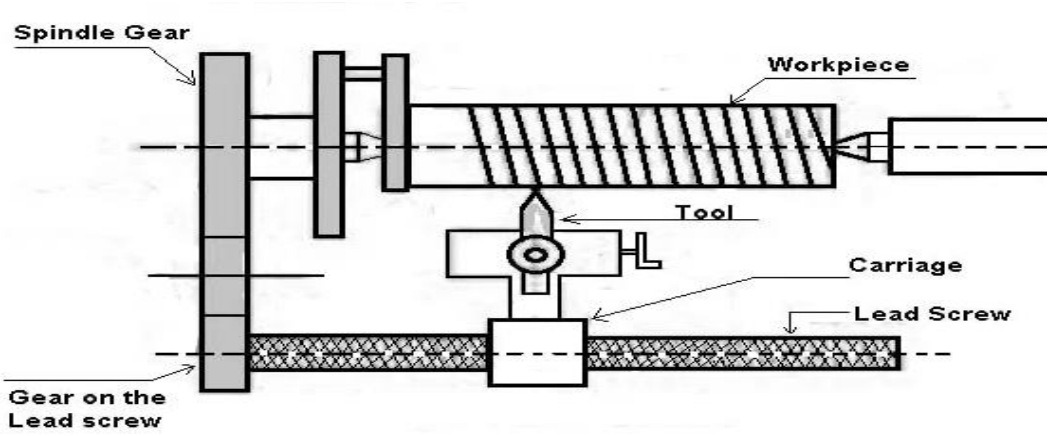


Figure 58.Threading

L O 6.2: Check work specifications

- **Content /Topic 3 Tips to consider when checking specifications**

1.1 Work dimensions

- **External diameters** are at the outside of a cylinder or cone.
- **Internal diameters** are the inside of a hollow cylinder or bore.
- **Depth** is the distance between the crest and root of a thread, measured perpendicular to the axis.
- **Pitch** is the distance from a given point on one thread to a similar point on a thread next to it, measured parallel to the axis of the cylinder. The pitch in inches is equal to one divided by the number of threads per inch.

1.2 Work profiles

- ✓ **Conicity of tapered holes**:

Taper boring is usually done with either the compound rest or the taper attachment The rules that apply to outside taper turning also apply to the boring of taper holes. Begin by drilling the hole to the correct depth with a drill of the same size as the specified small diameter of the taper. This gives you the advantage of boring to the right sue without having to remove metal at the bottom of the bore: which IS rather difficult: particularly in small: deep holes. A rod is said to be tapered when it increases or decreases in diameter at uniform rate as shown in the figure

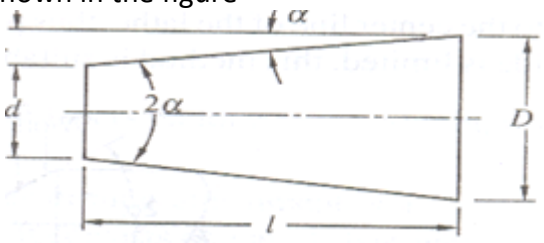


Figure 59.Taper boring

. If D is the larger diameter, and d is the smaller diameter and l is the length ordistance between the two diameters, then the taper can be expressed as

$$\text{Taper or Conicity, } T = \frac{D - d}{l}$$

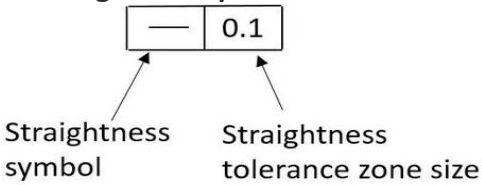
and half the taper angle can be expressed as

$$\text{Half the taper angle, } \alpha = \tan^{-1}\frac{D - d}{2l}$$

- ✓ **Surface straightness**

Straightness is a two-dimensional geometric tolerance. Straightness is a condition where one-line element of a surface or an axis must lie in a straight line. It controls how much a feature of one-line element of a surface can deviate from a straight line. Straightness tolerance is applied in the view where the elements to be controlled. Straightness tolerance specifies a tolerance zone within element or derived median line must lie. The feature control frame needs to be attached to the surface with an extension line or a leader when a surface needs to be controlled. Tolerance zone for both cylindrical and flat surface is applied along the entire surface.

The straightness specification



1. example of applying straightness to a surface is shown below. The straightness callout points directly to the surface of the pin. Therefore, we know that the straightness tolerance applies to the surface.

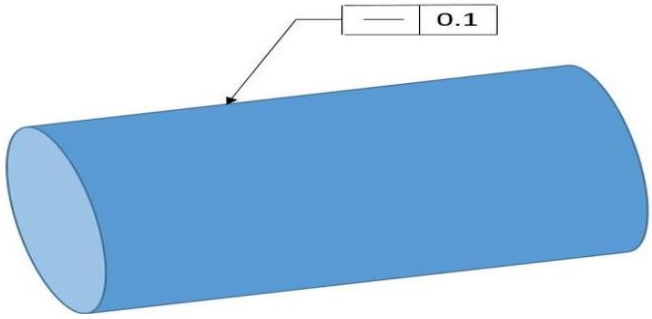


Figure 60.straightness specification

2. the hole below has a straightness callout below the size dimension. That means that the straightness tolerance applies to the axis of the hole.

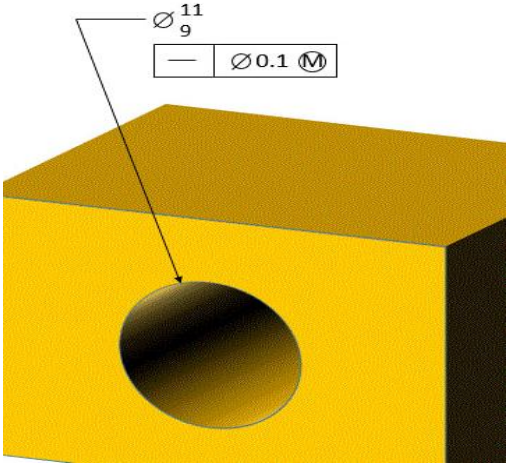


Figure 61.Cylindricity of holes

Cylindricity is a 3-Dimensional tolerance that controls the overall form of a cylindrical feature to ensure that it is round enough and straight enough along its axis. Cylindricity is independent of any datum feature the tolerance needs to be less than the diameter dimensional tolerance of the part. Cylindricity essentially forms a perfect cylindrical boundary around the object that the entire 3-Dimensional part must lie in.The Cylindricity symbol is used to describe how close an object conforms to a

true cylinder.

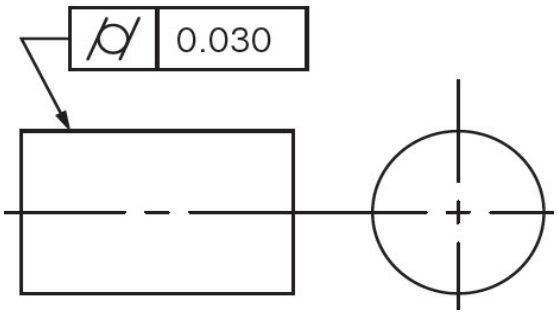


Figure 62.Cylindricity symbol

Cylindricity is a fairly common callout for shafts, pins and any critical cylindrical element. When a part needs to be both round and straight along its axis, such as a sliding shaft, or a dynamic locating pin. Cylindricity is measured by constraining a part on its axis, and rotating it around while a height gauge records the variation of the surface in several locations along the length. The height gauge must have total variation less than the tolerance amount

- ✓ **Concavity of grooves/Recesses**

The recessing (necking, grooving) technique as metal-cutting operation serves to produce
- undercuts for the production of threads, recesses in circumferential surfaces or hollow parts for grinding of simple and intricate work pieces,
- grooves for intricate machine parts, such as grooves for V-belts, oil grooves, snap rings, annular grooves.
Grooving or recessing operations, sometimes also called necking operations, are often done on work piece shoulders to ensure the correct fit for mating parts. When a thread is required to run the full length of the part to a shoulder, a groove is usually machined to allow full travel of the nut. Grooving the work piece prior to cylindrical grinding operations allows the grinding wheel to completely grind the workpiece without touching the shoulder.

- ✓ **Surface finish of holes:**

Surface finish is one of the essential quality control parameter to ensure that functional surfaces of manufactured parts conform to specified standards. Surface finish of parts can significantly affect their friction, wear, fatigue, corrosion, tightness of contact joints, positioning accuracy, etc. Surface finish is important factor for manufacturing process monitoring and quality control inspection

- ➢ **Roughness:** surface roughness of machined products has been reviewed where cutting conditions (such as cutting speed, feed rate, depth of cut, tool geometry, and the material properties of both the tool and work piece) significantly influence surface finish of the machined parts. The surface roughness can be affected by built up edge formation. Machining of an existing hole with focus on metal removal in order to prepare for finishing. The existing holes are made by methods such as drilling, casting, forging and flame cutting.
- ➢ **Smoothness**

The drill bit geometry has a number of features that help the drill create smooth surfaces. For example, drill bits with a smaller chisel and thinner web can be more accurate than old 118-degree drill points. "An old tool tended to move from side to side as it was drilling because the chisel pushed the material rather than cutting it “The modern geometry, however, cuts that center portion, shearing the chip. It's a freer-cutting tool, which creates a better sur-face finish.”, said Yakamavich.Machining of an existing hole to achieve a close hole tolerance and high quality surface finish. Small cutting depths,

generally below 0.5 mm (0.020 inch). for producing smooth and accurate holes in a work piece by enlarging existing holes with a bore, which may bear a single cutting tip of steel, cemented carbide, or diamond or may be a small grinding wheel. Single-point tools, gripped in a boring head attached to a rotating spindle, are moved circularly against the sides of the existing holes. The diameter of the hole swept out by the tool is controlled by adjustment of the boring head.(patil jaydeep and kinase sandip, 2013)

L O 6.3: Cool the work piece and cutter

- **Content /Topic 1Tips Cooling techniques**

It is very important that the bore is kept clean and free of chips while cutting to avoid surface damage and insert to breakage. Use high pressure coolant with the boring bar to flush the chips out while cutting.

1.1. Air cooling

Air-cooling and dry machining are both being trialled as possible solutions to the metal cutting industry's long running problems of extending tool life, reducing tool failure and minimizing the heat generation at the tool tip. Applying cold air to the tool interface of these modern tool tips will also help prolong their tool life reducing the cost of metal cutting.

1.2. Fluids cooling

- **Water soluble oils**: water soluble fluids designed to provide cooling and lubrication during metalworking operations. The use of coolant extends cutting tool life, improves part finish and tolerance, and improves productivity.
- **Synthetic oils**: Synthetic coolants are metalworking fluid concentrates that contain no mineral oil. When mixed with water, they form a clear fluid. Synthetics have excellent cooling properties and run very clean providing long life in the sump.

Example synthetic oil

APEX 6500

APEX 6500 is a moderate to heavy duty synthetic coolant. It has superior oil rejecting capabilities.

APEX 6420

APEX 6420 is a light to moderate duty synthetic coolant. It has superior oil rejecting capabilities. Formulated for use in grinding applications and light duty machining.

- **Petroleum-based oils**

Petroleum-based oils are: a) oils (including lubricants or fluids but not greases) derived from petroleum and their synthetic equivalents; or b) oils (including lubricants, fluids and greases) derived from petroleum and their synthetic equivalents, if recycled for use as oils.

Petroleum-based greases are: a) petroleum-based greases and their synthetic equivalents; or b) oils (including lubricants, fluids and greases) derived from petroleum and their synthetic equivalents, if recycled for use as greases.

PBOs and PBGs used as lubricants are considered to have undergone a degree of oxidation and are therefore reported under the fuel combustion source.

PBOs and PBGs are generally considered consumed when the oil or grease is applied or used in the operation of a facility in a manner consistent with their intended use (for example, in the transmission of a heavy vehicle).

LO 6.4: Finish the work

- **Content /Topic2Methods of finishing**

2.1 Polishing

Sand paper

Sandpaper is an essential tool in woodworking and other crafts. Using sandpaper properly will give you a polished, smooth surface that is ready for paint or stain. Sandpaper comes in three grades: coarse, medium, and fine. Sandpaper grades are measured in "grit.

- **Coarse-grade sandpaper** has a grit of 40 to 80. An 80-grit sandpaper should be coarse enough unless you have significant defects in the surface you'll be sanding.

Applications include:

- Stripping away finishes, such as paint or varnish
- Removing rust on metals or flaws in wood
- Leveling and shaping wood

- **Medium-grade sandpaper** has a grit of 100 to 150.
  - Smoothing work pieces
  - Removing scratches
  - Final preparation for finishing
- **Fine-grade sandpaper** has a grit of 180 to 220. A 220-grit sandpaper should be fine enough for your project, but there are higher grits if you want a smoother finish.

- Removing raised woodgrain fibers
- Scuffing between finish coats

Sandpaper can be used with power tools and for sanding by hand

Figure 63.Sandpaper

polish metal with sandpaper, but like many things in life, you have to know what you're doing so you don't damage what you're working on. Many sandpaper manufacturers sell finishing paper specifically designed for polishing metal. sandpaper and moving up to finer sandpaper, along the lines, aluminum oxide sandpaper or silicon carbide sandpaper when polishing metal; aluminum oxide is the best option for polishing hard metals such as iron and steel, and silicon carbide is good for softer metals such as aluminum and brass.

2.1. Smooth files

A file is a piece of very hard steel that has a series of parallel grooves cut into it, which leave behind rows of sharp cutting teeth. Files are typically used by hand and, depending on how coarse the teeth are, can aggressively remove material and shape metal quickly. The surface finish is somewhat rough and

imprecise and often needs additional sanding or polishing for good results. But files are still versatile, easy to use and can produce fine results in skilled hands.

Figure 64.Smooth files

2.2 Deburring

Deburring is also sometimes necessary to tidy and smooth components before they enter the plating baths.

Hand filing was once the only means of deburring plated materials, and it is still used in some circumstances today. Hand filing, however, requires a significant time investment, which greatly affects the timely delivery of finished products. Mechanical deburring techniques provide high-quality finishes at a fraction of the time.

Deburring methods include polishing, brushing and tumbling, flexible polishing, and satin finishing, which produces a smooth directional finish.

Polishing or processing wheels use different coverings depending on the delicacy of the item being deburred. Muslin, canvas, felt and even leather are all used, but cotton fabric wheels are the most common.

The surface requiring deburring determines the rigidity of the polishing wheel. Rigid canvas wheels are used for flat surfaces with little contouring and for rapid deburring of large amounts of metal. More delicate parts with restricted areas require a less rigid processing wheel and softer materials such as muslin.

Learning unity 7- Clean and store tools and equipment

L O 7.1: Handle the product

- **Content /Topic 1.Tools and products used for metal protection**

1.1 Oils

Oils are lubricants providing temporary protection of metal parts from oxidation caused by moisture, oil contaminants and chemically active atmosphere. protection oils contain Corrosion inhibitors, which form a barrier film on the substrate surface. The inhibitors consist of polar molecules possessing water-repellent properties. The inhibitor molecules absorb on the metal surface forming a film protecting the part from the attack of oxygen, water and other chemically active substances.

1.2 Oil gun

Oil Gun is specially designed for use with oil. The gun may be used to lubricate bearings, or to pre-charge hydraulic cylinders. Load the gun by pouring oil directly into the cylinder.

Figure 65.Oil gun

1.4. Greases

Grease is a solid-to-semifluid mixture of a fluid lubricant, thickener, and additives
Majority of greases on the market are composed of mineral oil blended with a soap thickener.
Grease should retain its properties under shear at all temperatures that it is subjected to during use Grease must be able to flow into the bearing through, **Greases** stand out in particular for their excellent adhesion to the surfaces to be lubricated; also, they are insoluble in water, they resist to shearing and last longer. Generally speaking, grease cannot be heated above 300°C (temperature at which the base oil separates from the thickener). Beyond this temperature, copper or aluminum-based thermal pastes or coatings are more suitable.in addition to its lubricating role (reduction of mechanical fatigue and energy losses due to friction), grease creates a waterproof barrier against external elements (dust, water, solvents, heat, etc.).

What is a grease expected to do?

- ✓ Reduce friction and wear.
- ✓ Provide corrosion protection.
- ✓ Seal bearings from water and contaminants.
- ✓ Resist leakage, dripping and throw off.
- ✓ Resist change in structure or consistency during service.
- ✓ Maintain mobility under conditions of application.
- ✓ Be compatible with seals.
- ✓ Tolerate or repel moisture.
- ✓ Be suitable for a wide range of temperatures.

1.5. Grease gun

Different equipment, machines, bearing types and vehicles require different types of grease. Proper identification of the grease once installed in a grease gun can be challenging.

Figure 66.Grease gun

Grease Guns are designed to handle most low- and medium-pressure manual lubrication applications. These guns are available in push, lever or pistol style.
Grease Guns can be used on a wide range of applications, including:

- ✓ Industrial applications
- ✓ Automobiles and trucks
- ✓ ATVs and snowmobiles
- ✓ Trailers
- ✓ Boats
- ✓ Lawn and garden equipment
- ✓ Farm equipment

1.6. Brushes

brushes remove burrs and cleans impurities off various surfaces. Brush types abound—wheel brushes, cup brushes, end brushes, and specialty brushes reach into corners and crevices like few other finishing tools. Choosing the right brush for the job and using the right technique can have a dramatic impact on throughput.
When you're working on carbon steel, you use a carbon steel brush. But when you're working with stainless steel or aluminum, you need to use a stainless steel or aluminum brush. If you use a carbon steel brush on stainless, the carbon from the wire brush will start to contaminate the stainless steel and will cause it to oxidize and rust
Brush Shape and Diameter. A stringer bead wheel brush can work well for cleaning pipe and similar welds between passes. A cup brush works well for cleaning surfaces. Narrow end brushes work well for cleaning in confined spaces, like holes. The logic behind brush selection goes back to how brushes behave in operation. If used on a flat surface at a high speed, narrow end brushes will flare out. This means that the wire tips don't have direct, near-perpendicular contact with the surface, and so they fail to work as they should.

- **Content /Topic 2. Method of protecting the product**

2.1. Oiling and greasing

Methods of this type include hand oiling, drop feed oiling, wick-feed oiling, and bottle oiling.
Hand oiling is the direct application of oil to a moving machine part from a hand oil can. An excess of oil is applied, which soon runs off, leaving the bearing to operate with insufficient oil until the next oiling. For this reason, bearings lubricated by hand oiling are not as well protected against wear as those on which more reliable oiling methods are used.
Drop feed oilers usually consist of a glass or plastic reservoir, a needle valve feed rate adjustment, a snap level shut-off, and a sight glass for observing the feed rate. They are generally used on lightly loaded, horizontal bearings that require a low rate of oil supply.

Wick Oilers have a wick of loose textured, long fiber wool that supplies oil to the bearing through capillary action. Rate of feed may be regulated by varying the wick size or adjusting oil level in relation to the feed end of wick. Raising the wick will stop oil flow. The underfeed oiler consists of a metal reservoir with a shank that threads into a hole in the bearing housing. Oil feeds up the wick to the shaft through the hole in the underside of the bearing sleeve. Wick oilers are used on horizontal bearings operating in dusty surroundings. The wick serves as a filter to prevent contaminants from reaching the bearing. When the wick becomes choked with dust it must be cleaned or replaced. When the wick end becomes glazed from the rotating shaft, it should be trimmed off to provide a fresh surface.

METHODS OF GREASE Application

1. By hand
2. By hand operated mechanical devices like grease gun, which delivers the grease to one point at a time.
3. By centralized grease systems which supply a number of points at a time from a central reservoir.

hand application
As the name implies is the application of the grease directly to the parts by hand. Ball and Roller bearings are greased by fingers into the space between the balls and rollers. Grease application is also done to open Gears and Guiders.

2.2. Product covering

One of the easiest and cheapest ways to protect Product use barrier coatings like paint, plastic, or powder. ... Plastic and waxes are often sprayed onto metal surfaces. Paint acts as a coating to protect the metal surface from the electrochemical charge that comes from corrosive compounds. these simple steps can add a lot of life to metal and stop the corrosion of metals

- ✓ Turn to non-corrosive metals such as aluminum and stainless steel.
- ✓ Keep the area around the metal surface dry.
- ✓ Use drying agents and moisture barrier products.
- ✓ Make sure underground piping is laid in a layer of backfill, such as limestone.
- ✓ Make sure any electrical components are cleaned regularly
- **Content /Topic 3 Product storage defect**

3.1 Effect of scratch

Scratches can appear because of:

- ✓ Poor molding
- ✓ The poor storage conditions of semi-finished goods. The semi-finished goods are stored in cartons/baskets most of the time before assembling. The way goods are stored and manipulated at this stage can inflict damage, particularly scratches
- ✓ Poor protection during production (assembling and packing) critical scratch marks can be classified as noted below:

  - Major defect: when scratches are at the front or on the side of the product and the dimensions are over 10mm.
  - Minor defect: when scratches are between 5-10mm and located at the front, back or on the side of the product.
  - Critical defect: it is almost impossible for scratches of this nature to be considered hazardous or unsafe for the user

3.2 Effect of Heat and cold on finished product

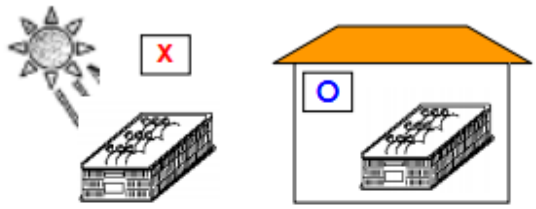
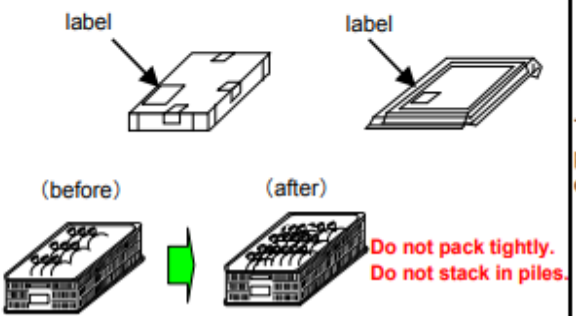
Subjecting metal to extreme heat causes it to expand in addition to impacting its structure, electrical resistance, and magnetism. Thermal expansion is pretty self-explanatory. Metals expand when subjected to specific temperatures, which vary depending on the metal. The actual structure of metal also changes with heat.

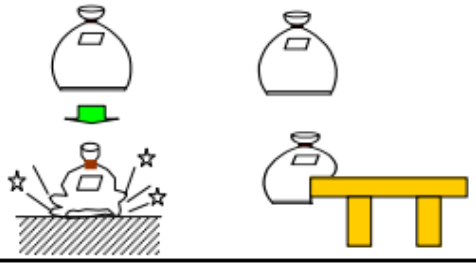
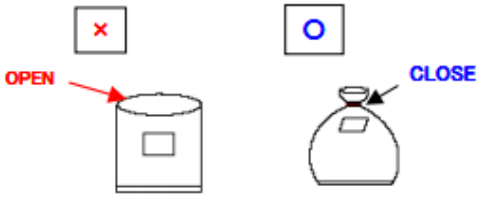
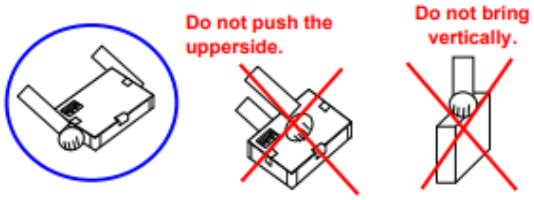
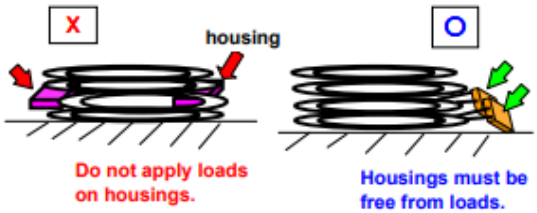
Heat also can impact the electrical resistance of metal. The hotter the metal gets, the more the electrons scatter, causing the metal to be more resistant to an electrical current. Metals heated to certain temperatures also can lose their magnetism.

3.3 Deformation

The real time temperature measurement coupled with analysis of loading history data allows us to carry out the study of energy balance in metals under deformation and failure. Two independent techniques for estimation of deformation and failure induced heat sources in loaded sample were proposed. The techniques are based on temperature data treatment and original heat flow detector. It is now well known that the real materials have a complex structure which can be considered as a hierarchy of the different scale levels. Structural changes occur in all scale levels and lead to irreversible deformation and failure of the material. The development of the irreversible deformation is accompanied by the processes of energy dissipation and storage and, as a result, leads to the changing of material temperature (self-heating). From the thermodynamically point of view we can conclude that the expended mechanical energy is converted into thermal energy generated by movement and annihilation of the defects and stored energy accumulated in the elastic fields of the defects. These process can be observed both in the whole sample volume (under quasi-static loading) and locally (in crack tip under crack propagation).

Table of Handling and storage instructions

<table>
<tr><th>Control Process</th><th>Illustration</th><th>Influence on Quality</th></tr>
<tr><td>1)
Please store plastic and carton cases with containing housing at room temperature avoiding moisture and direct sunlight.
2)
Please equalize housing temperature with room temperature.</td><td> 
</td><td>1) There are risks of breakage and discoloration due to housing material degradation.
2)
There are risks of damage on lance, hinge and broken on lock or other problems.</td></tr>
<tr><td>1)
Please turn up a label of packages during storage.</td><td rowspan="2"> 
</td><td rowspan="2">There are risks of not correct position of child parts, deformation or other problems.</td></tr>
<tr><td>2)
Please do not apply pressure to housings in bag packages during storage.
Please do not replace plastic cases and carton boxes with storage boxes.</td></tr>
</table>

When bringing housings, please pay attention in order not to give damage or shocks to the products.		There are risks of deformation, breakage, not correct position of child parts or loss of parts.
Please put the cover or close the bag to prevent from dust.		There is a risk of contact defect due to adherence of dust. Also there is a possibility to cause sealing defect.
When carring housings, please hold the underside of the container with both hands. Do not put the box vertically and not push the upperside of the box.		There are risk of deformation,damage or loss of parts.
Please store your products by the method of not applying loads on housings.		There are risks of deformation due to the pressure of the weight and risks of breakage due to the shock.

(By A. Iziumova, A. Vshivkov, A. Prokhorov, A. Kostina and O. Plekhov)

L O 7.2: Clean and lubricate machine

- **Content /Topic 1 Cleaning medium and tools**

1.1. Soft brushes

The brushes therefore are very functional in cleaning small hand tools such as wrenches, pliers, hammers, etc., large hand tools such as shovels, scoops, pry bars, etc., and equipment such as vehicles, hydraulic hoses, and air bottles. Additionally, they might be useful in cleaning durable and hard-wearing fabric surfaces such as tents, heavy canvas

Figure 67.Soft brushes

1.2 Soap solution

There are some great solutions for cleaning metal using common household products as well as cleaning products

- **Stainless steel and chrome**

For a proper clean of stainless steel, removing soap scum, food residue, grease and water marks, you'll need a specialised stainless steel cleaning product. Something like cif stainless steel is ideal

- **Aluminium**

Because baking soda is likely to spoil aluminium, it's best avoided here. In fact, it is far safer in all cases to opt for simple soapy water, or a special aluminium cleaner. If you'd really prefer to try a homemade solution, mix and apply a solution containing white vinegar and cream of tartar for sparkling results.

- **Copper and brass**

There are commercial copper cleaners around, but other options may also yield results. Try applying ketchup gently with a cloth! Another trick is to halve a lemon and sprinkle it with coarse ground salt. Gently scrub the copper to restore its natural sheen. Rinse, and then rub gently with a soft cotton cloth.

1.3 Solvent

Solvent Action - This property enables the cleaner to dissolve the oils present on the metal surface. Dissolves grease, hoping that the soil will then drop away. Often solvents are combined with true washing agents for better over all work. Solvent Wiping - The material used is usually a petroleum or chlorinated solvent applied by some absorbent material, usually a rag. Oil is removed by the action of the solvent while the soils are removed, or at least reduced by the rubbing action. The rags and solvent quickly become dirty and must be replaced frequently. This makes a solvent wiping expensive. Another drawback to solvent wiping is that it does not lend itself to automation. Many solvents used are flammable, hence a fire hazard; whereas nonflammable solvents are generally a health and environmental hazard.

1.4 Clothes

Figure 68.Clothes

The formation of rust or tarnish on metals after being treated with Miracle Polishing Cloth is considerably retarded, as the protective chemicals and waxes in the cloth penetrate into the pores of the metal and leave a wax coating, thereby causing the polished surface to retain its luster for a much longer period of time. Removes scuff marks from floors Removes bad corrosion from metals Removes alcohol, water, ink and heat stains from furniture, etc. Removes surface scratches from furniture, enamel, and silver Removes burn marks from electrical appliance, porcelain stoves, etc. Removes paint spots from metal, glass, porcelain, tile, and varnished surfaces Removes rust stains from bathtubs, wash bowls, bumpers, trim, wheels, and hub caps. Cleans, polishes and protects all motorcycle metals, aluminum, chrome, magnesium, stainless steel, nickel, brass, silver, removes rust from chrome, oxidation and pitting from aluminum parts and boot leather burn from exhaust pipes. Polishes without scratching any ferrous or non-ferrous metal, any precision metal product, any die mold or machinery, also removes rust and discoloration and perfect for removing heat caused blueing. Removes road film from glass and metals. Polishes all metal and wooden instruments, accordions and cymbals. Removes rosin stains from violins. Cleans lacquered instruments without harm. Polishes and waxes the wood and enamel parts, and removes rust and corrosion from the metal of golf clubs, fishing tackle, boats, guns, and outboard motors.
The Basics of Alkaline In-Process Cleaning for Metal Substrates by John Sparks Oakite

- **Content /Topic 2 Types of cleaning**

2.1. Air pressure cleaning

Figure 69.Air pressure cleaning

Compressed air is extremely forceful. Depending on its pressure, compressed air can dislodge particles. These particles are a danger since they can enter your eyes or abrade the skin. The possible damage would depend on the size, weight, shape, composition, and speed of the particles. The pressure used to remove the particles from machines and surfaces is also strong enough to blow the filings, shavings, chips and particles of metal into the eyes, ears or skin of people. Compressed air can enter the body where the skin is not present (i.e., ear, nose, rectum or any scratch or puncture in the skin, however small) and can cause damage. There have also been reports of hearing damage caused by the pressure of compressed air and by its sound.

Use effective guarding methods that prevent a chip or particle (of any size) from being blown into the eyes or unbroken skin of the operator or other workers nearby. You may also use barriers, baffles, or screens to protect other workers near the operator if there is a risk of exposure.
Compressed air used for cleaning in the workplace can be very dangerous if the necessary precautions are not taken. conditions. In the workplace, pressure to air guns can range from 55 to 160 psi.

There are different types of pressure cleaners available and the choice will always be a compromise between various advantages and disadvantages.

Pressure cleaners exist in many varieties and trademarks and for specific details it will be necessary to obtain information from manufacturers, instruction handbooks, etc.

Electric installations and water taps will be necessary. Application of detergent may require the installation of compressed air (air compressors).

Pressure cleaners may give pressures from 4–180 bar and it will be possible to change the pressure between these values according to cleaning purposes.

The pressure cleaner systems will either be:

- ✓ High pressure-low volume system or
- ✓ Low pressure-high volume system

High pressure-low volume systems are economic in use concerning water consumption but have several disadvantages concerning the maintenance of buildings, machines and equipment. When using high pressure for prerinsing and rinsing, the pressure may cause spreading of soil in the whole area, even under the roof construction.

Rinsing with high pressure will cause aerosols. Aerosols are small droplets of water that may contain chemicals and microorganisms which may lead to irritation of the respiratory tract. High pressure cannot be recommended for application of detergents and disinfectants because of these aerosols. If used for application of chemicals the pressure must not exceed 5 bar. Aerosols may also cause problems when penetrating coverings of electric installations.

High pressure can damage the wall and floor surfaces of the buildings, the equipment and machines. For example, high pressure used wrongly on tiled walls may loosen the tiles.

The advantages of using high pressure are the short time and low water consumption for rinsing purposes and removal of most soil types. It will be very time-consuming if used for prerinsing because of the low water consumption. Water hosing may then be used for prerinsing.

Low pressure-high volume systems are costly in use because of large water consumption.

Cleaning systems working with low pressure (30 bar) and low volume (18–20 1/min) have been developed. The low volume is increased a little compared to the high pressure-low volume system but overall this kind of cleaning system may save water because the system can be used for both prerinsing and rinsing.

When using pressure cleaners, the cleaning results will depend on:

- ✓ Water pressure and spreading angle
- ✓ Water amount
- ✓ Detergent
- ✓ Water temperature
- ✓ Time and efficiency

2.3 Cleaning with cloth rugs

The all Metal Shine polishing cloth is a great one of kind cloth for many non-precious metals. This 100% cotton flannel cloth is specially treated for the care, cleaning, and polishing of soft metal surfaces that are not coated or lacquered.

Rugs need to be vacuumed regularly and spot-cleaned when there is a stain. However, once a year, they should be deep-cleaned. Always consult your rug's care label to see if it should be dry-cleaned, hand-washed, or only spot-cleaned.

If your rug is small enough, it can be thrown in your washing machine. Use a cold setting on a delicate cycle, and let it air-dry.

However, if your rug is too big for the machine, you can deep-clean it by hand. We recommend doing this on a sunny day because you will need to bring it outside to wash and dry it.(3/x6557e/X6557E06.htm, n.d.)(/compressed_air.html, n.d.)

- **Content /Topic3.Lubrication system**

3.1. Oil re-circulation

Oil Recirculation Systems are not only used to pump oil to bearings or gears to lubricate them but also to purge them of wear debris and, if necessary, to remove heat introduced into the oil by power losses due to friction. Cooling has a multi-purpose range of small oil systems. However, the majority of recirculating oil systems are nearly always custom designed to suit the application. Reservoir, pumps, filters, oil coolers, reservoir heating, pressure control and instrumentation are selected depending on the duty and the viscosity of the lubricant required to be pumped. These can be fitted in our works on top of the oil reservoir or on a separate skid to form a compact unit but also, for larger systems, as individual items of equipment which are mounted on site and piped up to the plant being served.

oil re-circulating lubrication system is the precise regulation and exact monitoring of the lubricant supply to each lubrication point. Oil re-circulation involves a continuous oil flow to the lubrication points. This oil is controlled both in quantity and temperature, it is collected by drains piping and returned to a supply tank. The oil is therefore "re-circulated" back to the point. When the oil flows through the lubrication point it does not only act as a lubrication agent but also removes a large amount of heat from the bearing or lubrication area. The oil is the transported away and back to the lubrication tank.

Oil re-circulation is used extensively in the power industry and pulp and paper industry allowing for increases in operating speed and performance thanks to the fast change-over of lubricant that removes heat and provides full-oil immersion lubrication.

3.2. Air/Oil lubrication

Air/Oil lubrication use compressed air to transport oil lubricant to a bearing or spray. In oil and air lubrication systems, a volumetrically metered quantity of oil is pulled apart by a continuous air flow in a tube. It is carried along the tube wall in the direction of compressed-air flow. The quantity of oil is fed into the air flow in pulses at a mixing point (mixing valve). A nearly continuous flow of oil is produced that leaves the outlet nozzle as fine drops and is fed to the rolling bearing without contact. This means that

the bearing housing is under a slight overpressure, which keeps dirt away from the sensitive bearings. The air stream simultaneously cools the bearing and provides a positive pressure in the bearing housing to prevent contamination from entering the bearing housing.

3.3. Grease lubrication

Grease cleanliness is to safeguard the longevity of the lubricated parts or systems, because the lubricant film which separates the contacting surfaces - whether rolling or sliding - is usually very thin (less than 1m up to 10m). It is clear that the presence of any particles whose size is larger than the film thickness can be detrimental to the smooth running and service life of the bearing.

The shape and hardness of these particles must also be considered. The film thickness is affected by the viscosity of the base oil; the nature, microstructure and particle size of the thickener; as well as the presence of solid lubricants.

Historically, the analysis of grease has been confined to new grease testing for product acceptance and quality control. Because the majority of bearings are lubricated with grease, it would serve us to understand more about grease testing and, for the purpose of this article, solid contaminant level testing in industrial grease products

3.4 Re-circulating pump

When cleaning draft lines, the most effective way to do it is to use this recirculating line cleaning pump. Simply put, it is substantially easier to do, and much more effective, than cleaning it with a hand pump. This pump will work with any draft system up to 300 feet long.

This draft line cleaning kit creates a flow throughout beverage lines, circulating the cleaning chemical. This is a much more thorough clean than simply soaking the lines in the cleaning solution.

With a hard-coat finish on pump components and stainless-steel case, this line cleaning pump is built for long-term use. It's both durable and resistant to corrosion created by the cleaning chemicals. Its temperature-resistant hose is built to remain flexible, even in very cold conditions.

Cleaning your commercial draft tap system is a regular necessity for any bar to stay competitive. Clean lines are good business. In using this draft line cleaning pump, the beverages that you serve will be cleaner and therefore, taste better.(Machinery lubrication)

(/35977_SYS_Oil-Recirculation-Systems_DS.pdf, n.d.)

L O 7.3: Clean tools, materials and equipment

- **Content /Topic 1 Cleaning medium and tools**

1.2. Soft brushes

There is a lot more to brushes than meets the eye. There are dozens of different types of brushes, each type has a specific use, and there are different bristles for every type of job.

Example soft brush:

- **Duster**

For use on all surfaces to remove dust particles and boost visual appeal

Figure 70.duster soft brush

- **Grout Brush**

For use on tile floors to clear heavy dirt and grime from between tiles

Figure 71.grout brush

- **Push Broom**

For clearing floors of dirt and dust before scrubbing and mopping

Figure 72.push brush

1.3. Soap solution

Making your own cleaning solutions can save money, reduce your exposure to excessive chemicals, and give you a sense of self-reliance if you can't get to a store for your usual favorite cleaner.

We've put together five cleaning solutions to help you with house cleaning and some tips on how to use pantry items in ways you never thought possible to make your house sparkle
Follow these general tips for the best results:

- ✓ Mix cleaning solutions in small batches. Since there are no preservatives added, mixing too much at once can cause the cleaner to lose potency.
- ✓ Add your favorite essential oil to give a fresh scent.
- ✓ Label every bottle including the ingredients. This is particularly important if you reuse spray bottles or something that could be mistaken as a food container.
- ✓ Store homemade cleaning solutions safely away from children, pets, and vulnerable adults.

1.4. Solvent

Solvent cleaning is a cleansing process that uses chemical solutions to remove unwanted grease, oil, residue, coatings or paint from the surface of a material. There is more than one type of solvent, and each individual type may be better suited than another is to clean a specific type of base material. Solvent cleaning is generally the first surface preparation method applied to the parts. Solvent cleaning removes release agents, such as silicone that may coat the part during molding, and any machine oil transferred to the part. Abrading surfaces coated with oil or grease drives the contaminants further into the parts, and chemical alteration of the surface is ineffective in the presence of contaminants.

1.5. Broom

Brooms and Brushes Brooms are available in different widths and with different bristle types. Soft bristle brooms are usually better on indoor hard floors and hard bristles better on outdoor areas. The wider the broom, the larger the area that can be swept in one pass.

Figure 73.Broom

1.5 Mops

Always choose the right type of mop for the task you will be doing. There are cotton mops, cotton/polyester blends, sponge mops, dust mops and microfiber mops. Cotton and cotton polyester blends come in different weights. Female staff may use a lighter one than a male. Cotton mops are used for mopping as they are more absorbent and cotton/polyester ones are used for applying polishes to hard floor because they are lint free and so do not leave particles. Microfibre mops do not require the use of any chemicals. Sponge mops are not recommended for commercial heavy cleaning as they disintegrate quickly.(Corey M. Mackenzie, July 21, 2017)

- **Content /Topic 2 Types of cleaning**

2.1 Air pressure cleaning

It can remove dirt, grease and oil quickly from engines and machinery. Besides it can also be used for blowing dust, painting and other suitable works.

2.2. Cleaning with cloth rugs

Cleaning common user tools

- ✓ Dampen an old cloth in linseed oil. Wipe the dampened cloth over the tool, to thoroughly coat the metal with the oil
- ✓ Allow the linseed oil to soak into the metal for 10 minutes. Use a stainless steel brush to scrape off rust and dirt from the tool.
- ✓ Apply a couple of drops of liquid dish detergent to a clean cloth. Dampen the cloth with water, to create suds
- ✓ Clean the tool with the soapy cloth, to rinse off the linseed oil and remove remaining dirt. Rinse the tool with water, to remove the soapy solution(DOWLING)

L O 7.4: Store tools, materials and equipment

- **Content /Topic 1 Housekeeping basics**

1.1 Overall cleanliness

Cleanliness and Order. The type of operation will dictate the level and frequency of cleaning required. Many locations will only require cleaning once per day, but some manufacturing processes might require cleaning at the end of each shift, or possibly even periodically during the shift.

Enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt that is not otherwise hazardous. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.

Special-purpose vacuums are useful for removing hazardous products. For example, vacuum cleaners fitted with HEPA (high efficiency particulate air) filters may be used to capture fine particles of asbestos or fibre glass.

Dampening (wetting) floors or using sweeping compounds before sweeping reduces the amount of airborne dust. The dust and grime that collect in places like shelves, piping, conduits, light fixtures, reflectors, windows, cupboards and lockers may require manual cleaning.

Compressed air should not be used for removing dust, dirt or chips from equipment or work surfaces.

1.2 Adequate space and proper layout

Good industrial engineering not only facilitates the movement of raw materials, in-process goods, and finished product but also concentrates the hazards associated with specific aspects of the product process in a single area. For example, in a woodworking facility, all handling of flammable liquids and associated cleaning materials are in one area of the plant. Wiping rags can be concentrated and stored in the

appropriately listed waste material storage container (Figure 1). Doing so does not negate the importance of periodic removal of such waste material but does limit the exposure to these materials.

Figure 74.storage container

1.3 Correct storage and materials handling

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual material handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one metre (or about three feet) of clear space under sprinkler heads.

Stacking cartons and drums on a firm foundation and cross tying them, where necessary, reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction.(house.html, n.d.)http://global-(BASIC REQUIREMENTS FOR GOOD HOUSEKEEPING, 2002)

LO 7.5: clean the workplace

- **Content /Topic 1Cleaning medium and tools**

Cleaning is the removal of all visible soil and ships especial in workshop an approved way with the use of mechanical and chemical action or both, so that all areas are cleaned and sanitised to a high standard.

1.1. Soft brushes

Figure 75.Soft brushes

Wire Brushes is Great for cleaning tools, files, small engine parts and copper tubing, flaking paint, rust, dirt and scale, Rust removal, Surface cleaning, Burnishing, Finishing, Polishing, Deburring, Material removal. the wires brush is primarily an abrasive implement, used for cleaning rust and removing paint
Brass brush is great for cleaning, household and industrial, metal rust removal polishing and cleaning, laboratory instruments, fine metal finishing work, to removal paint and weld spatter on all types of metal parts or surfaces. It gets the dirt, grime, rust off, no problem!

Application

- ✓ Rust removal
- ✓ Clean dirt
- ✓ Metal parts rust removal polishing and cleaning

1.2. Soap solution

Soaps often contain colouring matter and perfume and act by emulsifying grease and lowering the surface tension of water, so that it more readily penetrates open materials such as textiles.the soap needs to cure for four to six weeks. During this time the water used in the recipe evaporates. Cured soap has a firmer texture and lasts longer in the shower. While curing, soap should be stored in a cool, dry and well ventilated space. If the moisture cannot escape while curing, the chance for dreaded orange spots increases
Stainless steel is easy to clean. Washing with soap or mild detergent and warm water followed by a clear water rinse is usually quite adequate for domestic and architectural equipment.

Method for cleaning stainless steel

	*CLEANING AGENT**	*METHOD OF APPLICATION***	*EFFECT ON FINISH*
Routine Cleaning	Soap, ammo-nia, or deter-gent and water	Sponge with cloth, then rinse with clear water and wipe dry.	Satisfactory for use on all finishes.

1.3. 1Solvent

Solvents are contained within many detergents in small quantities for general cleaning. Used individually, solvents are one of the most dangerous categories of chemicals that may be used for specific cleaning purposes.

1.4. Broom

Broom remove dust and fine dirt particles with soft, lightly crimped and flagged filament. It's provide an excellent all around tool for smooth and medium surfaces. Brooms can be used indoors and outdoors

Figure 76.Broom

Types of broom

- ✓ Hard stiff bristles: The sweeping broom with hard stiff bristles is used to clean areas with large, heavy, dry and wet debris and is the perfect choice for Outdoor cleaning.
- ✓ Medium stiff bristles: Brooms with medium bristles can be used wet and dry for sweeping medium sized debris and are recommended for use indoors on all type of surfaces.
- ✓ Soft bristles: Soft bristles are the perfect choice to remove fine dirt and dust and recommended to be used dry.

1.5. Mops

Always choose the right type of mop for the task you will be doing. There are cotton mops, cotton/polyester blends, sponge mops, dust mops and microfiber mops. Cotton and cotton polyester blends come in different weights. Female staff may use a lighter one than a male. Cotton mops are used for mopping as they are more absorbent and cotton/polyester ones are used for applying polishes to hard floor because they are lint free and so do not leave particles. Microfiber mops do not require the use of any chemicals. Sponge mops are not recommended for commercial heavy cleaning as they disintegrate quickly.

Figure 77.Mops

1.3. Clothes

There are different variety of cloths which are used in the housekeeping department for performing various cleaning activities like wet and dry cleaning by the housekeeping staff.

These are all-purpose cloths made of soft, absorbent material. They are used for wet cleaning and damp dusting of all surfaces above floor level. They can be also used for cleaning sanitary fittings such as bathtubs and wash basins.

Wipes include loosely woven or knitted cotton cloths and non-woven cloths. Synthetic sponges may also be grouped under this category. They are available in various sizes and shapes. Sponges are better than cloths for washing walls, woodwork, glass and upholstery.

Figure 78.Wipes cloth

These are meant for dusting and buffing. Soft, absorbent plain or checked cotton material or yellow flannelette of up to 15 sq. Cm is ideal for dusters. When used for damp dusting, they must be sprayed with a fine mist of water or dusting solution.

Figure 79.dusting cloth

These Cloths may be impregnated and coated with a mineral oil. These dusters must be folded several times into a hand-sized pad before use so as to provide a number of clean surfaces and avoid spreading dirt again to a clean surface.

Figure 80.Cloth Mittens

- **Content /Topic 2 Types of cleaning**

2.1 Air pressure cleaning

Compressed air used for cleaning in the workplace can be very dangerous if the necessary precautions are not taken. In the workplace, pressure to air guns can range from 55 to 160 psi.

Safe work practice

- ✓ Ensure all hoses and components are appropriately rated to handle the supplied pressure from the compressor. ALWAYS use the lowest pressure that will do the job.
- ✓ ALWAYS wear goggles or a face shield over safety glasses to protect the eyes.
- ✓ Use a noise reducing air gun and wear hearing protection when peak noise levels are greater
- ✓ wear the appropriate gloves to protect your hands.
- ✓ never use compressed air to clean your clothes or body.
- ✓ never tamper with air guns to modify them in any way.
- ✓ never point an air gun or direct air towards another individual or your skin.

2.2 Cleaning with cloth rugs

Metals are an indistinguishable part of our lives, and their different properties. From jewellery and cutlery to entire surfaces. Yet, without cleaning metals properly they lose their shine and beauty.

Examples clean metal by cloth

- ➢ **Cleaning Stainless Steel**

Stainless steel was first used in hospitals because it's easy to maintain and clean and is also a durable metal. Pure practicality. It's no surprise it made its way inside our homes as well. Stainless, however, doesn't mean this metal is impervious. If filth is left long enough on it, it can eat through the protective layer of chromium oxide and damage the metal.

- ➢ **Cleaning Aluminium**

Aluminium is a very common metal and it makes sense that it's very commonly used in our households. From appliances to utensils and cutlery the list is almost endless. The reason aluminium **grows dull** with time is **oxidation**. The aluminium oxide patina actually protects the metal and it isn't harmful to us. Clean shiny aluminium is pleasant to the eye, so here's how to keep it that way without harming it.

- ➢ **Cleaning Copper**

Now use a soft cloth to scrub the paste away and remember to go with the grain of the copper if possible. You can also use a soft-bristled toothbrush to do this. Once that's done rinse it thoroughly with water, buff it with a fresh soft cloth, and enjoy the fruits of your labour as the copper shines. Mind that copper hates water and stains easily from it, so make sure it's completely dried off before storing it each time

- ➢ **Cleaning Brass**

Brass is very similar to copper when it comes to cleaning so giving it a bath in the sink will do the trick. Use soft cloths and always remember to dry it off as quickly and as thoroughly as possible. Stop here if your items aren't pure bras.(Wayne Crosbie,Alan Hickman, 8 August 1967.)

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