FITTER

TRADE THEORY

NSQF LEVEL - 4.5

HANDBOOK FOR CRAFTS INSTRUCTOR TRAINING SCHEME

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Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

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A Comprehensive Training Program
under Crafts Instructor Training Scheme (CITS)
for Instructors

HANDBOOK ON TECHNICAL INSTRUCTOR TRAINING MODULES

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सत्यमेव जयते

भारत सरकार
कौशल विकास एवं उद्यमिता मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
AND ENTREPRENEURSHIP

Foreword

In today's rapidly evolving world, the role of skilled craftsmen and women is more crucial than ever. The Craft Instructor Training Scheme (CITS) stands at the forefront of this transformation, shaping the educators who will train the next generation of artisans and technicians. This book aims to provide an in-depth understanding of the subject, exploring its significance, methodologies, and impact on vocational training.

The Craft Instructor Training Scheme was established with the objective of enhancing the quality of instruction in industrial training institutes and other vocational training institutions. By equipping instructors with advanced skills and knowledge, the scheme ensures that they are well-prepared to impart high-quality training to their students. This, in turn, contributes to the creation of a highly skilled workforce capable of meeting the demands of modern industry.

The initial chapters provide the importance of specialized instructor training. Following this, detailed chapters delve into the curriculum covering advanced techniques, safety protocols, and instructional strategies. Each section is designed to offer both theoretical insights and practical applications, ensuring a well-rounded understanding of the subject.

The book offers recommendations for overcoming obstacles and enhancing the effectiveness of the program, with the ultimate goal of producing highly skilled instructors capable of shaping the future workforce.

This book is intended for a diverse audience, including current and aspiring instructors, vocational training administrators, policymakers, and industry stakeholders. It serves as a valuable resource for understanding the intricacies of the subject and its pivotal role in vocational education.

I extend my heartfelt gratitude to all contributors who have shared their experiences and expertise, enriching this book with their valuable insights. Special thanks to the contribution of the development team, reviewers and NIMI that have supported this endeavor, providing essential data and resources.

It is my sincere hope that this book will inspire and guide readers in their efforts to enhance vocational training, ultimately contributing to the development of a skilled and competent workforce.

ATUL KUMAR TIWARI, I.A.S.
Secretary, MSDE

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त्रिशलजीत सेठी
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GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

FOREWORD

The Craftsmen Training Scheme (CTS) implemented by the Directorate General of Training (DGT) provides skill training to the youth and ensures a steady flow of skilled manpower for the industry. It aims to raise quantitatively and qualitatively the industrial production by systematic training, and to reduce unemployment among the youth by providing them with employable skills.

The Craft Instructor Training Scheme (CITS) is an indispensable part of the Craftsmen Training Scheme (CTS). It offers comprehensive training both in 'skills' and in 'training methodology' to the instructor trainees to make them conversant with techniques of transferring hands-on skills.

I congratulate NIMI for taking the initiative of preparation of the course content for CITS. This will help institutionalize the mechanism for imparting training to the trainers all across the ecosystem. I also extend my gratitude to the Instructors and Officials of National Skill Training Institutes (NSTIs) and the DGT for their invaluable contribution in preparation of the CITS course content.

As we navigate the complexities of a rapidly changing world and the technological disruptions, the significance of CTS and CITS has increased manifold. It not only empowers individuals with practical skills but also lays the foundation for a prosperous future. I am confident that this book will serve as a guiding light to all instructor trainees for skill development and nation-building.

Trishaljit

(Trishaljit Sethi)

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PREFACE

The Craft Instructor Training Scheme is an indispensable module of the Craftsmen Training Scheme, which has been an integral part of the Indian skill development industry since its inception. This program aims to equip instructors with the necessary skills and teaching methodology to effectively transfer hands-on skills to trainees and promote a holistic learning experience. The first Craft Instructor Training Institute was established in 1948, followed by six more institutes across India in 1960. Today, these institutes, including the National Skill Training Institute (formerly Central Training Institute for Instructors), offer the CITS course, which is mandated by the Directorate General of Training (DGT).

The Craft Instructor training program is designed to develop skilled manpower for industries. The course aims to offer instructors an opportunity to improve their instructional skills, engage learners effectively, offer impactful mentoring, and make efficient use of resources, leading to a more skilled workforce in various industries. The program emphasizes collaborative and innovative approaches to teaching, resulting in high-quality course delivery. Overall, the Craft Instructor Training Scheme is a pivotal program that helps instructors grow in their careers and make a significant contribution to society. This program is essential for developing skilled manpower and promoting a robust learning environment that benefits both trainees and instructors alike.

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National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following experts to bring out this Instructional material **(Trade Theory)** for **CITS Fitter (NSQF Level - 4.5)** under the **CG&M** Sector for **Instructors**.

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NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

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NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

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ABOUT THE TEXT BOOK

The Vocational Instructor Training Program is a comprehensive initiative designed to equip aspiring students with the necessary skills and knowledge to effectively teach in vocational education settings. This program encompasses a range of pedagogical strategies, instructional techniques, and subject-specific content tailored to the diverse vocational fields. Participants engage in coursework that covers curriculum development, assessment methods, classroom management, and the integration of industry-relevant technologies. Practical experience and hands-on training are emphasized, allowing participants to apply theoretical concepts in real-world teaching environments. Through collaborative learning experiences and mentorship opportunities, aspiring vocational instructors develop the confidence and competence to facilitate engaging and impactful learning experiences for their students. This training program aims to cultivate a new generation of educators who are not only proficient in their respective vocational fields but also adept at fostering the success and employability of their students in today's competitive workforce.

This text book covers communication, self-management, information and communication technology, entrepreneurial and green skills. It has been developed as per the learning outcome-based curriculum.

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CONTENT

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LESSON 1 : First-Aid & Safety Precautions

Objectives

At the end of this lesson you shall be able to

- explain the importance of first Aid
- state the importance of safety and safety precaution follow in workshop
- explain the basic life saving techniques and CPR process.

First-Aid

First aid is defined as the immediate care and support given to an acutely injured or ill person, primarily to save life, prevent further deterioration or injury, plan to shift the victims to safer places, provide best possible comfort and finally help them to reach the medical centre/ hospital through all available means. It is an immediate life-saving procedure using all resources available within reach.

Imparting knowledge and skill through institutional teaching at younger age group in schools, colleges, entry point at industry level is now given much importance. Inculcating such habits at early age, helps to build good healthcare habits among people.

First aid procedure often consists of simple and basic life saving techniques that an individual performs with proper training and knowledge. The key aims of first aid can be summarized in three key points:

- Preserve life: If the patient was breathing, a first aider would normally place them in the recovery position, with the patient leant over on their side, which also has the effect of clearing the tongue from the pharynx. It also avoids a common cause of death in unconscious patients, which is choking on regurgitated stomach contents. The airway can also become blocked through a foreign object becoming lodged in the pharynx or larynx, commonly called choking. The first aider will be taught to deal with this through a combination of ‘back slaps’ and ‘abdominal thrusts’. Once the airway has been opened, the first aider would assess to see if the patient is breathing.
- Prevent further harm: Also sometimes called prevent the condition from worsening, or danger of further injury, this covers both external factors, such as moving a patient away from any cause of harm, and applying first aid techniques to prevent worsening of the condition, such as applying pressure to stop a bleed becoming dangerous.

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- Promote recovery: First aid also involves trying to start the recovery process from the illness or injury, and in some cases might involve completing a treatment, such as in the case of applying a plaster to a small wound.

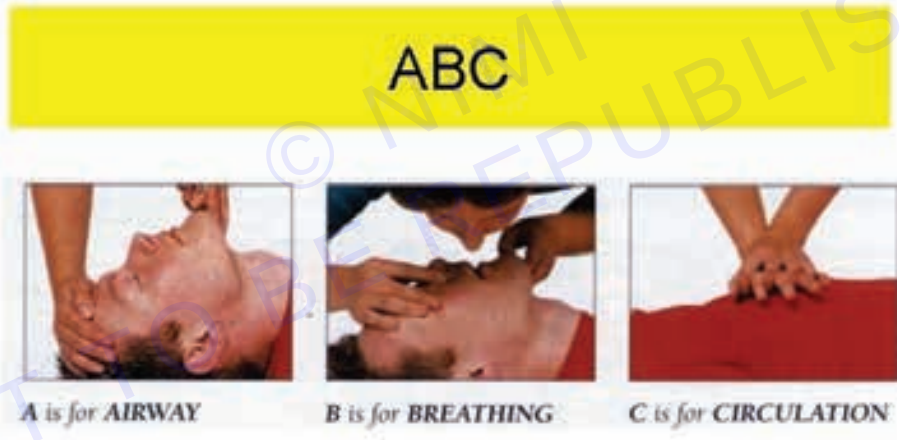
Training Basic principles, such as knowing to use an adhesive bandage or applying direct pressure on a bleed, are often acquired passively through life experiences. However, to provide effective, life-saving first aid interventions requires instruction and practical training. This is especially true where it relates to potentially fatal illnesses and injuries, such as those that require cardiopulmonary resuscitation (CPR); these procedures may be invasive, and carry a risk of further injury to the patient and the provider. As with any training, it is more useful if it occurs before an actual emergency, and in many countries, emergency ambulance dispatchers may give basic first aid instructions over the phone while the ambulance is on the way. Training is generally provided by attending a course, typically leading to certification. Due to regular changes in procedures and protocols, based on updated clinical knowledge, and to maintain skill, attendance at regular refresher courses or re-certification is often necessary. First aid training is often available through community organization such as the Red cross and St. John ambulance.

ABC of first aid

ABC stands for airway, breathing and circulation.

- Airway: Attention must first be brought to the airway to ensure it is clear. Obstruction (choking) is a life threatening emergency.
- Breathing: Breathing if stops, the victim may die soon. Hence means of providing support for breathing is an important next steps.

There are several methods practiced in first aid.



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- Circulation: Blood circulation is vital to keep person alive. The first aiders now trained to go straight to chest compressions through CPR methods.

When providing first aid one needs to follow some rule.

There are certain basic norms in teaching and training students in the approach and administration of first aid to sick and injured.

Not to get panic

Panic is one emotion that can make the situation worse. People often make mistake because they get panic. Panic clouds thinking and causes mistakes. First aider need calm and collective approach. If the first aider himself is in a state of fear and panic gross mistakes may result. It's far easier to help the suffering, when they know what they are doing, even if unprepared to encounter a situation.

Emotional approach and response always lead to wrong doing and may cloud one to do wrong procedures. Hence be calm and focus on the given institution. Quick and confident approach can lessen the effect of injury.

Call medical emergencies

If the situation demands, quickly call for medical assistance. Prompt approach may save the life.

Surroundings play vital role

Different surroundings require different approach. Hence first aider should study the surrounding carefully. In other words, one need to make sure that they are safe and are not in any danger as it would be of no help that the first aider himself get injured.

Do no harm

Most often over enthusiastically practiced first aid viz. administering water when the victim is unconscious, wiping clotted blood (which acts as plug to reduce bleeding), correcting fractures, mishandling injured parts etc., would leads to more complication. Patients often die due to wrong FIRST AID methods, who may otherwise easily survive. Do not move the injured person unless the situation demands. It is best to make him lie wherever he is because if the patient has back, head or neck injury, moving him would causes more harm.

This does not mean do nothing. It means to make sure that to do something the care givers feel confident through training would make matters safe. If the first aider is not confident of correct handling it is better not to intervene of do it. Hence moving a trauma victim, especially an unconscious one, need very careful assessment. Removals of an embedded objects (Like a knife, nail) from the wound may precipitate more harm (e.g. increased bleeding) Always it is better to call for help.

Reassurance

Reassure the victim by speaking encouragingly with him.

Stop the bleeding

If the victim is bleeding, try to stop the bleeding by applying pressure over the injured part.

Golden hours

India have best of technology made available in hospitals to treat devastating medical problem viz. head injury, multiple trauma, heart attack, strokes etc, but patients often do poorly because they don't gain access to that technology in time. The risk of dying from these conditions, is greatest in the first 30 minutes, often instantly. This period is referred to as Golden period. By the time the patient reach hospitals, they would have passed that critical period. First aid care come handy to save lives. It helps to get to the nearest emergency room as quickly as possible through safe handling and transportation. The shorter that time, the more likely the best treatment applied

Maintain the hygiene

Most importantly, first aider need to wash hands and dry before giving and first aid treatment to the patient or wear gloves in order to prevent infection

Cleaning and dressing

Always clean the wound thoroughly before applying the bandage lightly wash the wound with clean water.

Not to use local medications on cuts or open wounds

They are more irritating to tissue than it is helpful. Simple dry cleaning or with water and some kind of bandage are best.

- Stop bleeding: Control of bleeding is one of the most important things to save a trauma victim. Use direct pressure on a wound before trying any other method of managing bleeding.
- Treat shock: Shock, a loss of blood flow from the body, frequently follows physical and occasionally psychological trauma. A person in shock will frequently have ice cold skin, be agitated or have an altered mental status, and have pale colour to the skin around the face and lips. Untreated, shock can be fatal. Anyone who has suffered a severe injury or life-threatening situation is at risk for shock.
- Choking victim: Choking can cause death or permanent brain damage within minutes.
- Treat a burn: Treat first and second degree burns by immersing or flushing with cool water. Don't use creams, butter or other ointments, and do not pop blisters. Third degree burns should be covered with a damp cloth. Remove clothing and jewellery from the burn, but do not try to remove charred clothing that is stuck to burns.
- Treat a concussion: If the victim has suffered a blow to the head, look for signs of concussion. Common symptoms are: loss of consciousness following the injury, disorientation or memory impairment, vertigo, nausea, and lethargy.
- Treat a spinal injury victim: If a spinal injury is suspected, it is especially critical, not move the victim's head, neck or back unless they are in immediate danger.

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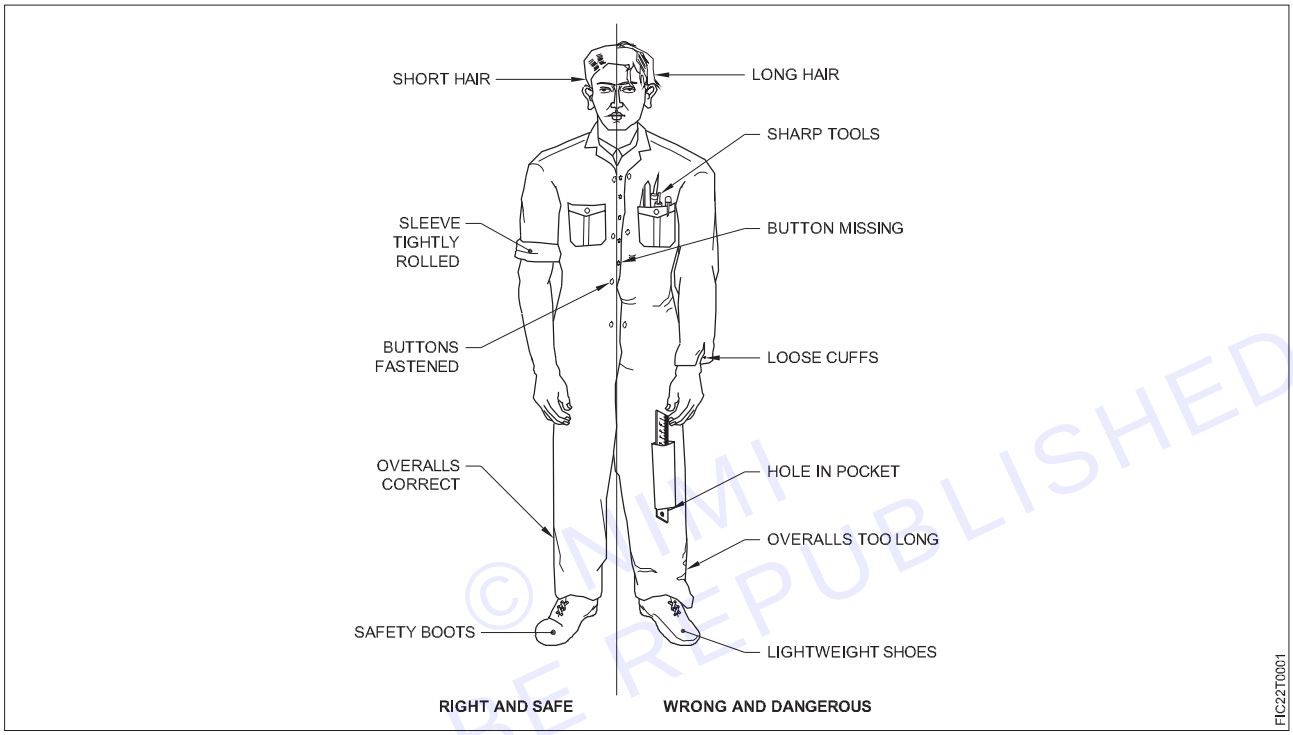
Introductions of Safety on Workshop

Generally, accidents do not happen; they are caused.

Most accidents are avoidable. A good craftsman, having a knowledge of various safety precautions, can avoid accidents to himself and to his fellow workers and protect the equipment from any damage. To achieve this, it is essential that every person should follow safety procedure.

Safety in a workshop can be broadly classified into 3 categories.

- General safety
- Personal safety
- Machine safety



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General safety

- Keep the floor and gangways clean and clear.
- Move with care in the workshop, do not run.
- Don't leave the machine which is in motion.
- Don't touch or handle any equipment/
- machine unless authorized to do so.
- Don't walk under suspended loads.
- Don't cut practical jokes while on work.
- Use the correct tools for the job.
- Keep the tools at their proper place.
- Wipe out split oil immediately.
- Replace worn out or damaged tools immediately.
- Never direct compressed air at yourself or at your co-worker.
- Ensure adequate light in the workshop.
- Clean the machine only when it is not in motion.
- Sweep away the metal cuttings.
- Know everything about the machine before you start it

Personal safety

- Wear a one piece overall or boiler suit.
- Keep the overall buttons fastened.
- Don't use ties and scarves.
- Roll up the sleeves tightly above the elbow.
- Wear safety shoes or boots Cut the hair short.
- Don't wear a ring, watch or chain.
- Never lean on the machine.
- Don't clean hands in the coolant fluid.
- Don't remove guards when the machine is in motion.
- Don't use cracked or chipped tools.
- Don't start the machine until
- the workpiece is securely mounted
- the feed machinery is in the neutral
- the work area is clear.
- Don't adjust clamps or holding devices while the machine is in motion.
- Never touch the electrical equipment with wet hands.
- Don't use any faulty electrical equipment.
- Ensure that electrical connections are made by an authorized electrician only.
- Concentrate on your work. Have a calm attitude.

Machine safety

- Switch off the machine immediately if something goes wrong.
- Keep the machine clean.
- Replace any worn out or damaged accessories, holding
- devices, nuts, bolts etc. as soon as possible.
- Do not attempt operating the machine until
- you know how to operate it properly.
- Do not adjust tool or the workpiece unless the power is off.
- Stop the machine before changing the speed.
- Disengage the automatic feeds before switching off.
- Check the oil level before starting the machine.
- Never start a machine unless all the safety guards are in position.
- Take measurements only after stopping the machine.
- Use wooden planks over the bed while loading and unloading heavy jobs.

Safety is a concept, understand it. Safety is a habit, cultivate it.

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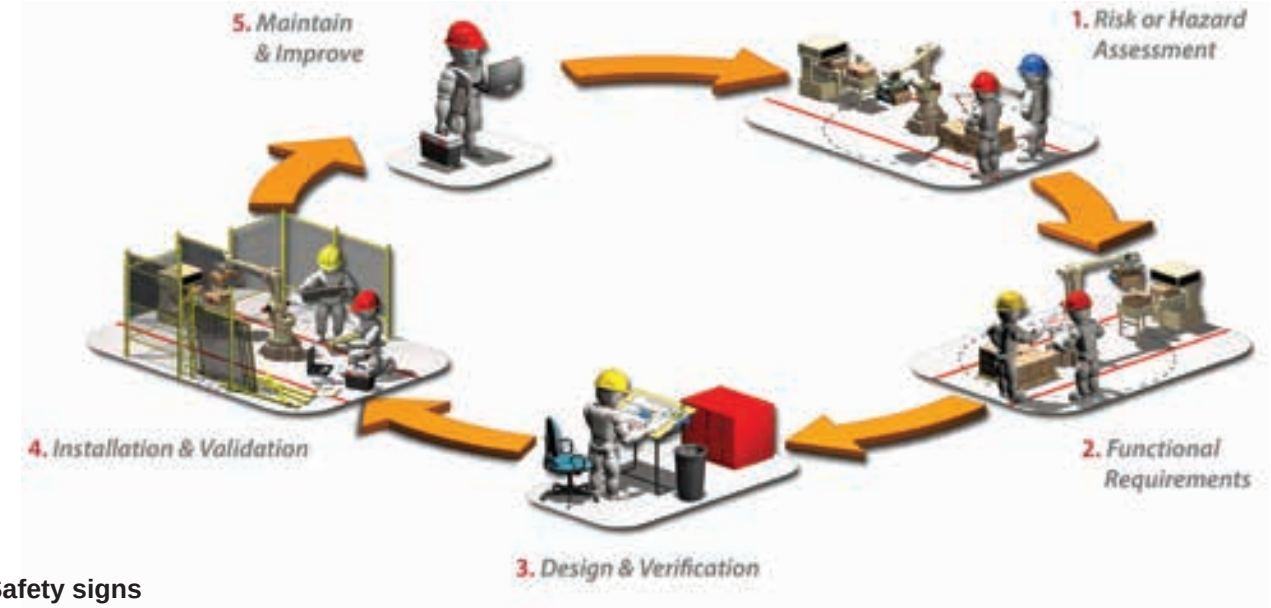


Safety signs

As you go about your work on a construction site you will see a variety of signs and notices. Some of these will be familiar to you - a 'no smoking' sign for example; others you may not have seen before. It is up to you to learn what they mean - and to take notice of them. They warn of the possible danger, and must not be ignored.

Safety signs fall into four separate categories. These can be recognized by their shape and colour. Sometimes they may be just a symbol; other signs may include letters or figures and provide extra information such as the clearance height of an obstacle or the safe working load of a crane.

The four basic categories of signs are as follows

- prohibition signs
- mandatory signs
- warning signs
- information signs

- **Prohibition Signs:**

Prohibition signs	SHAPE	Circular
	COLOUR	Red border and cross bar. Black symbol on white background
	MEANING	Shows it must not be done
	Example	Nosmoking

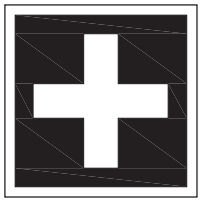
- **Mandatory Signs:**

Mandatory signs	SHAPE	Circular
	COLOUR	White symbol on blue background
	MEANING	Shows what must be done
	Example	Wear hand protection

- **Warning Signs:**

Warning signs	SHAPE	Triangular
	COLOUR	Yellow background with black border and symbol.
	MEANING	Warns of hazard or danger.
	Example	Caution, risk of electric shock.

- **Information Signs:**

Information signs	SHAPE	Square of oblong.
	COLOUR	White symbols on green background
	MEANING	Indicates or gives information of safety provision
	Example	First aid point.

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Basic life support technique

Basic first aid

Basic first aid refers to the initial process of assessing and addressing the needs of someone who has been injured or is in physiological distress due to choking, a heart attack, allergic reactions, drugs or other medical emergencies. Basic first aid allows one to quickly determine a person's physical condition and the correct course of treatment.

Definition of BLS (Basic Life Support)

CPR can be life sustaining. If one is trained in CPR and the person is suffering from choking or finds difficulty in breathing, immediately begin CPR. However, if one is not trained in CPR, do not attempt as you can cause further injury. Bur some people do it wrong. This is a difficult procedure to do in a crowded area. Also there are many studies to suggest that no survival advantage when bystanders deliver breaths to victims compared to when they only do chest compressions. Second, it is very difficult to carry right maneuver in wrong places. But CPR, if carefully done by highly skilled first aiders is a bridge that keeps vital organs oxygenated until medical team arrives.

Remember

A-B-Cs The ABCs of first aid refer to the three critical things the first aiders need to look for.

- Airway - Does the person have an unobstructed airway?
- Breathing - Is the person breathing?
- **Circulation -** Does the person show a pulse at major pulse points (wrist, carotid artery, groin)

CPR (Cardio-Pulmonary Resuscitation) can be life sustaining:

CPR can be life sustaining. If one is trained in CPR and the person is suffering from choking or finds difficulty in breathing, immediately begin CPR. However, if one is not trained in CPR, do not attempt as you can cause further injury. Bur some people do it wrong. This is a difficult procedure to do in a crowded area. Also there are many studies to suggest that no survival advantage when bystanders deliver breaths to victims compared to when they only do chest compressions. Second, it is very difficult to carry right maneuver in wrong places. But CPR, if carefully done by highly skilled first aiders is a bridge that keeps vital organs oxygenated until medical team arrives.

Place the person on their back and open their airway:

Place the person carefully on their back and kneel beside their chest. Tilt their head back slightly by lifting their chin.

Open their mouth and check for any obstruction, such as food or vomit. Remove any obstruction if it is loose. If it is not loose, trying to grasp it may push it farther into the airway.

Check for breathing

Place your ear next the person's mouth and listen for no more than 10 seconds. If you do not hear breathing, or you only hear occasional gasps, begin CPR.

If someone is unconscious but still breathing, do not perform CPR. Instead, if they do not seem to have a spinal injury, place them in the recovery position. Keep monitoring their breathing and perform CPR if they stop breathing.

Perform 30 chest compressions

Place one of your hands on top of the other and clasp them together. With the heel of the hands and straight elbows, push hard and fast in the centre of the chest, slightly below the nipples.

Push at least 2 inches deep. Compress their chest at a rate of least 100 times per minute. Let the chest rise fully between compressions. Perform two rescue breaths:

Making sure their mouth is clear, tilt their head back slightly and lift their chin. Pinch their nose shut, place your mouth fully over theirs, and blow to make their chest rise.

If their chest does not rise with the first breath, retilt their head. If their chest still does not rise with a second breath, the person might be choking.

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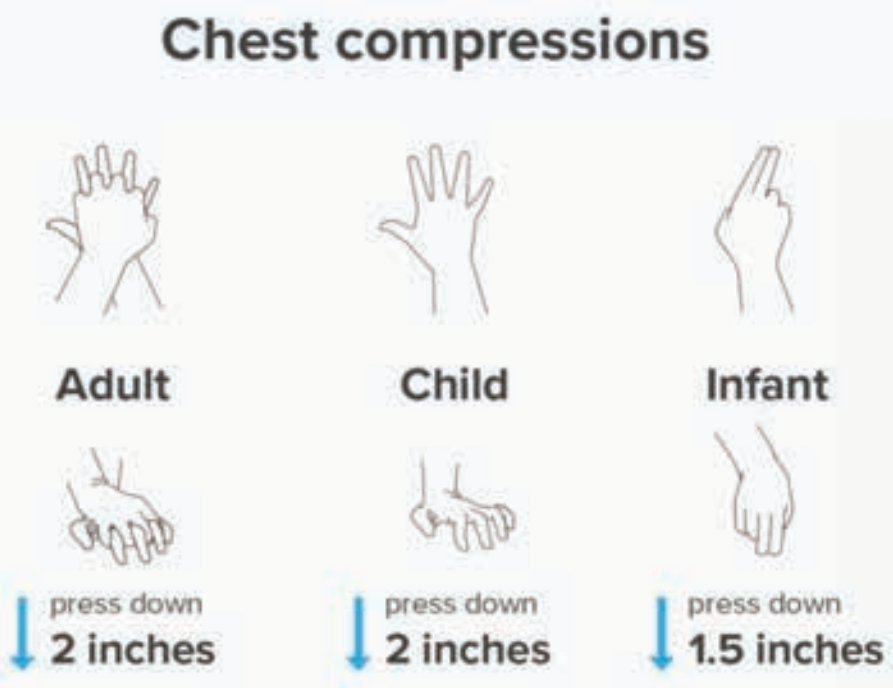

Perform 30 chest compressions at a rate of 100 per minute, letting the chest rise between each

Repeat

Repeat the cycle of 30 chest compressions and two rescue breaths until the person starts breathing or help arrives. If an AED arrives, carry on performing CPR until the machine is set up and ready to use.

When to use CPR and when not to

Use CPR when an adult is not breathing at all. For a child or infant, use CPR when they are not breathing normally. Always use CPR if the adult or child is not responding when you talk to them or tap them.

If someone is not breathing, giving CPR can ensure that oxygen-rich blood reaches the brain.

This is important, as without oxygen, someone can sustain permanent brain damage or die in under 8 minutes.

A person might need CPR if they stop breathing in any of the following circumstances

- a cardiac arrest or heart attack
- choking
- a road traffic accident
- near-drowning
- suffocation
- poisoning
- a drug or alcohol overdose
- smoke inhalation
- electrocution
- suspected sudden infant death syndrome

Only perform CPR if the adult is not breathing, or in children and infants, when they are not breathing normally, and their blood is not circulating. This is why it is important to ensure that the person does not respond to verbal or physical calls to attention before starting the CPR process

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Summary

CPR is a life-saving first aid procedure. It can significantly improve someone's changes of

surviving if they suffer a heart attack or stop breathing following an accident or trauma.

The steps vary depending on whether the person is an infant, child, or adult. However, the basic cycle of chest compressions and rescue breaths will remain the same.

Only use CPR when an adult has stopped breathing. Check the person to see whether they respond to verbal or physical stimuli before starting CPR.

Safety and precaution of basic life support

1 If upward pressure is applied on the chest, the middle bone may be break.

2 While giving artificial respiration, close the nose.

3 Check the patient's airway and give artificial respiration only if the airway is open.

4 Due to excessive air pressure while breathing, the lungs may burst or liquid may come out from the stomach.

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LESSON 2 : Fitter trade introduction & their responsibilities

Objectives

At the end of this lesson you shall be able to

- state the importance of fitter trade and their application
- state the roles and responsibilities of an instructor
- state the common tasks performed by fitters

Importants of fitter trade and their inormation

Introduction of fitter

The role of fitter is very important in the field of mechanical engineering and industrial trade. Fitters are skilled professionals and are responsible for assembling, installing and maintaining various mechanical components and systems.

F: -Fitness, heisphysically Fit.

I:- Intelligent , have a soundmind.

T: -Talented, have a talent to learnquickly.

T:-Target, Wanted to achieve a goal.

E:-Efficient,efficient in doing work.

R:-Regularity

Fitter does 75% of work by hand and 25% of work by machine.

Types of fitter

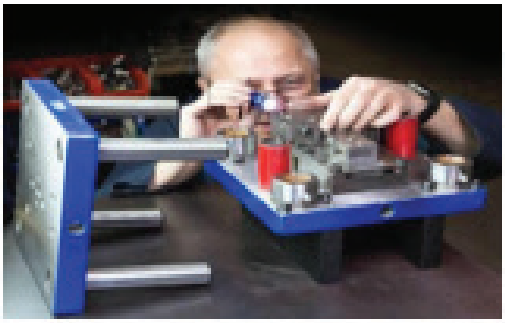
Bench fitter: A bench fitting is a mechanical job work done using a bench vice to hold the job and thE operation with normal manual tools.

Pipe fitter:A Pipefitter is a professional who builds pipe systems for heating, hot water, and cooling. They also forge steam engines that power types of machinery like dishwashers or clothes dryers.

These individuals must be able to work with materials like steel wool and various electric products.

Die fitter: Die Fitter Sheet Metal Experience working as a tool and die maker. Fitting and assembling tools and die parts.

Lock fitter: Repair and open locks, make keys, change locks and safe combinations, and install and repair safes.



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Mechanical fitter: Mechanical fitters are the most common type of fitters and are employed across a wide range of industries, including petrochemicals, manufacturing, construction, automotive, and aerospace. They are responsible for assembling and maintaining mechanical components such as equipment, engines, pumps, conveyors, and other machinery. Mechanical fitters possess excellent technical skills and knowledge of various tools and equipment.

Structural fitter: Structural fitters are involved in the fabrication and assembly of structural components used in construction and manufacturing industries. They read blueprints, measure and cut materials, and weld or bolt them together to construct frameworks, platforms, and supports.

Maintenance fitter: Maintenance fitters are responsible for the upkeep and repair of machinery and equipment. They conduct regular inspections, troubleshoot issues, replace faulty parts, and perform preventative maintenance tasks to ensure smooth operation.

Skill and knowledge in fitter trade: Use of different tools, Hack sawing , Filling ,Marking , Drilling, Chiping Grinding , Reaming ,Scraping, Threading and taping , Riviting Welding etc.

Aplication for fitter trade

- Manufacturing
- Industries
- Construction
- Industries
- Automotive Industries
- Aerospace Industries
- Mining Industries
- Railway Industries
- Maintenance

Most used hand tools and machines in fitter trade

- Files
- Hammers
- Measuring tools
- Try Square
- Callipers
- Hacksaw Frame and Blade
- Drilling machine
- Lathe machine
- Grinder machine

Fitter work

The work of a fitter encompasses a wide range of activities, all aimed at ensuring the proper functioning and maintenance of mechanical systems. Some of the common tasks performed by fitters include

1 Reading blueprints and technical drawings to understand the assembly and installation process.

2 Selecting and using appropriate tools, machinery, and equipment for cutting, shaping, and assembling parts.

3 Fitting and aligning mechanical components with precision and accuracy.

4 Welding, soldering, or bolting parts together to create sturdy connections.

5 Testing assembled components and systems for functionality and performance.

6 Conducting routine inspections and preventative maintenance tasks.

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7 Repairing or replacing faulty parts or components.

8 Collaborating with engineers, designers, and other professionals to ensure proper installation and functionality of systems.

9 Adhering to safety protocols and regulations throughout the work process.

In conclusion, fitters play a crucial role in various industries by ensuring the precise fitting, assembly, and maintenance of mechanical components and systems. With their technical skills, attention to detail, and ability to interpret blueprints, fitters contribute to the smooth operation of machinery and equipment. Aspiring fitters can explore different specializations within the field and can expect competitive salaries based on their experience and expertise.

Roles and responsibilities of an instructor

Types of teaching person

Teacher: A person who works to impart knowledge in an official institution of formal education by being responsible for the overall learning progress of the learners undertaken by him/her. It includes teachers working in preschools, schools, Colleges, Universities etc.

Trainer: A person who guides and supports someone in acquiring new physical skills by guiding them in physical activities and demonstrating the ways to achieve the desired goals in a systematic manner. A gym trainer, a sports trainer, a dance trainer, etc, are a few examples.

Instructor: A person who provides live interactions to the learners during a learning activity which forms part of the program. An instructor cannot work without a teacher. Either the instructor can act as a teacher to teach the basic pre-requisites of that activity or there has to be a separate teacher to do that, e.g. in the case of a flight instructor.

Role of an Instructor has the following important roles to play in a training institute

As an organizer

- **Organizing a training programme:** Based on the syllabus provided, the Instructor has to organize the entire training programme by analysing it further. • Preparing training material: Before commencing the course the Instructor has to prepare various kinds of teaching aids like lesson plan, information sheet, training aids, demonstration plan, etc. This requires a lot of preparation.
- **Conducting a training programme:** The main job of a vocational instructor is to conduct training programme, which includes planning, preparation, presentation, testing and evaluation.
- **Demonstrating in Workshop:** For acquiring particular skill there will be certain steps which are to be followed. For example, stitching of a garment, an instructor has to draw the style feature on the chalkboard. Then the Instructor has to do the drafting of the same either on the board or on a paper. The paper pattern is marked on the cloth & then cutting is performed. The cut component will be stitched with the help of sewing machine. By attending this demonstration, the trainees will learn the entire cutting & stitching procedure.
- **Enabling Attitude Formation:** An instructor must motivate and guide to improve the attitude of the trainees towards the training without which they will not be able to acquire the skill which has been taught.
- **Performing Evaluation & Grading:** No training is completed if it is not properly evaluated & graded. The extent of instructional objectives achieved will be known through testing and evaluation. Grading will help the learners to perform better than the previous test.

  Instructor's efficiency in teaching can also be done by means of evaluation and grading.

As a manager

- **Maintenance of tools & equipments:** For conducting training various kinds of tools & equipments are required. An instructor has to procure all tools and equipment's as per the syllabus & maintain them properly.
- **Supervise the practical training:** During the practical exercise it is very much necessary for the instructor to be present with the trainee. Just by giving the theoretical knowledge to the trainees and then asking them to do practical work is not enough. But the instructor must be physically present to supervise and guide the trainees.

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- **Liaison with the institution:** The instructor is the link between administration & the trainees. So Instructor has to inform the administration about the training activity of the trade, at the same time Instructor must also keep the student informed about the instructions issued by the administration.
- **As a student:** Vocational instructor should always update their knowledge, and skills with new techniques, depending on the changes in latest technology.

Responsibilities of an instructor

Besides the responsibilities towards teaching-learning processes, the instructor has responsibilities.

- Towards the learners/trainees
- Towards the administration
- Towards the industries
- Towards the society and nation
- Towards himself/herself
- Towards the profession
- Towards the parents

Responsibility towards the learner's trainees: Trainees comes to the institute for training and the aim is to become a competent craftsman. In order to fulfil this aim of trainees the trainer.

- must guide and instruct them properly and complete the training programme as per the schedule.
- evaluates the trainees' performance and brings the trainee who are below average level to the standard level required.
- develops attitudes and safe working habits in trainees to use the raw materials economically which are given for learning purpose.
- must cultivate good habits like workshop safety, punctuality, time management, etc.

Responsibility towards the administration

As an Instructor he is the link between the trainees and administration, he should be

- loyal and sincere towards the administration.
- interpreter and communicator of working policies to the trainees and support to the administration.
- a person who does not waste material by excess disposal.
- able to maintain discipline and also report the happening of any incident to the administration.

Responsibility towards the industries: As the industrial establishments are the beneficiaries, the instructor should:

- suggest changes in training programme for the day to day development
- keep himself updated about the latest technology, equipments, materials in the industries.
- keep liaison with industries by field visits and placements, etc.

Responsibility towards the society and nation: Teaching is more than providing skills and knowledge in a particular trade. Training should also be done to develop the society and should benefit the nation as a whole.

For this the instructor can influence the learners by:

- Developing a sense of responsibility towards the society.
- Making them realize that when they get something from the society they also have to contribute to the society.
- Building a society which will help ultimately building a nation. The trainees should develop this sense of building a nation.

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Responsibility towards herself/himself: The instructor's job is a noble one and thrusts him/her with a lot of responsibilities in the course of performing the job.

- He should be sincere and honest towards the profession.
- Takes maximum efforts to develop his personality.
- Cultivates pleasant manners.
- Maintains the dignity of the profession.
- Keeps good health and update the knowledge.
- Takes interest in teaching.

Responsibility towards the profession: The instructor has to constantly update his knowledge and skill to improve the process of teaching and learning. Improving the process of teaching-learning would mean the following innovative strategies and techniques that would cause significant improvement in the training programmes.

He can do this by

- adopting positive attitude towards innovative methods.
- understanding the basics and application of outcome of research findings,
- following better and tested new strategies and techniques,
- utilization of self-study materials for self-improvement
- identification of various principles and factors that aid productive learning and developing course materials and using them carefully.

Responsibility towards the Parents: As an instructor he should develop proper liaison with trainees and their parents and should act as a link between them. Therefore, he should

- keep them informed about the progress and shortcomings of the trainees.
- guide the parents in deciding the future career of the trainees.

Qualities of an instructor

- Should be socially flexible.
- Should provide a variety of learning experiences.
- Should have a friendly personality.

Prerequisites of an instructor The requisites and prerequisites of an instructor include the ability and qualities of an instructor. Communication skills, subject knowledge and experience are few of those qualities.

Qualification

The instructor must fulfil certain qualifications required for the post. The qualifications are classified into two types.

They are;

- Essential Qualification
- Desirable Qualification

Qualities of an instructor can be classified as

- Physical quality
- Mental quality
- Moral Quality
- Physical quality

Personal quality

- Good Health: An instructor can be prompt, regular, enthusiastic, by keeping good health.

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- Dress and Appearance: An instructor's dress must always be simple and neat. Instructor must avoid attractive dresses which may distract the attention of the learners.
- **Voice:** An instructor's voice must be clear and audible. It must not be harsh and monotonous.
- **Language and Speech:** The language of an instructor should be simple and clear, easily understandable. It should not be ornamental and grammatically incorrect. Instructor should develop himself to be a good orator.

Mental quality

- Knowledge of the subject
- Knowledge of principles and method of teaching.
- Knowledge of psychology as psychological factor which helps in learning.

Moral quality

- Justice and impartiality: An instructor must be impartial in handling and dealing with their trainees
- Self-control and will power: Instructor must have good self-control and will power to face the trainees.
- Sympathy and perseverance: Instructor should have sympathy, kindness and immense patience.

Personal quality

- **Leadership:** Instructor must have leadership qualities to guide properly and give instruction to the trainees.
- **Class control:** Controlling the class is also an important factor without which discipline cannot be maintained; when discipline is not maintained we cannot expect desired learning outcome.
- **Class manners:** His behaviours towards trainees should be very polite and gentle the instructor must avoid addressing them rudely and retrain from insulting them badly.
- **Good habits:** An instructor must have good habits like punctuality, regularity and honesty, sincerity.

Traits of good instructors

As the teaching is a noble task, an instructor must require the knowledge and skill technique of teaching. Following are the most important factors to be performed by an instructor.

- Has to make the course interesting.
- Has to possess sense of promoting the knowledge and skill.
- Has to encourage trainee's participation.
- Admire the interest of the trainees.
- Should be neatly dressed.
- Should have sound knowledge of the subject.
- Should possess (balanced) and business like attitude.
- Should show a great deal of enthusiasm.
- Should use many illustrations
- Should have pleasant voice.
- Should readily assume responsibility.
- Should have a moderates honourable view.
- Should use knowledge skill for transfer and application.
- Should reasonably strict and maintain discipline.
- Has the teaching material well organized.
- Should be fair in evaluation.
- Has to maintain proper training records.

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LESSON 3 : Cutting tools

Objectives

At the end of this lesson you shall be able to

- demonstrate the material cutting tool like files and its classification and their grade and care maintenance
- state the hacksaw frame its construction and safety precaution while using it
- state the specification of chisel and its uses.

Files Element classification and their grade

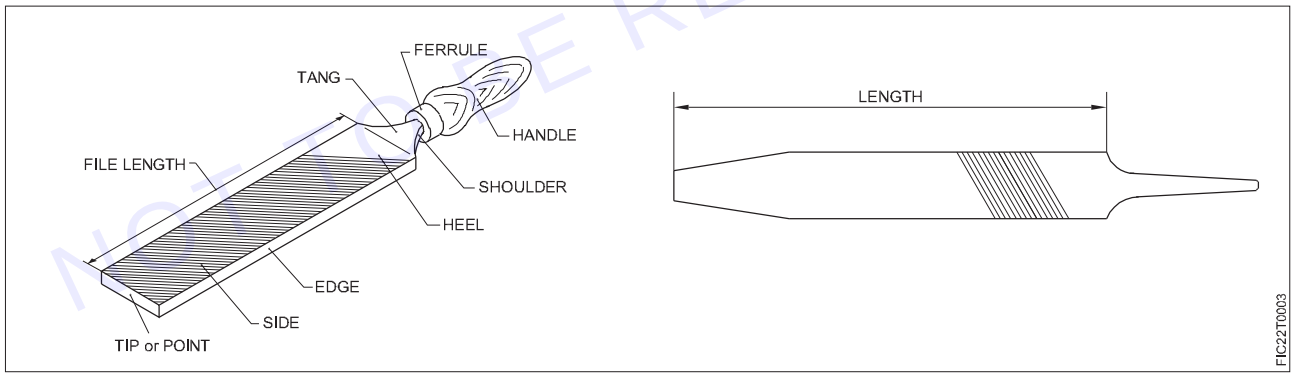
Definition of file and element

1 **File:** A Tool used to remove from a work piece it is common in wood working, metal working and other similar trade and hobby task.

2 **Material:** Materials Generally files are made of high carbon or high grade cast steel. The body portion is hardened and tempered. The tang is however not hardened.

3 **Element of files**

- Tang,
- face,
- edge,
- heel,
- shoulder,
- tip or Point,
- handle



Tip or point

The end opposite to tang

Face or side

The broad part of the file with teeth cut on its surface

Edge: The thin part of the file with a single row of parallel teeth

Heel: The portion of the broad part without teeth

Shoulder: the curved part of the file separating tang from the body

Tang: The narrow and thin part of a file which fits into the handle

Handle: The part fitted to the tang for holding the file

Ferrule: A protective metal ring to prevent cracking of the handle.

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4 **Grades of files:** Files are manufactured in different types and grades to meet the various needs. Files are specified according to their length, grade, cut and shape. Length is the distance from the tip of a file to the heel. File grades are determined by the spacing of the teeth.

Rough file:A rough file is used for removing rapidly a larger quantity of metal.

It is mostly used for trimming the rough edges of soft metal castings.

Bastard file:A bastard file is used in cases where there is a heavy reduction of material

Second cut file:A second cut file is used to give a good finish on metals.

It is excellent to file hard metals. It is useful for bringing the jobs close to the finishing size.

Smooth file: A smooth file is used to remove small quantity of material and to give a good finish.

Dead smooth:A dead smooth file is used to bring the material to accurate size with a high degree of finish.

The most used grades of files are bastard, second cut, smooth and dead smooth. These are the the grades recommended by the bureau of Indian standards (BIS)

Different sizes of files with the same grade will have varying sizes of teeth. In longer files, the teeth will be coarser.

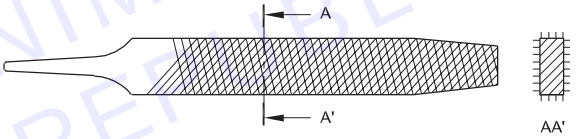
The number of cutting edge in rows in each of the above grades over a Length of 10mm as shown in .

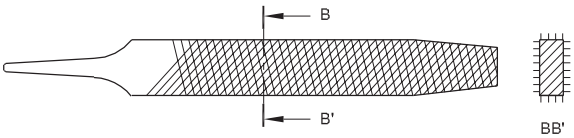
Types of files and its care and maintence

Definition of file: It is made of high carbon steel HCS To make the surface flat by cutting And chipping by saw. It is used to remove unnecessary .Metal from the job or for finishing. Filing allowance is usually keptfrom0.02mm to 0-5mm.

Parts of file

- Tip,
- Point
- face
- Edge
- Heel
- Tang
- Shoulder
- Handle



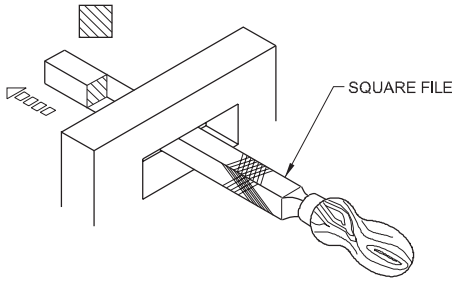


Types of file

- According to length
- According to Shape
- According to Cut.

According to shape or section

- Flat file
- Hand file
- Triangular file
- Square file
- Half
- Round file
- Round file
- Knife edge file.



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Flat file

These files are of a rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point.

The faces are double cut, and the edges single cut. These files are used for general purpose work. They are useful for filing and finishing external and internal surfaces.

Hand file

These files are similar to the flat files in their cross section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is single cut whereas the other is safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces already finished.

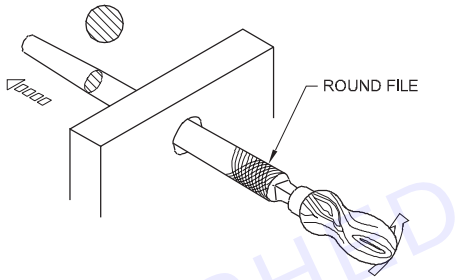
Square file: The square file is square in its cross section.

It is used for filing square holes, internal square corners, rectangular openings, keyways and splines.

Round file

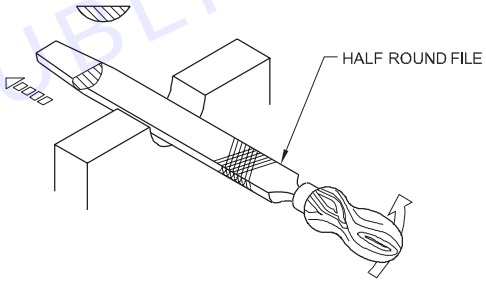
A round file is circular in its cross section.

It is used for enlarging the circular holes and filing profiles with fillets.



Half round file

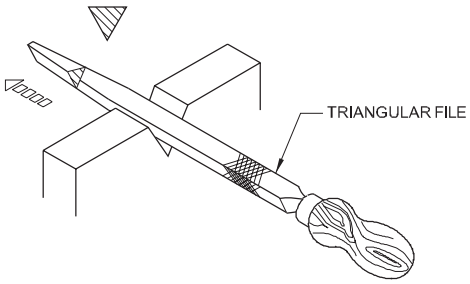
A half round file is in the shape of a segment of a circle. It is used for filing internal curved surfaces.



Knife edge file

A knife edge file has the cross section of a sharp triangles. It is used for filing narrow grooves and angles above 10º. The above files have one third of their lengths tapered.

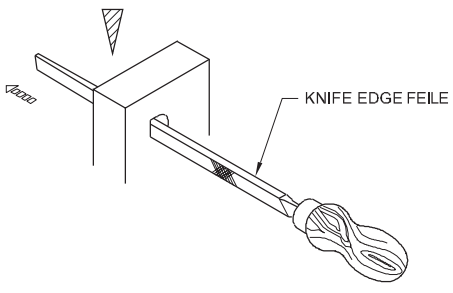
They are available both single and double cuts.



Triangular file

A triangular file is of a triangular cross section.

It is used for filing corners and angles which are more than 60o .Square, round, half-round and triangular files are available in lengths of 100, 150, 200, 250, 300 and 400mm. These files are made in bastard, second cut and smooth grades.



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According to cut

- Curved Cut File
- Single Cut
- Double Cut File
- Rasp cut file

The teeth of all file are formed by cuts made on its face. Files have cuts of different types. Files with different cuts have different uses.

Single cut

A single cut file has rows of teeth cut in one direction across its face. The teeth are at an angle of 600 to the centre line. It can cut chips as wide as the cut of the file. Files with this cut are useful for filing soft metals like brass, aluminium, bronze and copper. Single cut files do not remove stock as fast double cut files, but the surface finish obtained is much smoother.

Double cut

A double cut file has two rows of teeth cut diagonal to each other. The first row of teeth is known as OVERCUT and they are cut at an angle of 700 . The other cut, made diagonal to this, is known as UPCUT, and is at an angle of 510 . This removes stock faster than the single cut file.

Rasp cut

The rasp cut has individual, sharp, pointed teeth in a line, and is useful for filing wood, leather and other soft materials. These files are available only in half round shape.

Curved cut: These files have deeper cutting action and are useful for filing soft materials like - aluminium, tin, copper, and plastic

Care and maintenance during to use of files: File Card It Is a bush the size of a thin star made up of a fine file which has a cut for removing trapped metal and particles from leaf teeth.

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Hacksaw frame and its construction

Definition of hacksaw

A hacksaw frame is used along with a blade to cut metals of different sections, and is specified by the type and maximum length of the blade that can be fixed.

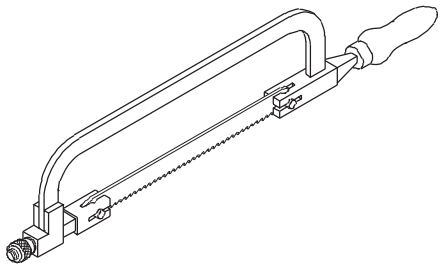
Example: - Adjustable hacksaw frame - tubular - 250 - 300mm or 8” - 12”.

Parts of a hacksaw frame

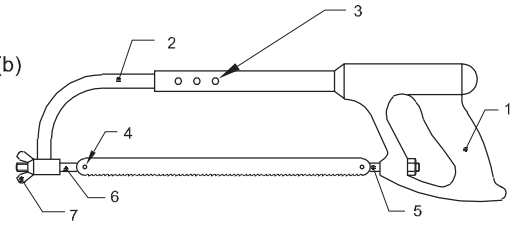
1 Handle
2 Frame
3 Tubular frame with holes for length adjustment
4 Retaining pins
5 Fixed blade-holder
6 Adjustable blade-holder
7 Wing-nut.

A hacksaw blade is made of either low alloy steel (LA) or high speed steel (HSS), and is available in standard lengths of 250 mm and 300mm.

(a)



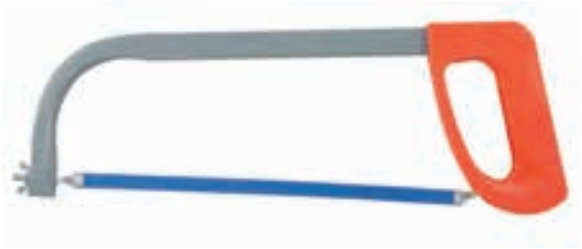
(b)



a Frame

1 Made from either tube or a solid flat.

2 Fixed or adjustable.



b **Handle** Straight wooden or piston grip type made of metal.

c Holding pins

1 Also called prongs.

2 Made zinc alloys.

d Wing nut

1 Known as fly nut.

2 Driven by the thumb & made of steel.

Types of hacksaw frames

Solid frame

Only a blade of a particular standard length can be fitted to this frame. e.g 300 mm or 250 mm.

Adjustable frame

Different standard lengths of blades can be fitted to this frame i.e. 250 mm and 300 mm.

a Flat type

b Tubular type.

c Used for engineering work:– coping saw & jewellers saw.

Used

Pierced decorative scroll work such as book ends, bracelets, letter openers & ornaments, cut from copper, brass, pewter's etc.

Any other types

a Tubular Type Adjustable

b Pistal Grip Adjustable

c Deep Cutting Frame

a Tubular Type Adjustable: Fabricated Sheet handle. Size adjustable to 250 mm & 350 mm. Categories.

b Pistal Grip Adjustable: Comfort pistol grip handle with

c Patented pattern for better grip & control. Allows

d Positioning of the blade at 90°

e Deep Cutting Hacksaw Frame: Deep Cutting Hacksaw Frame is of 'U' shape, it is also a frame made to use blades of same length like fixed hacksaw frame. But its depth is kept very high, due to which it does not get stuck in the job even after deep cutting.

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Types of chisel and their specification

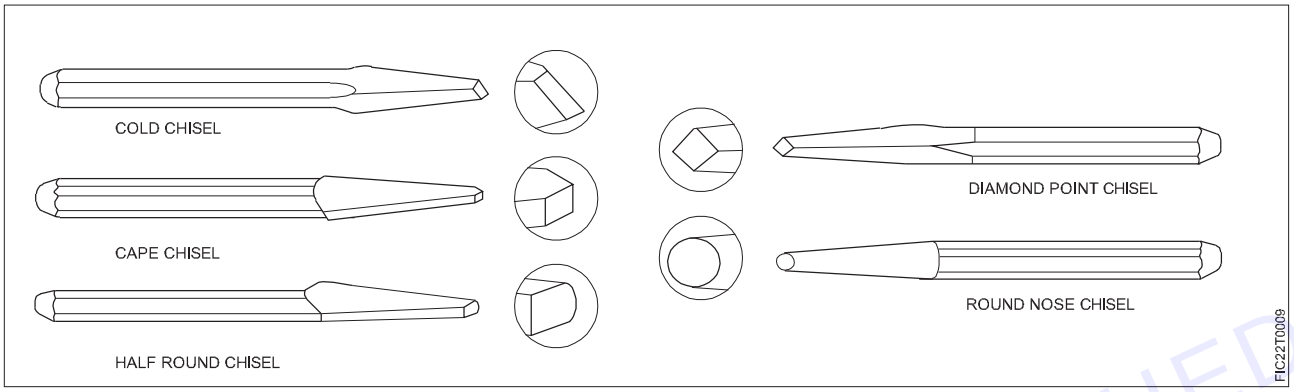
Precaution's

a Hold the work securely in the vice to avoid spring and chatter.

b Loosen under the pressure or cut the blade will be broken.

c The tendency is to cut too fast with a Hacksaw is not desirable so to 60 strokes per minute is required.

d Do not, however, pinch a frail piece too hard, judgement must be used. Never used oil as lubricant when hand hacksawing.



Introduction

Chisels are handy tools used for carving, shaping, or cutting hard materials like wood, stone, or metal. They come in various shapes and sizes for different purposes.

Types of chisel

1 Flat chisel

2 Cross-cut chisel

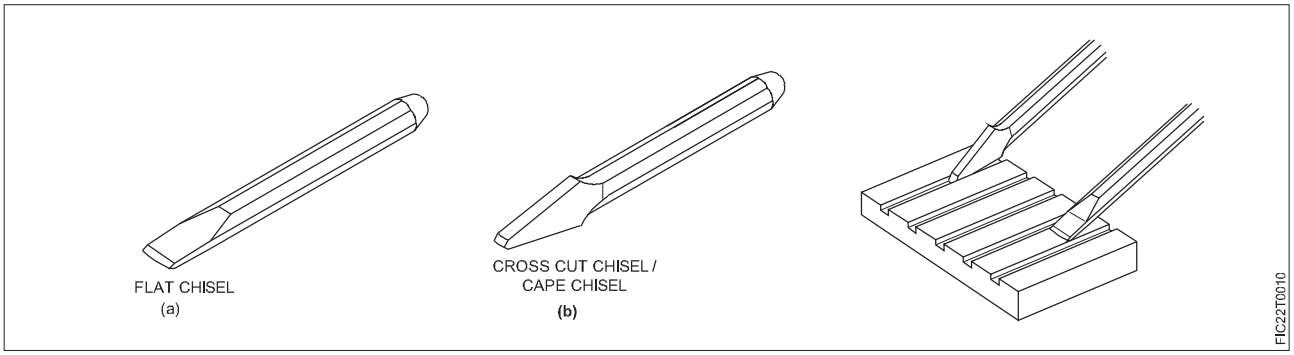
3 Half-round nose chise

4 Diamond point chisel

5 Web chisel.

1 Flat chisel: Flat chisels have a straight, flat cutting edge and are commonly used for general cutting, shaping, and carving tasks in woodworking, metalworking, and masonry. They come in various sizes and are versatile tools for removing material, creating straight lines, or smoothing surfaces. Flat chisels are essential in tasks such as cutting mortises, shaping wood, or chipping away excess material from metal or stone. They're typically struck with a mallet or hammer to apply force for cutting through the material.

2 Cross-cut chisel: A crosscut chisel, also known as a "mortise chisel," is a type of chisel specifically designed for cutting mortises, which are rectangular slots or holes typically used in woodworking joints.



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3 **Half-round nose chisel:** They are used for cutting curved grooves (oil grooves). A half-round nose chisel is a specialized type of chisel with a curved cutting edge resembling a half-circle or half-oval shape at the tip.

4 **Diamond point chisel:** A half-round nose chisel is a specialized type of chisel with a curved cutting edge resembling a half- circle or half-oval shape at the tip.

5 **Web chisel:** A web chisel, also known as a "corner chisel," is a specialized type of chisel designed for cutting square corners or cleaning out corners in woodworking and carpentry.

Specification

- **Point angles and materials:** The correct point/cutting angle of the chisel depends on the material to be chipped. Sharp angles are given for soft materials, and wide angles for hard materials. The correct point and angle of inclination generate the correct rake and clearance angles.
- **Rake angle:** Rake angle is the angle between the top face of the cutting point, and normal (90°) to the work surface at the cutting edge.
- **Clearance angle:** Clearance angle is the angle between the bottom face of the point and the tangent to the work surface originating at the cutting edge. If the clearance angle is too low or zero, the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip. If the clearance angle is too great, the rake angle reduces. The cutting edge digs in and the cut will become deeper and deeper.
- **Crowning:** A slight curvature is ground called "Crowning" to the cutting edge of the chisel, to prevent digging of corners, which leads to breakage of chisel point. "Crowning" allows the chisel to move freely along a straight line while chipping.

Material to be cut	Point angle	Angle inclination
High Carbon Steel	65°	39.5°
Cast iron	60º	37°
Mild steel	55º	34.5º
Brass	50º	32º
Copper	45°	29.5°
Aluminium	30º	22º

1 **Type:** Specify the type of chisel needed for the task, such as flat chisel, bevelled edge chisel, gouge chisel, mortise chisel, etc.

2 **Blade Width:** Provide the desired width of the chisel blade, which can range from narrow for detail work to wider for general cutting or shaping tasks.

3 **Blade Material:** Specify the material of the chisel blade, such as high-carbon steel, alloy steel, or hardened tool steel, depending on durability and sharpness requirements.

4 **Overall Length:** Specify the overall length of the chisel, including both the blade and the handle, which can vary depending on the type and size of the chisel.

5 **Bevel Angle:** For bevelled edge chisels, specify the bevel angle of the cutting edge, which can affect the chisel's cutting performance and versatility.

6 **Weight:** Consider the weight of the chisel, which can impact the ease of handling and the amount of force required for cutting or shaping tasks.

7 **Special Features:** Specify any special features required, such as a diamond point for engraving, a half-round nose for carving curved surfaces, or a web (corner) chisel for cutting square corners.

8 **Brand or Manufacturer:** Specify any brand or manufacturer preferences, if applicable, to ensure consistency in quality and performance.

Precaution: When using a chisel, always wear safety goggles to protect your eyes from flying debris, and make sure to keep your hands away from the striking area to avoid accidental injuries. Additionally, always use a sharp chisel to prevent it from slipping and causing accidents.

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MODULE 2

LESSON 4 : Types of drilling machine and their specification

Objectives

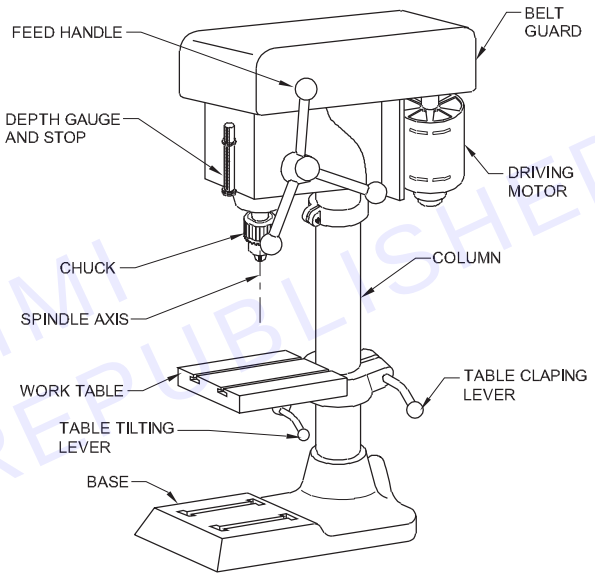
At the end of this lesson you shall be able to

- identify the various types of drilling machines and its parts and functions
- state the different types of work holding devices
- state the purpose of different types of tool holding devices
- name the different types of drills and its parts, function and uses.

Definition of drilling machine: A drill machine is a tool uses for drilling hole in various material, such as a metal ceramic wood or plastic.

Parts of drilling machine

- base.
- Column (pillar)
- work table
- spindle
- drill chuck
- hand feed level
- depth gauge adjustable
- fixed handle
- belt guard
- driving motor



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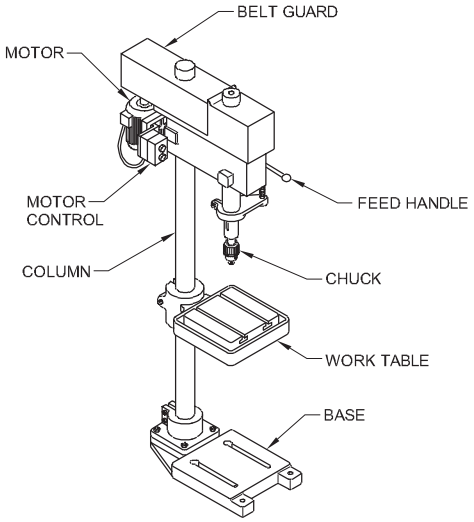
Types of drill machine:

Drilling machine stationary type

- **Sensitive bench drilling machine:** The simplest type of the sensitive drilling machine is shown in the figure with its various parts marked. This is used for light duty work. This machine is capable of drilling holes up to 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle. For normal drilling, the work-surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.
- **Pillar drilling machine:** This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and driven by more powerful electric motors. They are also used for light duty work. Pillar drilling machines are available in different sizes. The larger machines are provided with a rack and pinion mechanism to raise the table for setting the work



- Radial drilling machines:

Radial drilling machines are used to drill

- large diameter holes
- multiple holes in one setting of the work
- heavy and large work pieces.

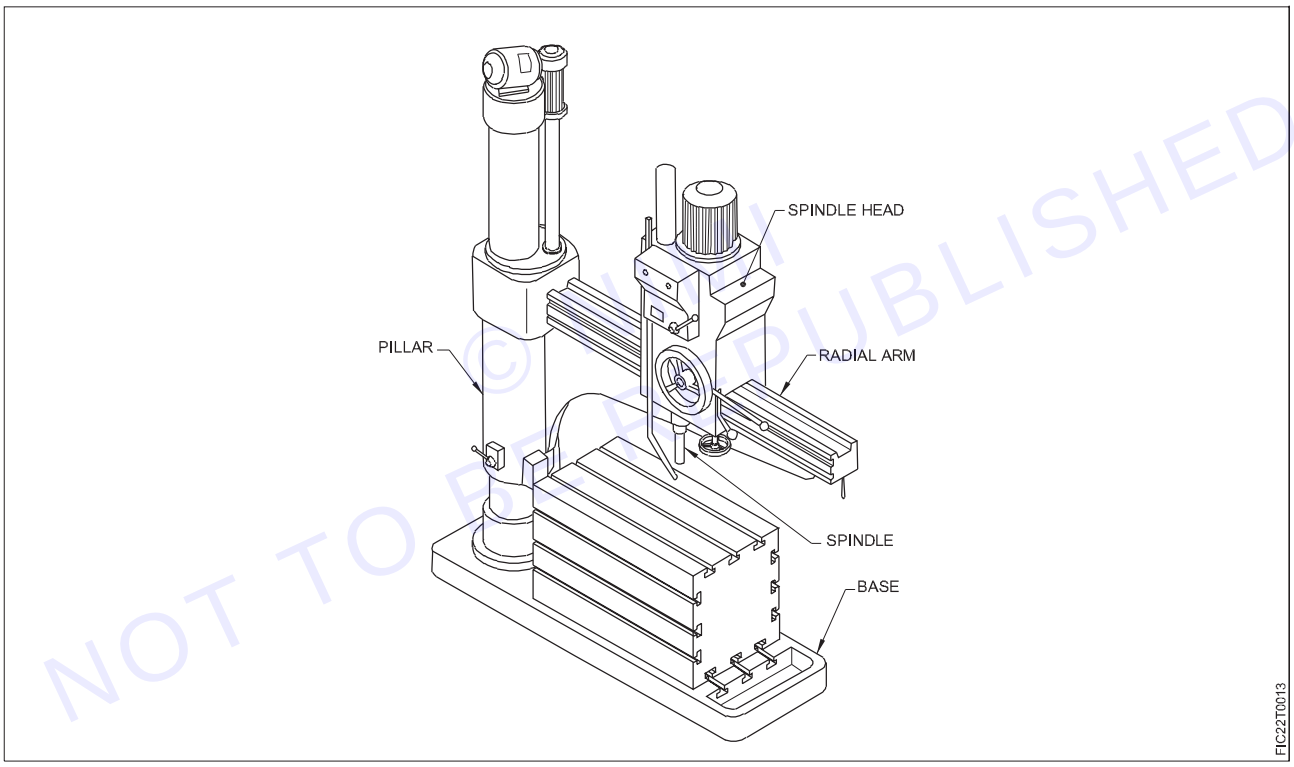
The radial drilling machine has a radial arm on which the spindle head is mounted. The spindle head can be moved along the radial arm and can be locked in any position.

The arm is supported by a pillar (column). It can be rotated about with the pillar as center. Therefore, the drill spindle can cover the entire working surface of the table.

The arm can be lifted or lowered.

The motor mounted on the spindle head rotates the spindle. The variable-speed gear box provides a large range of R.P.M.

The spindle can be roated in both clockwise and anticlockwise directions. Angular holes can be drilled on machines having tilting tables.



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Some another type of drilling machine

Gang drilling machine

The Gang Drilling Machines are offered with two or more drilling units fitted on common table assembly. Common cast iron bench is made of close grained cast iron, is provided with machined T-slots and have common coolant channel all around it. The Gang Drilling Machine is fitted with drilling head of capacity 15mm to 32mm with drilling head (specification same as that of general drilling machines, Stated in the adjacent table). Drilling head, depending on the job height can be easily move upwards and downwards with help of worms and gears fitted in mounting coupling of drilling unit is called Gang Coupling. This type of set up is highly suitable for mass production of same component with multiple operations at the same point or at same level of job face.

Multi spindle drilling

The phrase multi spindle drilling machine refers to numerous CNC (computer numerical control) drilling machines equipped with many spindles and several necessary accessories that are developed and constructed with the frame itself.

The drilling machine is one of the machine tool variants that has undergone extensive study and development in metalworking. Because of its multi-tasking and handy design can accomplish various drilling and boring jobs in a single stop. In the early twentieth century, the drilling machine evolved from the milling machine design.

Since then, numerous machining centers have been extensively employed for professional and precise purposes in various sectors, contributing to the advancement of industrial achievement. With the market acceptance of multi-spindle technology, multi-spindle drilling machines have been embraced in multiple stages.

The milling and drilling operations on a single multi-spindle drilling machine may fulfil a wide range of machining needs. This capability is based on the various tracks attached to the axes, which allow the cutting tool to travel around the work piece.

The client's demands determine the number of axes on multi-spindle drilling machines. There is no ultimate ideal number; simply the most appropriate decision based on user demands. Unlike lathes, a multi drilling machine can perform a broad range of operations, from single microscopic pieces to heavy and massive gang milling.

Deep hole drilling machines

Deep hole drilling machines are metal cutting machine tools that can create very deep and extremely precise holes in just about any metal. Manufacturers relying on deep hole drilling machines can further

optimize the process by using tools such as BTA and gun drills. It's a prominent method in engineering materials and components used across numerous sectors. In this article, we take a quick look at how deep hole drilling machines work, the processes and some of the most common applications.

Deep hole drilling machines are used when a project requires high-precision round bores. It can produce holes that are within extremely tight tolerances, providing incredible accuracy compared to standard drilling methods. Using special tools and setups, these gun drilling machines deliver high-pressure coolant, and cleanly evacuate chips while achieving depth-to-diameter holes beyond the capabilities of a normal CNC machine.

This process is unique in that it can measure residual stresses at a microscopic level with a penetration of over 750 millimeters (30 inches), without completely destroying the original component. There are essentially three basic types of deep.

Automatic drilling

Automated drilling is the control of drilling by automatic means. The aim of automated drilling is to reduce human intervention to a minimum. A combination of control systems and information technology tools are used to implement automated drilling.

Widespread use of automated drilling can be seen in machines which employ CNC (Computer Numerical Control). These machines commonly employ stepper motors and servo motors to achieve precision and instructions based on a CAD are sent to the machines through software to achieve the finished product.

The feedback from the surface that is worked on is also collected and the further steps are constantly adjusted with the feedback.

Safety precautions

Wear safety eye protection while drilling.

Let the spindle stop of its own accord after turning the power off.

Never try to stop the spindle with your hand.

Plexiglas and other brittle plastics can be difficult to drill.

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Work holding device for different jobs

Definition

Work holding device is a general term for devices that attach and fix a work piece to a machine tool. If the workpiece is not attached correctly, the machine will not be able to make the work piece precisely. This is why work holding devices are essential peripheral devices.

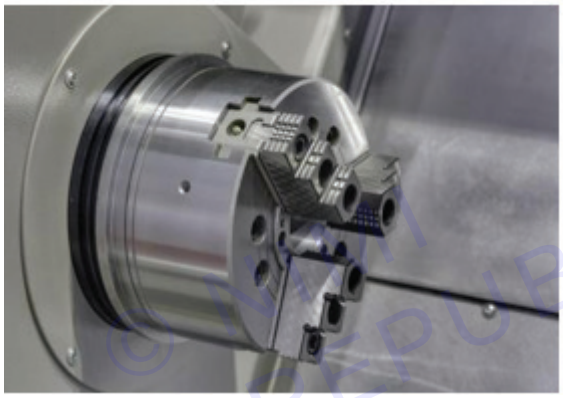
Among work holding devices, jigs are the most well-known tool. Jigs are aids for attaching and fixing the workpiece to the machine tool and for correctly applying the cutting tool to the desired cutting point. There are various types of jigs.

Principle: The process of locating (or positioning) and securing a work piece for machining process.

➢ **Holding devices for lathe**

a Chuck

Generally, chucks are used to attach a work piece to a lathe. Chucks are one of the types of jigs. A chuck is attached to the main spindle of a lathe and plays the role of transmitting the rotation of the spindle to the work piece and of holding the work piece tightly so that the work piece, which is rotating at a high speed, does not fly away due to centrifugal force.



Chucks are widely used to hold cylindrical work pieces that are relatively short in length. When a long, narrow work piece is set in the chuck, the center of the end face that is not gripped by the chuck must be supported by a device called a lathe center to prevent deflection (explained later).

Chucks commonly use jaws to hold the work piece. There are a wide variety of chucks, distinguished by the number of jaws, structure, and drive system.

First, chucks are classified as 2-jaw, 3-jaw, and 4-jaw chucks according to the number of jaws. Generally, 3- jaw chucks are most commonly used. 2-jaw chucks have two jaws facing each other and are suitable for holding irregularly shaped work pieces, but the gripping force is not high. Four-jaw chucks can support a work piece at four points, so they are suitable for holding a plate or block-shaped work pieces.

The architecture of the chuck can be divided into two types: the solid type and the hollow type, which has a through-hole in the center of the chuck and is hollow. The solid type is more rigid and suitable for heavy cutting, while the hollow type is lighter and suitable for high-speed rotation.

In terms of jaw drive systems, there are two main types: hand chucks and power chucks. There are also collect chucks that do not use jaws, instead using a part called a collect to grip cylindrical work pieces.

b Manual chuck

Manual chucks are chucks in which the jaws are opened and closed manually by using a special tool. There are two types of manual chucks: scroll chucks and independent-jaw chucks.

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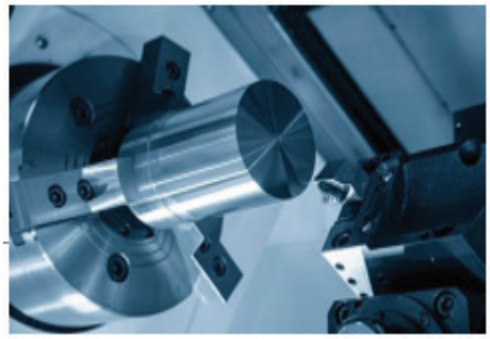

Scroll chucks are chucks in which each jaw moves simultaneously by turning the open/close screw on the side of the chuck. Since the jaws move simultaneously, the center point of the workpiece and the center of the chuck always coincide.

The main advantage of this chuck is that it can be easily handled even by beginners. Most scroll chucks are of the 3-jaw type.

In the case of independent-jaw chucks, each jaw moves independently. For this type of chuck, 4-jawed chucks are the most common. Since each jaw moves individually, a certain level of skill is required to operate the independent-jaw chuck. However, it has the advantage of being able to grasp a variety of workpiece shapes.

c Power chuck

Power chucks are chucks that use hydraulic or pneumatic pressure to automatically open and close the jaws to grip the workpiece, and are widely used in processing sites. There are automatic bar feeders that enable continuous processing of bars, and oscillating chucks that can firmly hold even rough-surfaced workpieces.

d Collet chuck

Collet chucks are a type of chuck that uses a collet, a cylindrical part with multiple slits, to hold a workpiece. Since the collet holds the workpiece as if wrapping it, the force is dispersed and the workpiece will not be damaged. Collet chucks are used in lathes to hold workpieces and in machining centers (MC) to hold tools.

e Other chucks

There are special chucks designed for specific workpiece shapes or indexing chucks that can index to 90 degrees, 120 degrees, etc. while gripping the workpiece. Indexing means moving the rotary axis to the target angle precisely.

Chucks that are compatible with automation include the automatic jaw changer (AJC) system, which can automatically change jaws, and the automatic chuck changer (ACC) system, which can automatically change the chuck itself.

- **Lathe center**

When machining a relatively long workpiece with a small diameter, the workpiece will not be chucked, but supported by a device called a lathe center on both sides of the workpiece. The lathe center is attached to both the headstock and the tailstock. Since the lathe center supports the end faces of the workpiece, the workpiece can be machined to the very edge of both ends.

Since the rotation of the main spindle is not transmitted to the workpiece by just attaching both ends to the lathe center, a driving plate or work carry is used to transmit the rotation of the main spindle to the workpiece. This method can hold thin or rectangular-shaped workpieces that cannot be gripped by the chuck.

- **Holding devices for grinding machine**

1 For cylindrical shaped workpiece for cylindrical grinding machines, which grind the periphery and end faces of cylindrical workpieces, the method of gripping the workpiece is similar to lathes. Thus, like lathes, they mainly use chucks and centers.

However, centerless grinding machines, which are more powerful for mass-production machining, do not use jigs or other fixtures. In centerless grinders, the workpiece is supported and machined at three points: the grindstone, the supporting plate, and the regulating wheel.

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2 For plate, block material workpiece.

Surface grinding machines that grind the flat surfaces of plate or block materials often use a magnetic chuck that uses electromagnets or permanent magnets to lock the workpiece in place.

Magnetic chucks can firmly fix workpieces made of iron, nickel, or other ferromagnetic materials that easily stick to magnets.To hold workpieces that do not stick to magnets, such as aluminum, a vacuum chuck is used, which uses vacuum force to grab the workpiece.

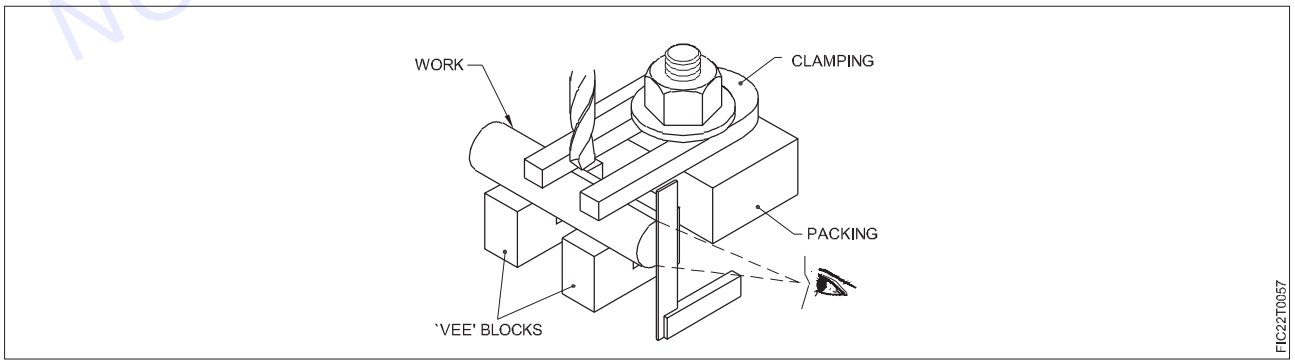
Bench vice: It is work holding device , to hold work piece then applied other operations as like filing, hack-sawing, tapping reaming etc.

Machine vice:: It is very important vice of machine shop hold the work than apply machining process, as like milling, shaping, slotting drilling etc.

Angle plate: It is working support device, we are usefor marking , than support to work piece JIG: it is a device , it is hold the. work piece and guide the tool.

Jig: It is a device , it is hold the. work piece and guide the tool.

Fixture: It is device ,it is used for only hold the job , it is not guide the tool.



Clamps and bolts

Drilling machine tables are provided with T-slots for fitting bolt heads. Using clamps and bolts, the work pieces can be held very rigidly.

While using this method, the packing should be, as far as possible, of the same height as the work, and the bolt nearer to the work. There are many types of clamps and it is necessary to determine the clamping method according to the work.

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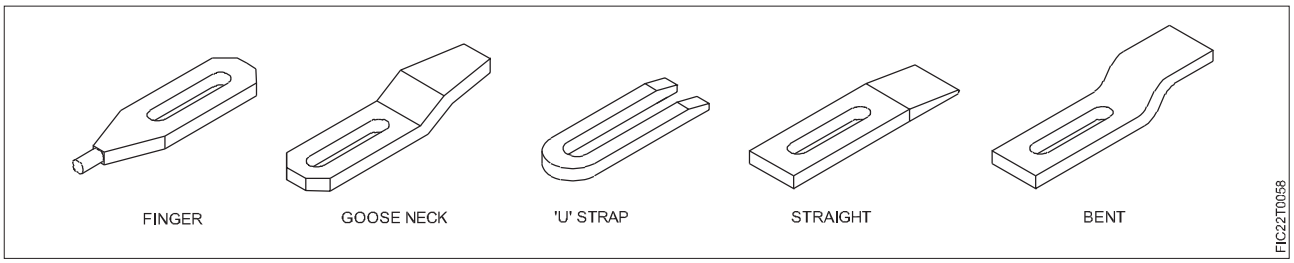

Safety precautions

1 To avoid personal injury maintain a safe distance from the clapping holding tool and work piece.

2 Where oil and grease are required in the holding device, oil and grease should be applied.

3 The holding device should be cleaned after use because this working smoothly.

Introduction to tool holding devices

Definition – A tool holding device is a device used to securely hold a tool for machining or any other work.

Types of tool holding device's

1 Tool post

2 Drill holding device

3 Tap wrench

Tool post

The tool post is a lathe part which is seated on the top of the compound slide it holds and supports the tool or tools in position closely against the job.

Types of tool post

1 Pillar type tool post.

2 Open side tool post.

3 Quick Change tool post.

4 Turret or multi tool post.

Drill holding devices

Drill chuck's

Taper shank drills with sufficiently large Shank are directly fitted in the tapered hole of the spindle nose drill check is used for holding straight shank drills a drill with tool big taper shank is held in socket which fits in the tapered hole of the spindle.

A drill chuck is the most popular drill bit holding device in the world. You must have seen one of these in your workshops at least if not used one. But here is the truth: When you are working with shank-type drill bits, drill chuck is the holding device you should be using. Because most industrial workers are using it every day.

Now, to use the drill chuck, you have to fit it into the spindle of the drill machine.

Drill chuck design

There are three main components in that drill chuck which you should know: jaws, nut ring, and key. Most drill chucks commonly have three jaws, but some can have four also. But mostly 3 jaw chuck are used by people. And these jaws have in-built teeth inside them that strengthen their grip over the drill bit. But when you fit the drill bit inside the chuck, you have to use the key to tighten the drill bit properly.

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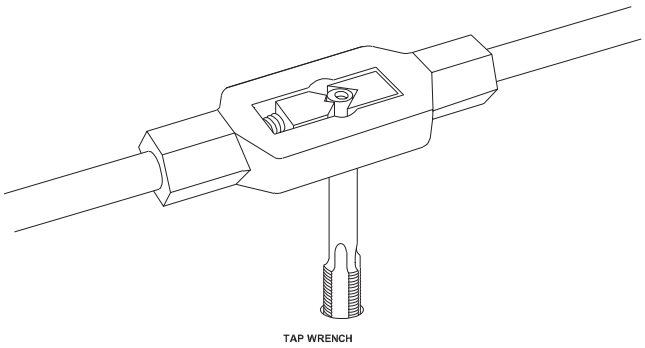
Tap wrench

Tap wrench is a device which is used to drive the hand taps.



TAP WRENCH

Types

1 Solid tap wrench

2 Adjustable tap wrench

Hand taps are picked up with tap wrenches. The square of the tap is screwed tight between the adjustable clamping jaws. Due to the adjustability of the clamping jaws, taps with different square sizes can be fixed. The clamping jaws are moved by turning an arm of the tap. The length of the arms of the tap wrench creates a leverage effect which facilitates cutting by hand. Screw extractors or hand reamers can also be operated with a tap wrench. Due to the design of the tap iron, the plumb line of the tap is facilitated. The design elements of the adjustable tap wrench have been known for over 100 years and have remained almost unchanged since then. The materials, however, have changed. Today the bodies are mainly made of zinc die-cast instead of grey cast iron.

3 T- Hand tap wrench

Handle tap wrenches, ideal for holding taps, reamers, screw extractors and other such small hand turned tools, handle tap wrench allows you to turn taps to help make screw threads. Fixed wrench has an extended shank for hard-to-reach tapping jobs. Fixed “T” handle for tapping in open areas.

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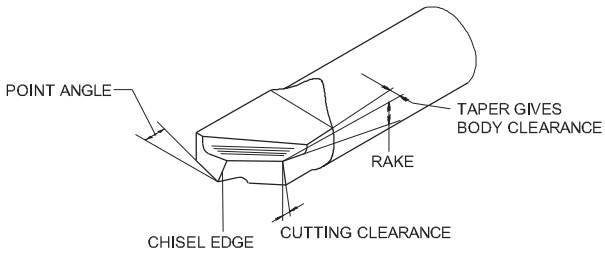
Different types of drills and its parts, functions and uses

Introduction of drill and their nomenclature

Introduction of drill

Drilling is the production of cylindrical holes of definite diameters in workpieces by using a multi-point cutting tool called a ‘drill’.



Part of drill & functions

1 **Shank :** This is the driving end of the drill which is fitted on to the machine. Shanks are of two types. Taper shank, used for larger diameter drills, and straight shank, used for smaller diameter drills.

2 **Tang :** This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

3 **Body :** The portion between the point and the shank is called the body of a drill.

The parts of the body are flute, land/margin, body clearance and web.

4 **Flute :** Flutes are the spiral grooves which run to the length of the drill. The flutes help.

- To form the cutting edges
- To curl the chips and allow these to come out
- The coolant to flow to the cutting edge.

5 **Land :** The land/margin is the narrow strip which extends to the entire length of the flutes. The diameter of the drill is measured across the land/ margin.

6 **Body clearance :** Body clearance is the part of the body which is reduced in diameter to cut down the friction between the drill and the hole being drilled

7 **Web :** Web is the metal column which separates the flutes. It gradually increases in thickness towards the shank.

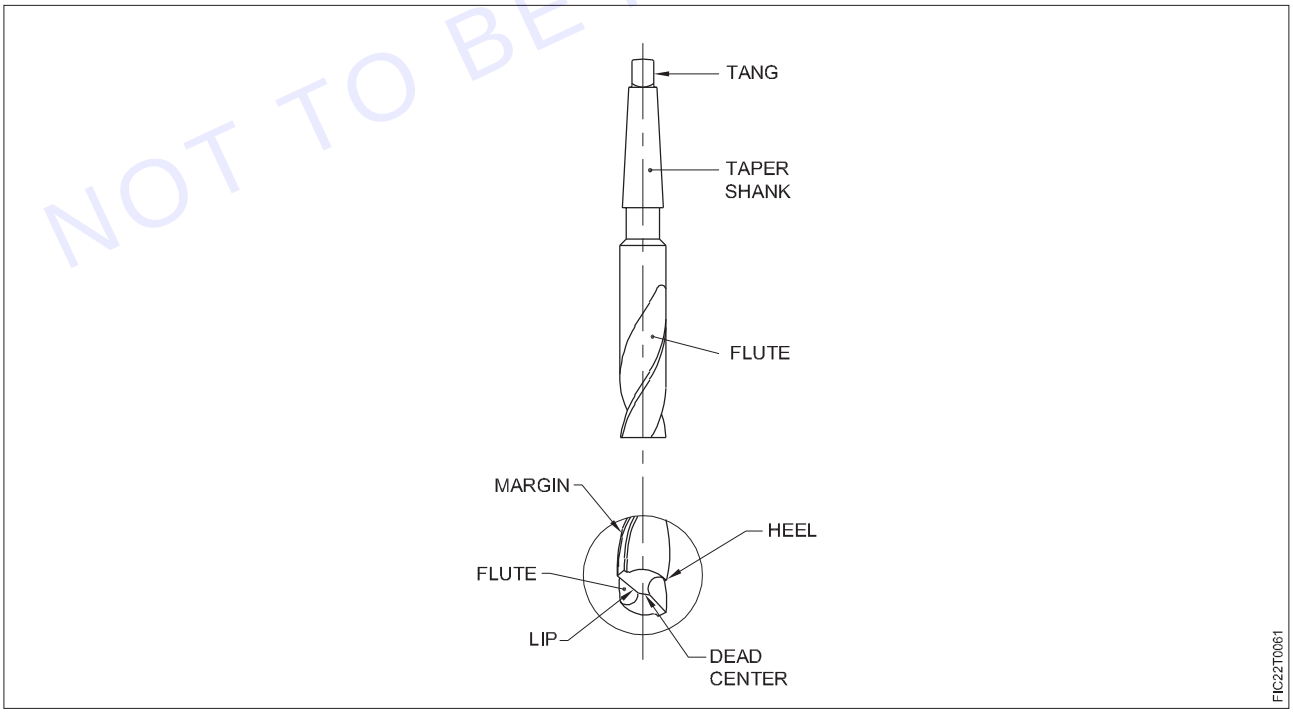
8 **Point :** The cone shaped end which does the cutting is called the point. It consists of a dead centre, lips or cutting edges, and a heel.

9 **Cutting edges :** The cone shaped end which does the cutting is called the point. It consists of a dead centre, lips or cutting edges, and a heel.

10 **Heel :** Heel which are the trailing edge of the drill point.

11 **Dead centre:** It is a type of drill bit used for making a starting point or center hole in a workpiece before drilling with a larger drill bit.

12 **Neck:** The section of reduced diameter between the body and the shank of a drill.



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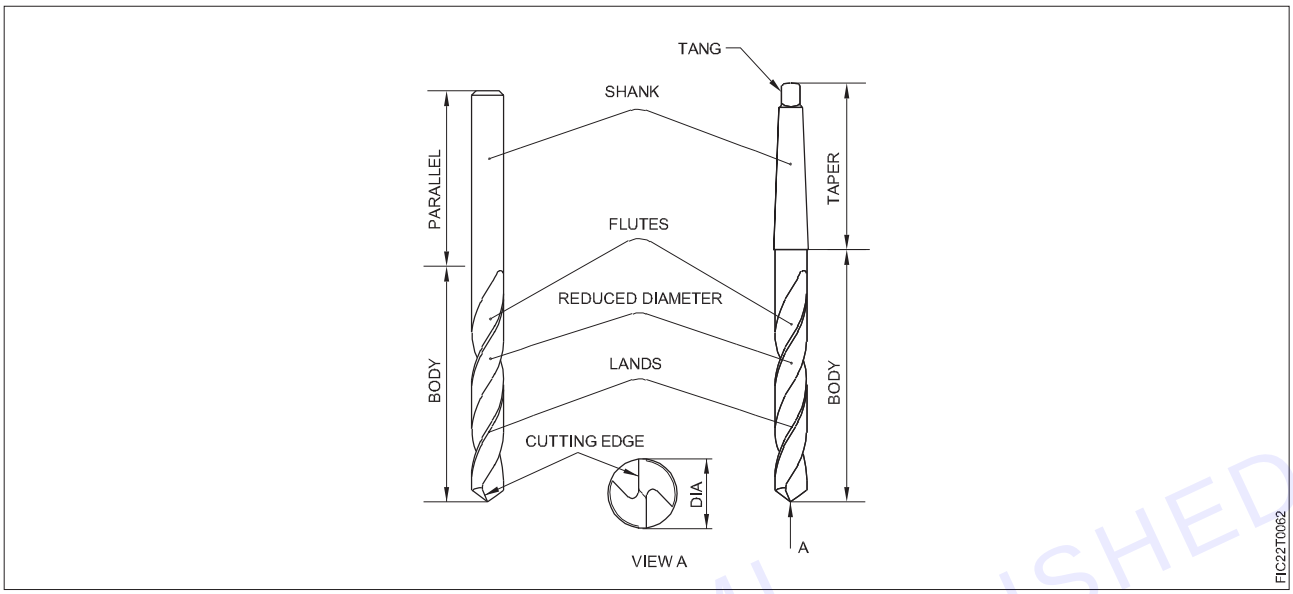
Types of drills and their specific uses

Flat drill : The earliest form of drill was the flat drill which is easy to operate, besides being inexpensive to produce. But it is difficult to hold during operation,and the chip removal is poor. Its operating efficiency is very low.

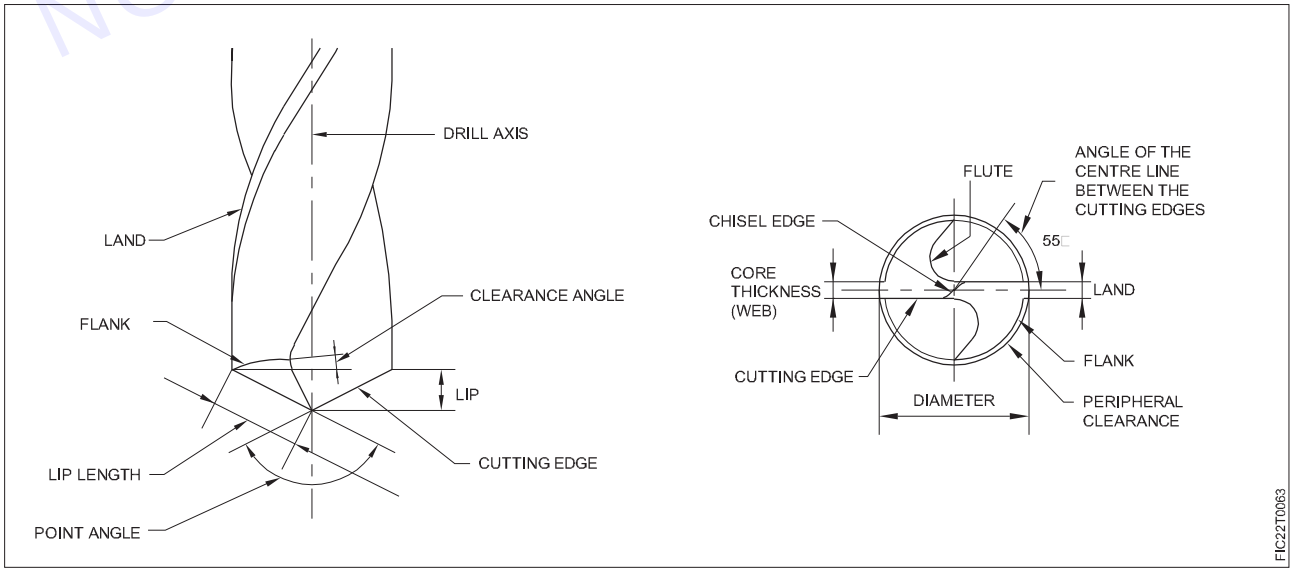
Twist drill : Almost all drilling operation is done using a twist drill. It is called a twist drill as it has two or more spiral or helical flutes formed along its length. The two basic types of twist drills are, parallel shank and taper shank. Parallel shank twist drills are available below 13mm size



Parts of a twist drill : Drills are made out of high speed steel. The spiral flutes are machined at an angle of 27 1/ 2° to its axis. The flutes provide a correct cutting angle which provides an escape path for the chips. It carries the coolant to the cutting edge during drilling. The portions left between the flutes are called 'lands'. The size of a drill is detemined and governed by the diameter over the lands. The point angle is the cutting angle, and for general purpose work, it is 118°. The clearance serves the purpose of clearing the back of the lip from fouling with the work. It is mostly 8°

Deep hole drills : Deep hole drilling is done by using a type of drill known as 'D' bit Drills are manufactured with varying helix angles for drilling different materials. General purpose drills have a standard helix angle of 27 1/2°. They are used on mild steel and cast iron.

A slow helix drill is used on materials like brass, gun metal, phosphor-bronze and plastics. A quick helix drill is used for copper, aluminium and other soft metals.



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LESSON 5 : Definition of cutting speed, spindle speed (RPM), feed, depth of cut

Objectives

At the end of this lesson you shall be able to

- state the factors for determining the cutting speed
- determine RPM/spindle speed
- select RPM for drill sizes from tables

Definition of cutting speed: Cutting speed is the speed at which the cutting edge passes over the material while cutting, and is expressed in metres per minute.

Cutting speed is also sometimes stated as surface speed or peripheral speed. The selection of the recommended cutting speed for drilling depends on the materials to be drilled and the tool material. Tool manufacturers usually provide a table of cutting speeds required for different materials. The recommended cutting speeds for different materials are given in the Based on the cutting speed recommended, the r.p.m, at which a drill has to be driven

Cutting speed calculation

n – r.p.m

v - Cutting speed in m/min.

d - diameter of the drill in mm.

$\pi = 3.14$

Definition of RPM (Spindle speed)

The term “RPM” stands for “Revolutions Per Minute,” and it is commonly used to measure the rotational speed of a spinning object, such as the spindle in machinery. The spindle speed, often expressed in RPM, is crucial in various industrial and manufacturing processes, especially in machining operations like milling and drilling.

In machining, the spindle speed is a critical parameter that determines the cutting speed of a tool as it interacts with the workpiece. The appropriate spindle speed depends on factors such as the material being machined, the type of cutting tool, and the desired surface finish.

Formula for spindle speed (RPM)

(Cutting speed×1000)/(dπ)

Recommeded cutting speed

Materials being drilled (HSS Tool)	
Aluminium	70-100
Brass	35-50
Bronze(phosphor)	20-35
Cast iron (grey)	25-401
Copper	35-45
Steel (medium carbon/mild steel)	20-30
Steel (alloy, high tensile)	5-8
Thermosetting plastic (low speed due to abrasive properties)	20-30

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Calculations of spindle speed rpm, examples

At what should a 20mm dia. Drill be run cutting, steel at 25 m./min. Surface speed? Sol: cutting speed 25 = πdn/1000

N = 25×1000/π20

N = 398 rpm

Definition of feed

Feed is the distance (X) a drill advances into the work in one complete rotation.

Feed is expressed in hundredths of a millimeter.

Feed rate: The overall rate at which the cutting tool moves along or into the workpiece. It is a combination of both axial and radial feeds.

The rate of feed is dependent up on a number of factors.

- The finish required
- Type of drill (drill material)
- Material to be drilled

Factors like rigidity of the machine, holding of the workpiece and the drill, will also have to be considered while determining the feed rate. If these are not to the required standard, the feed rate will have to be decreased.

It is not possible to suggest a particular feed rate taking all the factors into account.

Drill diameter (mm) H.S.S	Rate of feed (mm/rev)
1.0-2.5	0.040-0.060
2.6-4.5	0.050-0.100
4.6-6.0	0.075-0.150
6.1-9.0	0.100 -0.200
9.1 - 12.0	0.150-0.250
12.1 - 15.0	0.200 -0.300
15.1-18.0	0.230-0.330
18.1-21.0	0.260-0.360
21.1 - 25.0	0.280 -0.380

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Definition of depth of cut

Axial Feed (or Depth of Cut): This refers to the distance the cutting tool penetrates into the work piece along its axial direction.

It influences the depth of the cut and, in turning or milling operations, is often associated with the term “depth of cut.”

Depth of cut

The drill diameter is 40mm and find the depth of for the job? Sol. Depth of cut = dia.of hole /2 40/2=20mm

LESSON 6 : Introduction of bench/pedestal grinder

Objectives

At the end of this lesson you shall be able to

- define the bench / pedestal grinder parts and function
- state the safety precaution while using it
- state the common defects and care maintenance.

Introduction of bench / pedestal grinder

Definition: A bench grinder or pedestal grinder is a machine tool used for shaping, sharpening, and polishing metal objects by abrasive grinding. It is a stationary tool mounted on a bench or pedestal and features grinding wheels with varying coarseness for different applications.

Parts

1 **Grinding wheels:** The grinder is equipped with two grinding wheels, typically made of abrasive materials like aluminum oxide or silicon carbide. These wheels come in different grit sizes, allowing for coarse and fine grinding.

2 **Motor:** Bench grinders are powered by electric motors that drive the rotation of the grinding wheels. The motor's power and speed can vary depending on the specific application and the size of the grinder.

3 **Tool rests:** Adjustable tool rests provide support and guidance for the workpiece during grinding. They can be positioned at different angles to achieve the desired grind.

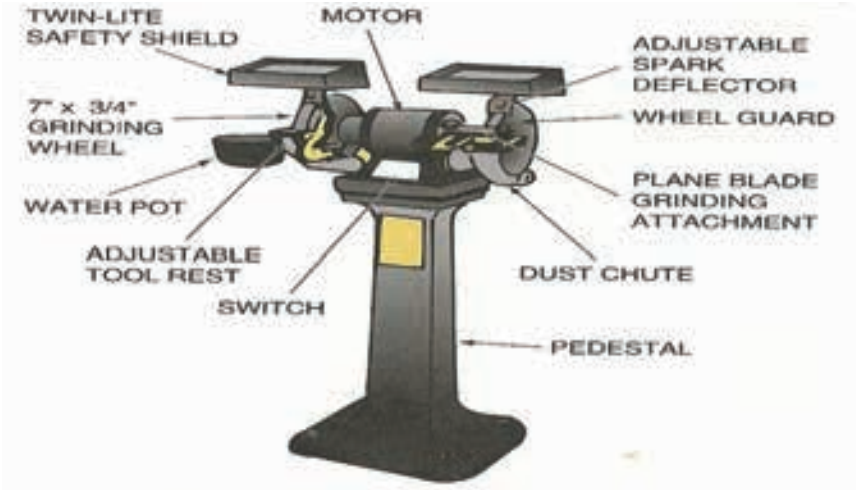
4 **Eye shields and spark guards:** Safety features like eye shields and spark guards protect the operator from sparks, debris, and potential wheel breakage. These components are crucial for maintaining a safe working environment.

Common uses

1 **Sharpening Tools:** Bench grinders are widely used for sharpening various cutting tools, such as chisels, drill bits, and blades.

2 **Grinding Metal:** They are employed for removing excess material, smoothing surfaces, and shaping metal pieces.

3 **Polishing:** With the use of polishing wheels or compounds, bench grinders can be utilized for polishing and buffing metal surfaces.



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Precautions while using pedestal grinder

1 An operator must be fully trained and instructed in the safe use, care, and protection from abrasive wheels before use. Fasten the pedestal and bench grinders on a solid surface securely.

2 Ensure all the guards are in place and secure before using a grinder.

3 Adjust tool rests to within 3 mm (1/8 in.) of wheels. Never adjust rests while the wheels are moving. Work rest height should be on a horizontal centre line of the machine spindle.

4 Maintain 6 mm (1/4 in.) wheel exposure with a tongue guard or a movable guard.

5 Check that the wheels have blotters on each side.

6 Check the wheel fits properly to the spindle when mounting. If it is loose, get another wheel.

7 Tighten the nuts before you turn the grinder on.

8 Before you plug in the grinder, manually spin the wheel to make sure it is spinning freely.

9 Safety procedures to follow when using bench and pedestal grinders

10 Make sure the cables are not damaged and in good condition.

11 Keep the cables out of the work area.

12 Wear proper personal protective equipment:

13 Eye, ear and face protection,

14 Metatarsal safety boots, where required, and

15 Respiratory protection may be required, depending on the work.

16 Wear gloves only where necessary and if there is no risk of entanglement. Make sure all guards are in place.

Inspect the wheel for chips or cracks before using

1 Stand to one side of the grinder until the wheel reaches operating speed

2 Bring work into contact with the grinding wheel slowly and smoothly without bumping.

3 Apply gradual pressure to allow the wheel to warm up evenly. Use only the pressure required to complete a job.

4 Move the work back and forth across the face of the wheel.

5 This movement prevents grooves from forming.

6 Wait for the piece to cool before touching the end.

7 Wheels are made only for grinding certain items.

8 Do not grind rough forgings on a small precision grinding wheel.

9 Support dressing tool so you can apply leverage without undue effort

10 Dress wheels regularly. Do frequent, light dressings rather than one heavy dressing.

11 Support dressing tools so you can apply leverage without undue effort.

12 With revolving cutter dressing tools, use the lugs as anchors.

13 Replace worn wheels if you cannot dress it.

14 Ensure the grinder speed does not exceed the operating speed marked on the wheel.

15 Visually inspect wheels for possible damage before mounting.

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Introduction on common defects of grinding wheel

Definition

Grinding wheel is a cutting tool which has many small cutting edges. The abrasive grains in wheel act as grinding tools, removing material from work piece.

Defects of grinding wheel

Grinding wheels become inefficient due to two main causes known as loading and glazing.

1 Loading

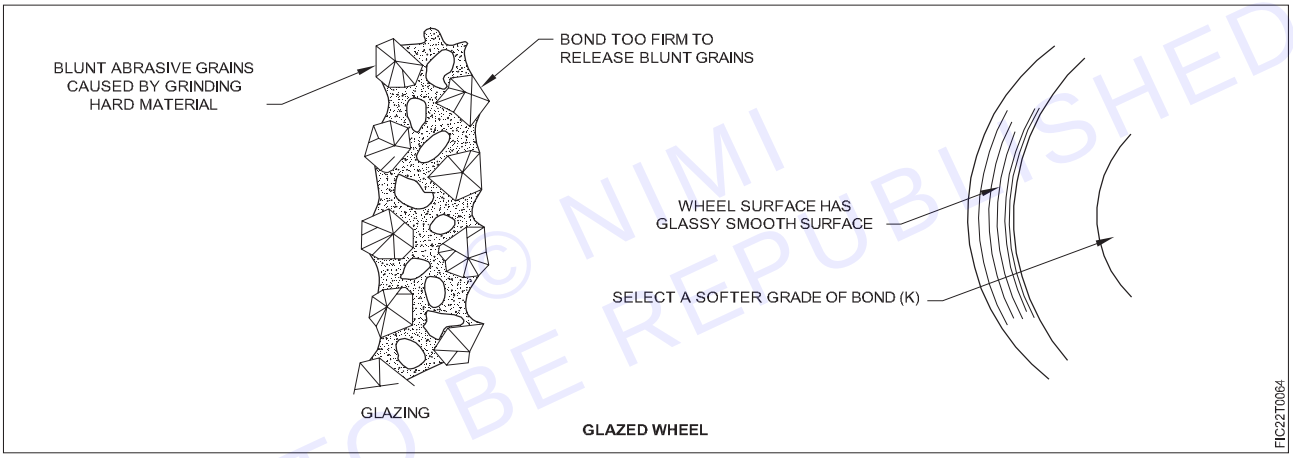
When soft materials such as aluminium, copper, lead etc. are ground, the metal particles get clogged in the pores of the wheel. This condition is called loading.

2 Glazing

When a surface of the wheel develops a smooth and shining appearance, it is said to be glazed. This indicates that the wheel is blunt, i.e. the abrasive grains are not sharp.

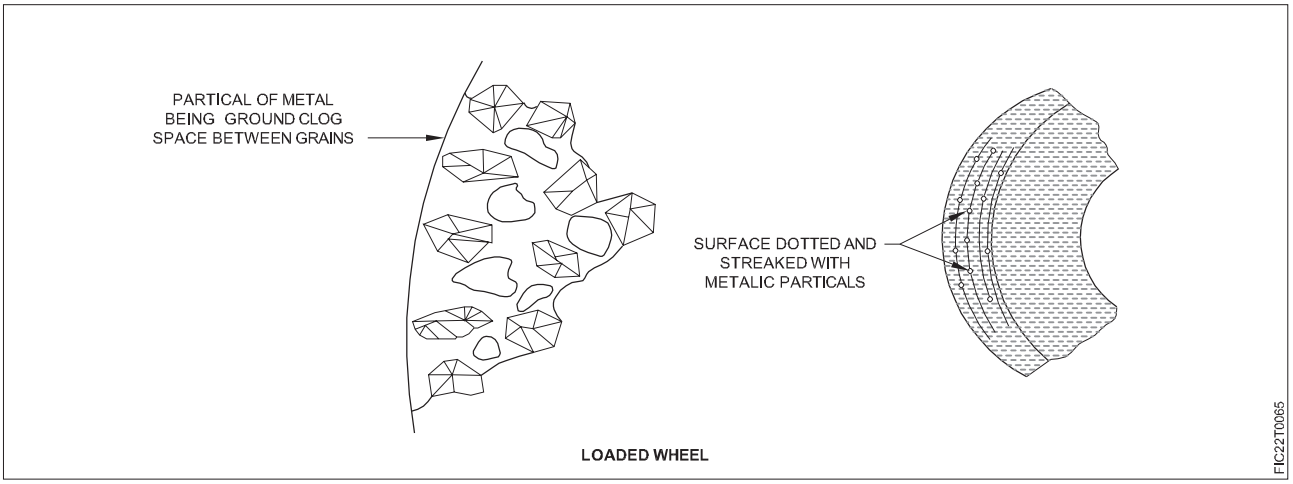
Effects of loading and glazing

When such grinding wheels are used, there is a tendency to exert extra pressure in order to make the wheels cut Excessive pressure on the grinding wheel will lead to the fracture of the wheel, excessive heating of the wheel, weakening of bonding of the wheel and bursting of the wheel.



Safety & precautions While grinding

1 Gloves, safety glasses, hear protection and apron should be worn.
2 Ensure you do not run the grinding wheel above specified RPM
3 Use proper wheel guards on machine before grinding.
4 Remove work piece from grinding wheel before turning machine off.



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1 **Wear appropriate protective gear:** This includes safety goggles to protect your eyes from flying debris, a face shield to protect your face, and ear protection if the grinding process is noisy. Additionally, wear gloves and long sleeves to protect your hands and arms from sparks and debris.

2 **Use the right equipment:** Ensure that the grinder you are using is suitable for the task at hand and is in good working condition. Follow manufacturer guidelines for maintenance and use.

3 **Inspect the work area:** Before starting, ensure that the work area is clear of any obstacles or clutter. Make sure there are no flammable materials nearby that could ignite from sparks.

4 **Secure workpiece:** Make sure the workpiece is properly secured in place using clamps or a vice to prevent it from moving during grinding.

5 **Keep a safe distance:** Maintain a safe distance between yourself and the grinder while it's in operation. Stand to the side rather than in front of the grinder to avoid being hit by flying debris.

6 **Use the proper technique:** Hold the grinder firmly with both hands and keep a firm grip on the handle. Apply steady pressure while grinding and avoid excessive force.

7 **Be mindful of sparks:** Grinding generates sparks, which can pose a fire hazard, especially in environments with flammable materials. Keep a fire extinguisher nearby and be vigilant about sparks.

8 **Take breaks:** Grinding can be physically demanding, so take regular breaks to avoid fatigue and maintain focus.

9 **Follow proper procedures:** Familiarize yourself with the specific grinding process you are performing and follow all recommended procedures and safety protocols.

10 **Never remove safety guards:** Grinding machines are equipped with safety guards for a reason. Never operate a grinder without its safety guards in place.

11 **Turn off power when not in use:** When you're finished grinding, make sure to turn off the grinder and unplug it from the power source before leaving the area.

12 **Training and supervision:** Ensure that anyone operating a grinder has received proper training and supervision, especially if they are new to the task.

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LESSON 7 : Introduction to taps and die

Objectives

At the end of this lesson you shall be able to

- state features and uses of threading hand taps
- state the different types of die
- state the method of thread cutting and safety

Introduction to tap and it's specification

They are made from high carbon steel or high speed steel, hardened and ground.

The threads are cut on the periphery and are accurately finished.

To form the cutting edges, flutes are cut across the thread.

The end of the shank of the tap is made of square shape for the purpose of holding and turning the taps.

The end of the taps are chamfered (taper lead) for assisting, aligning and starting of the thread.

The size of the taps, the thread standard, the pitch of the thread, the dia. of the tapping hole are usually marked on the shank.

Marking on the shank are also made to indicate the type of tap i.e. first, second and plug.

Type of tap in a set

Hand taps for a particular thread are available as a set consisting of three pieces.

A hand tap set is used to manually cut an internal thread. Normally, a hand tap set consists of three taps: taper tap, center tap and finishing tap. The hand taps have a square shaft to be clamped securely in thread holding tools. The hand taps can be clamped in an adjustable tap wrench and holding tools with ratchet.

These are:

– first tap or taper tap

– second tap or intermediate tap

– plug or bottoming tap

These taps are identical in all features except in the taper lead.

First tap or taper tap: The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep. The taper lead distributes the cutting force over a large area, and the taper shape helps the thread to start. They can therefore be used to start a thread prior to use of second or bottom leads, or for through holes.

Second tap or intermediate tap: Second taps have a lead of 3-5 threads at 8 degrees per side. They are the most popular and can be used for through holes, or blind holes where the thread does not need to go right to the bottom.

Plug or bottoming tap: The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth. Bottom taps have a chamfer (lead) of 1–2 threads, the angle of the lead being around 18 degrees per side. They are used to produce threads close to the bottom of blind holes

For identifying the type of taps quickly - the taps are either numbered 1,2 and 3 or rings are marked on the shank.

The taper tap has one ring, the intermediate tap has two and the bottoming tap has three rings.

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Calculation involved in finding out drill size (metric and inch)

What is tap drill size?

Before a tap is used for cutting internal threads, a hole is to be drilled. The diameter of the hole should be such that it should have sufficient material in the hole for the tap to cut the thread.

Tap drill sizes for different threads

ISO metric thread

Tap drill size for M10 x 1.5 thread

Minor diameter = Major diameter - (2 x depth) Depth of thread = 0.6134 x pitch of a screw

2 depth of thread = 0.6134 x 2 x pitch

= 1.226 x 1.5 mm

= 1.839 mm

Minor dia = 10 mm - 1.839 mm

= 8.161 mm or 8.2 mm.

This tap drill will produce 100% thread because this is equal to the minor diameter of the tap. For most fastening purposes a 100% formed thread is not required.

A standard nut with 60% thread is strong enough to be tightened until the bolt breaks without stripping the thread. Further it also requires a greater force for turning the tap if a higher percentage formation of thread is required.

Considering this aspect, a more practical approach for determining the tap drill sizes is Tap drill size = major diameter - pitch

= 10 mm - 1.5 mm

= 8.5 mm.

Compare this with the table of tap drill sizes for ISO metric threads.

BSW inch (1") threads formula 1" = 8 T.P.I

Tap drill size = Major diameter - No.of threads per inch 1 inch = 8

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Introduction to die and theirs types

1 **Definition:** A die is a specialized tool used in manufacturing processes, particularly in metalworking, to shape or cut materials into specific shapes or forms.

Dies are typically made from hardened steel and are designed to withstand the high pressures and forces involved in the manufacturing process.

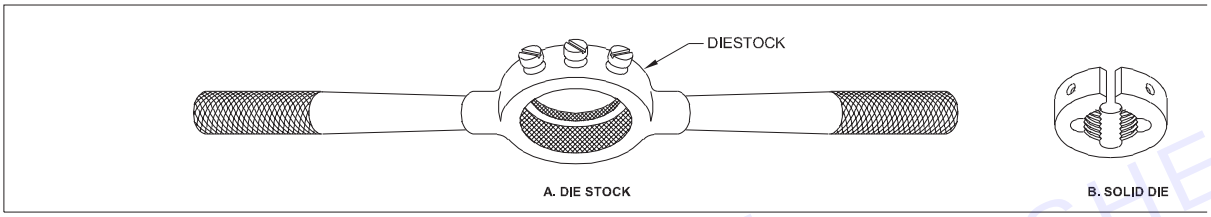
They are essential components in various industries, including automotive, aerospace, electronics, and more

Type of dies

1 **Solid die :** A solid die is a type of die used primarily for cutting or forming operations in metalworking and other manufacturing processes.

2 **Split die :** A split die is a type of die used for cutting threads on cylindrical workpieces, such as bolts, screws, and studs.

3 **Adujastable die :** An adjustable die, also known as an adjustable round die or adjustable split die, is a specialized type of threading die used for cutting external threads on cylindrical workpieces.



4 **Die nut :** The die nut is used for chasing or reconditioning the damged threads. Die nuts are not to be used for cutting new threads. The die nuts are available for different standards and sizes of threads. The die nut is turned with a spanner.

5 **Die Plate:** A die plate, also known as a die shoe or die set, is a critical component in various manufacturing processes, particularly in metalworking and forming operations.

6 **Pipe die :** A pipe die is a specialized tool used for threading pipes to create screw threads that allow pipes to be joined together securely.

7 **Chejar die :** A chaser die, also known as a thread chasing die, is a tool used for repairing or restoring damaged threads on bolts, screws, or other threaded components. Instead of cutting new threads like a tap or a die, a chaser die follows the existing thread pattern and reshapes or cleans up the damaged threads to their original form.

8 **Acrone die :** Acorn Cone Dies are Designed with a straight hook angle for production threading work on steel parts using screw machine or other thearding equipment.

9 **Adjustable screw Plate die:** This is another type of a two piece die similar to the half die. This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading.

When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held.

Methods of thread cutting by die

1 First prepare the size of the rod on which the thread to be cut .

2. There should be slide chamfer at the end on the rod this makes it easier for the die to climb.

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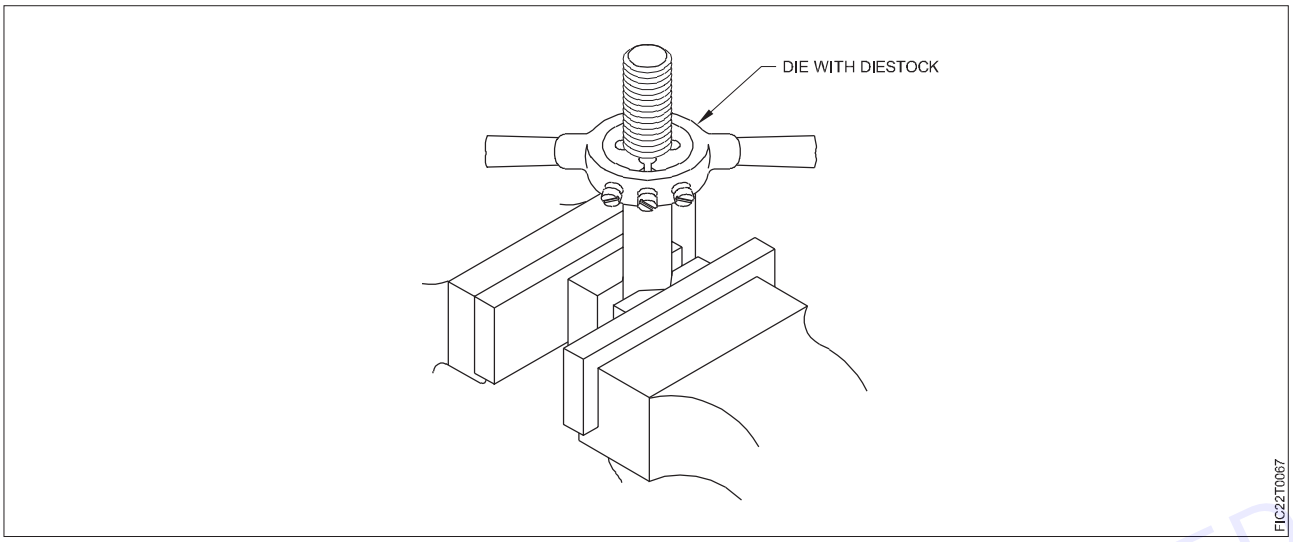
3 Hold rod or pipe firmly.

4 Hold the die in position in the die stock.

While cutting thread, use lubrication according to metal of the job.



What types of precautions to be taken for dieing operation

1 Before starting to cut the thread from die ,check the size of rod .There must be chamfer on the rod.

2 Small job should be held firmly in device.

3 Good lubrication should be used while cutting thread.

4 Equal force should be applied on both handles of the stock.

5 The thread should be cut by moving the die back and forth.

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LESSON 8 : Lubrication and coolant

Objectives

At the end of this lesson you shall be able to

- define the lubricants its types and application
- define the coolants its types and its application
- state the recommended fluid for various metals.

Lubrication and coolant, types and appplication

Definition of lubricants: With the movement of two mating parts of the machine, heat is generated. If it is not controlled, the temperature may rise resulting in total damage of the mating parts. Therefor a film of cooling medium with high viscosity is applied between the mating parts which is known as a 'lubricant'. A 'lubricant' is a substance having an oily property available in the form of fluid, semi-fluid, or solid state. It is the lifeblood of the machine, keeping the vital parts in perfect condition and prolonging the life of the machine. It saves the machine and its parts from corrosion, wear and tear and it minimises friction.

Types of lubricants

a Liquid

Mineral oil: Mineral oil is one of the most commonly used liquid lubricants. It is derived from crude oil and is suitable for general-purpose lubrication applications. Mineral oil provides good lubrication properties and is often used in automotive engines, industrial machinery, and hydraulic systems. Ex. Petrol, diesel, kerosene.

Animal oil -lard oil, fish oil

Synthetic Oils: Synthetic oils are manufactured from chemically synthesized base oils and additives. They offer superior performance compared to mineral oils in terms of stability, temperature resistance, and lubrication properties. Synthetic oils are used in high- performance applications such as aerospace, precision machinery, and high-speed engines.- Ex. silicon lubricant.

Vegetable Oils: Vegetable oils, such as soybean oil and rapeseed oil, can also serve as effective liquid lubricants. They are biodegradable and environmentally friendly, making them suitable for applications where environmental concerns are important, such as agriculture and food processing machinery. Ex. Mustered oil, coconut oil.

b Semi liquid lubricant

While not strictly liquid, greases are semi-fluid lubricants consisting of a base oil thickened with a soap or other thickener. Greases offer better adhesion and staying power compared to liquid lubricants, making them suitable for applications where frequent reapplication of lubricant is impractical.

c Solid lubricant-mica, wax

Application of lubricants:

- Reduces friction
- Prevents wear
- Prevents adhesion
- Aids in distributing the load
- Cools the moving elements
- Prevents corrosion
- Improves machine efficiency

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Definition of coolants: Coolants (Cutting fluids) play an important role in reducing the wear of cutting tools. Coolants (Cutting fluids) are essential in most metal cutting operations. During a machining process, considerable heat and friction are created by the plastic deformation of metal occurring in the shear zone when the chip slides along the chip tool interface. This heat and friction cause the metal to adhere to the cutting edge of the tool, and the tool may break down. The result is poor finish and inaccurate work.

Types of coolants

1 Water-based coolants

- **Soluble Oils:** Soluble oils are water-based coolants that contain emulsified mineral or synthetic oils, along with additives such as corrosion inhibitors, lubricants, and biocides. They offer good lubrication and cooling properties and are suitable for a wide range of machining operations, including drilling, milling, and grinding.
- **Synthetic Coolants:** Synthetic coolants are water-based fluids formulated from synthetic chemicals, such as polyalphaolefins (PAO) or polyglycols. They offer excellent cooling and lubricating properties, high stability, and resistance to bacterial growth. Synthetic coolants are suitable for high-speed machining, aluminum machining, and operations requiring tight tolerances.

2 Oil-based coolants

- **Straight Oils:** Straight oils, also known as neat oils, are mineral or synthetic oils used without dilution. They offer excellent lubrication and cooling properties and are suitable for heavy-duty machining operations, such as broaching, threading, and gear cutting. Straight oils provide good surface finish and corrosion protection but may require additional cleaning due to their high viscosity.
- **Semi-synthetic** Coolants: Semi-synthetic coolants are oil-based fluids blended with water to create an emulsion. They combine the lubricating properties of oil with the cooling and flushing properties of water. Semi-synthetic coolants offer improved stability and performance compared to soluble oils and are suitable for a wide range of machining operations.

3 Synthetic coolants

- **Polyalphaolefins (PAOs):** PAOs are synthetic hydrocarbon-based fluids known for their high thermal stability, oxidation resistance, and lubricating properties. They are suitable for high-temperature machining operations, such as aerospace machining and hard metal machining.
- **Polyalkylene Glycols (PAGs):** PAGs are synthetic fluids with excellent lubricating and cooling properties. They offer high thermal stability, low volatility, and resistance to microbial growth. PAGs are suitable for machining operations involving high-speed steel, stainless steel, and non-ferrous metals.

4 Vegetable-based coolants

- **Vegetable Oils:** Vegetable-based coolants are derived from natural oils, such as soybean oil, rapeseed oil, or coconut oil. They are biodegradable, environmentally friendly, and offer good lubrication and cooling properties. Vegetable-based coolants are suitable for applications where environmental concerns are important, such as food processing and agricultural machinery.

5 Air-based coolants:

- **Air or mist coolants:** Air-based coolants, also known as air or mist cooling systems, use compressed air to create a fine mist of coolant that is directed onto the cutting tool and workpiece. Air-based coolants offer minimal fluid consumption, reduced environmental impact, and improved operator safety. They are suitable for high-speed machining operations and applications where fluid contact is limited.

Application of coolants:

- Cools the tool and the work piece
- Lubricates the chip / tool interface and reduces the tool wear due to friction
- Prevents chip welding - Improves the surface finish of the work piece
- Flushes away the chips
- Prevents corrosion of the work and the machine

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Recommended cutting fluids for various metals

Material	Drilling	Reaming	Threading	Turning	Milling
Aluminium	Soluble oil Kerosene Kerosene	Soluble oil Kerosene Mineral oil and Lard oil	Soluble oil Kerosene and Lard oil	Soluble oil	Dry Soluble oil Lard oil Mineral oil
Brass	Dry Soluble oil Mineral oil Lard oil	Dry Soluble oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil
Bronze	Dry Soluble oil Mineral oil Lard oil	Dry Soluble oil Mineral oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil Mineral oil Lard oil
Cast iron	Dry Air jet Soluble oil Lard oil	Dry Soluble oil Mineral oil Lard oil	Dry Sulphurized oil Mineral oil Lard oil	Dry Soluble oil	Dry Soluble oil
Copper	Dry Soluble oil Mineral oil Lard oil Kerosene oil	Soluble oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil
Steel Alloys	Soluble oil Sulphurized oil Mineral oil Lard oil	Soluble oil Sulphurized oil Mineral oil Lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Mineral oil Lard oil
General purpose steel	Soluble oil Sulphurized oil Lard oil	Soluble oil Sulphurized oil Lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Lard oil

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LESSON 9 : Introduction to reamer and their types

Objectives

At the end of this lesson you shall be able to

- different types of reamers
- state the various uses of reamers

Introduction to reamer and their types

Types of reamer & explain it:

1 **Hand reamer:** Hand reamer is used for reaming hole by hand great skill needed to use this reamer. Hand reamer have a straight shank.

- **Design:** Hand reamers have a cylindrical body with straight or spiral flutes along their length. They feature a tapered cutting end, which gradually increases in diameter towards the shank end. Hand reamers may have a square or hexagonal shank for gripping with a wrench or other hand tool.
- **Cutting Flutes:** Hand reamers can have straight or spiral flutes. Straight flutes run parallel to the reamer's axis, while spiral flutes spiral around the reamer. Spiral flutes are more efficient in chip evacuation, making them suitable for deep-hole and interrupted cutting applications.
- **Tapered End:** The cutting end of a hand reamer is tapered to facilitate entry into the hole and gradual enlargement as the reamer is rotated. This tapered design helps to minimize chatter and ensure a smooth cutting action.
- **Square or Hexagonal Shank:** Hand reamers typically feature a square or hexagonal shank at the non-cutting end. This shape allows for easy gripping with a wrench or other hand tool, providing leverage and control during the reaming process.
- **Materials:** Hand reamers are commonly made from high-speed steel (HSS) or cobalt steel for durability and wear resistance. Some hand reamers may also be coated with titanium nitride (TiN) or other coatings to further enhance cutting performance and tool life.
- **Applications:** Hand reamers are versatile tools used in various industries, including metalworking, woodworking, automotive, and construction. They are suitable for enlarging and finishing holes in a wide range of materials, including metals, plastics, and composites.
- **Manual Operation:** Hand reamers are operated manually by rotating them in the hole using a wrench or other hand tool. The reamer is inserted into the pre-drilled hole, and then rotated clockwise and counterclockwise to remove material and achieve the desired dimensions and surface finish.
- **Accuracy and Precision:** Hand reamers allow for precise control over hole size and surface finish, making them suitable for applications where tight tolerances are required. However, achieving consistent results with hand reamers requires skill and experience in manual machining techniques.

2 **Machine Reamer :** They are mounted in the spindle of machine and roasted. Morse taper rock to these machine reamers they are, so that they are easily caught in machine spindle

- **Design:** Machine reamers have a cylindrical body with straight or spiral flutes along their length. The cutting end of the reamer is typically tapered to facilitate entry into the hole and gradual enlargement as the reamer rotates. Machine reamers may have a straight or Morse taper shank for mounting in machine tool chucks or holders.
- **Cutting Flutes:** Machine reamers can have straight or spiral flutes, similar to hand reamers. Straight flutes run parallel to the reamer's axis, while spiral flutes spiral around the reamer. Spiral flutes are more efficient in chip evacuation, making them suitable for deep-hole and interrupted cutting applications.

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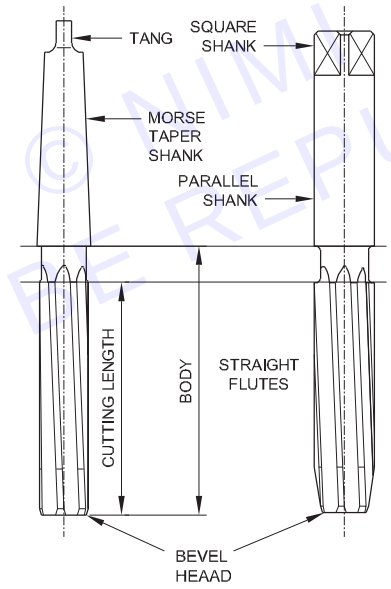
- **Shank types:** Machine reamers are available with different shank types to suit various machine tool setups. Common shank types include straight shank, which is suitable for use with drill chucks, and Morse taper shank, which is compatible with drill press or milling machine spindles.
- **Materials:** Machine reamers are typically made from high-speed steel (HSS), cobalt steel, or carbide materials. HSS machine reamers are suitable for general-purpose machining of ferrous and non-ferrous materials. Cobalt and carbide machine reamers offer higher hardness and wear resistance, making them suitable for machining hardened steels and exotic alloys.
- **Coatings:** Some machine reamers may be coated with titanium nitride (TiN), titanium carbonitride (TiCN), or other coatings to enhance cutting performance and tool life. Coatings can improve lubricity, reduce friction and heat generation, and extend tool life in high-speed machining applications.
- **Applications:** Machine reamers are used in a wide range of machining operations, including milling, drilling, boring, and turning. They are commonly used in manufacturing industries such as aerospace, automotive, medical, and precision engineering to achieve tight tolerances and high-quality surface finishes.
- **Accuracy and precision:** Machine reamers allow for precise control over hole size and surface finish, making them essential tools for applications where tight tolerances are required. They produce accurately sized and finished holes with minimal deviation from the specified dimensions.
- **Operation:** Machine reamers are operated using machine tools such as milling machines, drill presses, or CNC machining centers. The reamer is mounted in the machine spindle or tool holder, and the machine's spindle or cutting tool is used to rotate the reamer and feed it into the pre-drilled or bored hole.



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LESSON 10 : Precision measuring instrument

Objectives

At the end of this lesson you shall be able to

- explain various types of precision measuring instruments like vernier caliper, vernier height gauge, micrometers etc.
- working principles of various precision measuring instruments
- state the safety precautions and care and maintenance while using

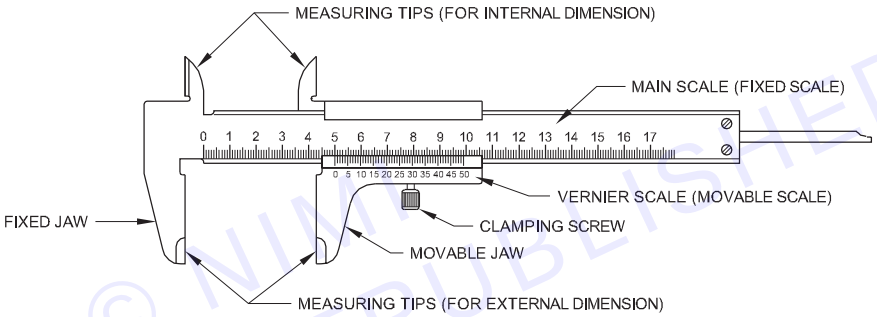
Universal Vernier Caliper (Metric)

- **Definition of universal vernier caliper**

It is the precision measuring instruments by which we can measure external internal and depth of a job with 0.02 mm accuracy

Parts

1 Fixed jaw
2 Movable jaw
3 Thumb grid thumb rest
4 Depth bar
5 Beam
6 Nibs
7 Locking screw
8 Find adjusting unit



1 Main scale: The main scale is a graduated scale marked in millimeters (or inches) along its length. It is fixed to the caliper body and serves as the primary reference for measurement.

2 Vernier scale: The vernier scale is a secondary scale that slides along the main scale. It contains divisions that are slightly smaller than those on the main scale. The vernier scale allows for more precise measurement readings by providing additional subdivisions beyond the main scale divisions.

3 Measuring jaw: The measuring jaw is the stationary upper jaw of the caliper, against which the object being measured is placed. It typically has an inside and outside measuring surface for different types of measurements.

4 Sliding jaw: The sliding jaw is the lower movable jaw of the caliper, which moves along the main scale and vernier scale. It is adjusted to contact the opposite side of the object being measured, allowing the caliper to accurately measure the distance between the jaws.

5 Depth bar: Many vernier calipers also feature a depth probe or rod attached to the lower end of the sliding jaw. This probe extends perpendicular to the measuring jaws and allows for depth measurements of holes, slots, and other recessed features.

6 Locking screw: Some vernier calipers are equipped with a locking screw or clamp mechanism to secure the sliding jaw in position once the measurement has been taken, preventing accidental movement and ensuring measurement accuracy.

- **Principal of universal vernier caliper**

The difference between two sliding scale i.e.main scale division & vernier scale division

Least count of universal vernier caliper

value of 1 main scale division = 1mm hence 49 main scale division = 49mm

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49 main scale division are divided into 50 Vernier scale division So division = 49 mm on main scale

Hence 49/50 = 0.98

1 division Vernier scale = 0.98mm 1×49/50 = 49×2/50×2 98/100 = 0.02mm

Safety precaution

1 **Proper handling:** Handle the caliper with care to avoid dropping or mishandling, which could damage the delicate measuring surfaces and affect accuracy.

2 **Keep clean:** Ensure that the measuring faces of the caliper are clean and free from debris, dust, or oil residues, as these can interfere with accurate measurements.

3 **Avoid excessive Force:** Do not apply excessive force when closing the jaws of the caliper around an object. Use gentle pressure to prevent damaging the measuring faces and ensure accurate readings.

4 **Avoid overextension:** Avoid overextending the jaws of the caliper beyond their intended range, as this could lead to damage or misalignment of the measuring surfaces.

5 **Use correct technique:** Use the correct technique when taking measurements to ensure accuracy. Make sure the object being measured is properly aligned and seated between the jaws of the caliper.

6 **Avoid abrasive surfaces:** Avoid measuring rough or abrasive surfaces that could damage the measuring faces of the caliper. Use protective measures such as a surface plate or protective film if necessary.

7 **Store properly:** Store the caliper in a protective case or pouch when not in use to prevent damage and contamination. Avoid storing it in areas with high humidity or temperature fluctuations.

8 **Regular maintenance:** Periodically inspect the caliper for signs of wear, damage, or misalignment. Clean and lubricate the moving parts as needed to ensure smooth operation and accurate measurements.

9 **Use personal Protective Equipment (PPE):** Depending on the application, wear appropriate PPE such as safety glasses or gloves to protect against potential hazards.

10 **Training:** Ensure that operators are properly trained in the use of the caliper and understand the safety precautions and procedures. Regular training and refresher courses can help reinforce safe practices.

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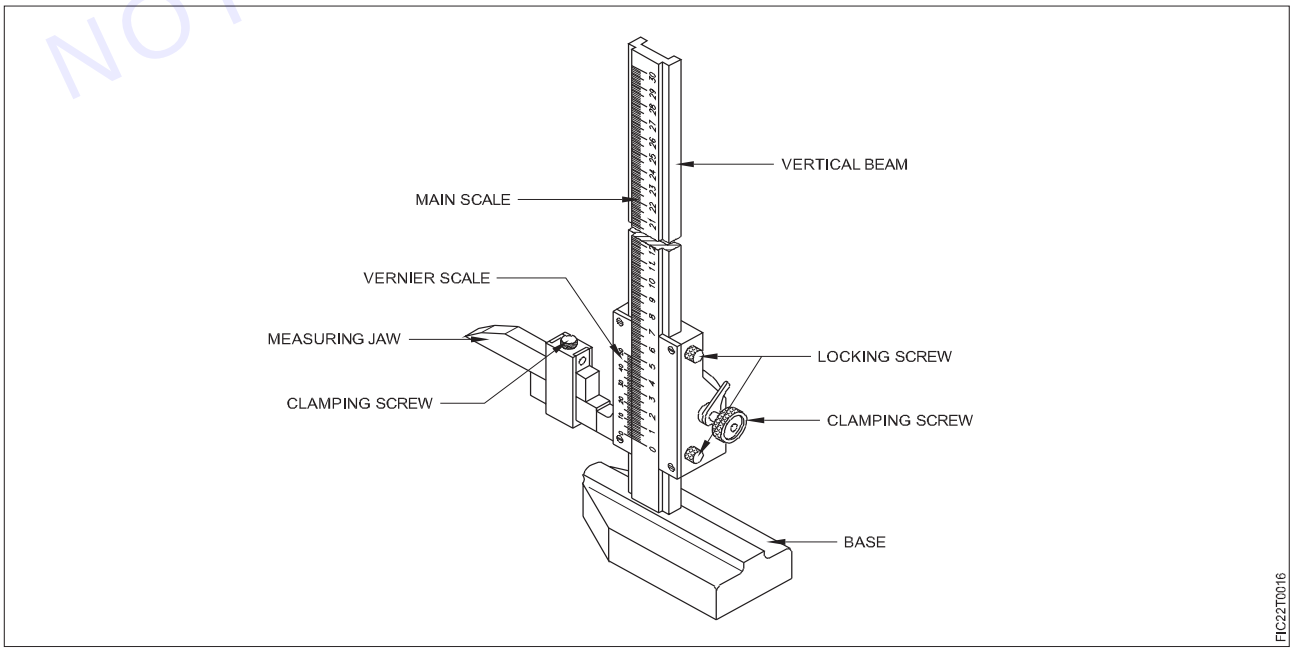
Vernier height gauge

- **Introduction of vernier height gauge and its parts**

A Vernier height gauge is a precision measurement tool used to measure vertical distances or heights with a high degree of accuracy. It consists of several key parts, each playing a crucial role in its functionality. Here are the main parts of a Vernier height gauge.



1 **Base:** The bottom part of the height gauge that provides stability and support when measuring.

2 **Vertical beam or column:** This is the tall, vertical part of the gauge that rises from the base. It serves as a reference for measurements and provides the structure for other components to slide up and down.

3 **Vernier scale:** The Vernier scale is a secondary scale that allows for highly precise readings. It is typically found on a sliding jaw or carriage that moves along the vertical beam. The Vernier scale consists of evenly spaced divisions that are slightly smaller than the main scale divisions. By aligning the Vernier scale with the main scale, users can read measurements to fractions of the smallest scale division.

4 **Main scale:** The main scale is the primary scale marked along the vertical beam or column. It provides the coarse measurement readings, usually in millimeters or inches, depending on the gauge.

5 **Sliding jaw or carriage:** This movable part holds the Vernier scale and can be adjusted up and down the vertical beam to measure different heights.

6 **Measuring jaw:** The part of the sliding jaw or carriage that makes contact with the object being measured. It typically has a flat surface for accurate height measurements.

7 **Locking screw or clamp:** A mechanism, often a screw or clamp, used to secure the sliding jaw or carriage in place once the desired measurement is obtained.

8 **Fine adjustment knob:** Some Vernier height gauges have a fine adjustment knob to make precise adjustments to the height without needing to release and reposition the sliding jaw.

9 **Scriber:** A pointed attachment or feature at the bottom of the height gauge used for marking or scribing lines on the workpiece.

These parts work together to enable precise vertical measurements, making Vernier height gauges essential tools in fields requiring accurate height measurements, such as machining, engineering, and quality control.

- **Principle of vernier height gauge**

The principle of a Vernier height gauge is based on using a Vernier scale to make precise measurements of vertical distances or heights. The Vernier scale, which slides parallel to the main scale, allows for finer measurements by aligning its divisions with those on the main scale. This alignment provides a more accurate reading than the main scale alone, enabling high precision in height measurements.

- **Specific use of vernier height gauge**

A Vernier height gauge is specifically designed for accurately measuring vertical distances or heights with high precision. Some specific uses of Vernier height gauges include:

1 **Measuring the height of workpieces:** In machining and manufacturing processes, Vernier height gauges are commonly used to measure the height of components, parts, or workpieces with precision, ensuring they meet required specifications.

2 **Setting up machinery:** Vernier height gauges are used to set up machinery and equipment to specific heights or distances, ensuring precise alignment and operation.

3 **Checking flatness and parallelism:** These gauges can also be used to check the flatness and parallelism of surfaces by measuring the height difference between multiple points on a surface.

4 **Quality control:** In quality control processes, Vernier height gauges are employed to verify the dimensions and tolerances of manufactured parts, ensuring they meet quality standards.

5 **Layout and marking:** Vernier height gauges can be used for layout and marking purposes, such as scribing lines or marking reference points at specific heights on workpieces.

Overall, Vernier height gauges are indispensable tools in various industries where accurate height measurements are essential, such as machining, engineering, metalworking, woodworking, and quality control.

- **Safety precautions while using vernier height gauge**

When using a Vernier height gauge, it's important to follow safety precautions to prevent accidents and ensure accurate measurements. Here are some safety precautions to consider:

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1 **Wear appropriate personal protective equipment (PPE):** Depending on the specific application and workplace regulations, wear safety glasses, gloves, and other PPE as necessary to protect yourself from potential hazards.

2 **Inspect the equipment:** Before use, inspect the Vernier height gauge for any damage, defects, or irregularities. Ensure that all components are in proper working condition and that the gauge is securely mounted or positioned.

3 **Handle with care:** Vernier height gauges are precision instruments, so handle them with care to avoid damaging delicate parts or causing misalignment. Avoid dropping or roughly handling the gauge.

4 **Secure workpieces:** When measuring workpieces, ensure they are securely positioned and supported to prevent movement or slippage during measurement. Use clamps or fixtures if necessary to hold the workpiece in place.

5 **Avoid excessive force:** When making measurements, apply gentle and steady pressure to the measuring jaw or carriage. Avoid using excessive force, as it may damage the gauge or produce inaccurate measurements.

6 **Use appropriate techniques:** Follow proper measurement techniques and procedures recommended by the manufacturer or your organization. Familiarize yourself with the operation of the Vernier height gauge before use.

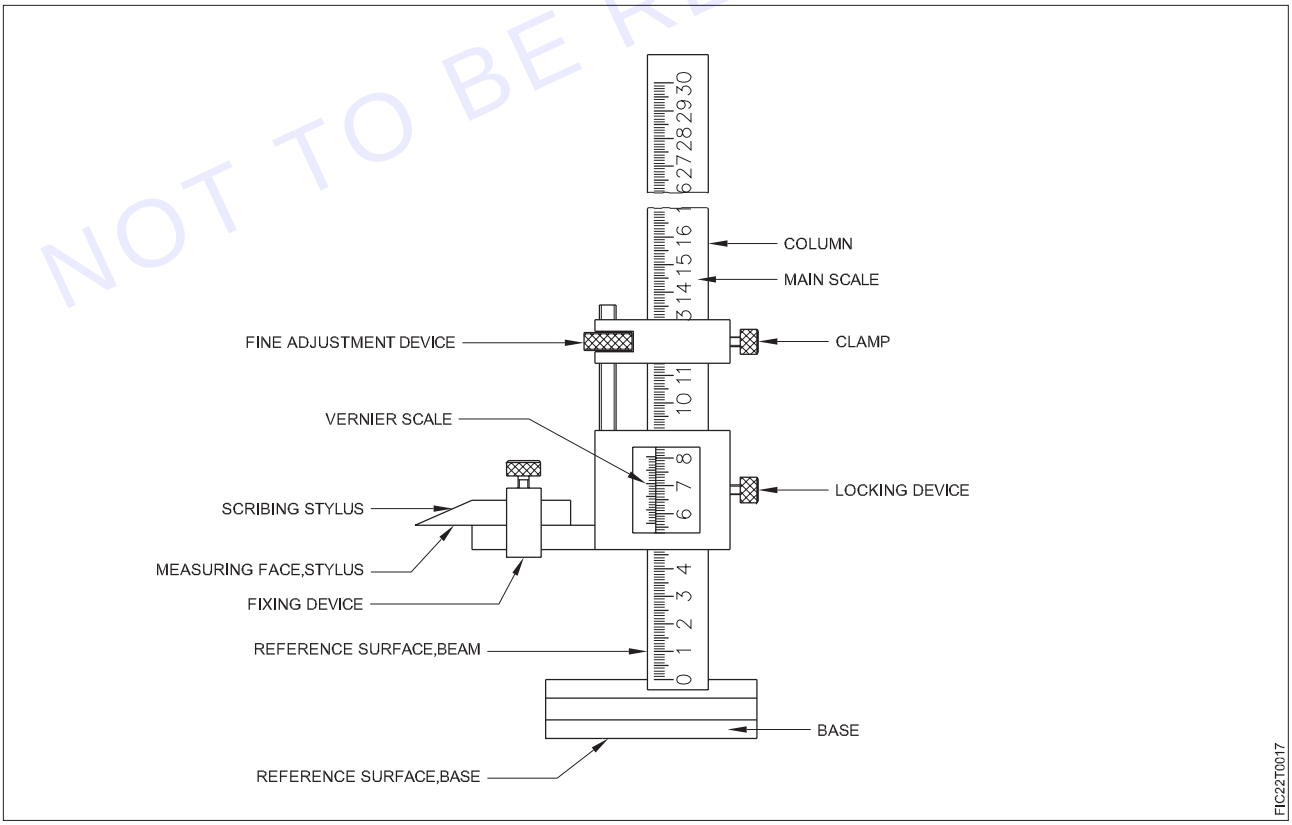
7 **Keep the workspace clean:** Maintain a clean and organized workspace free of clutter or debris. This reduces the risk of accidents and ensures accurate measurements by minimizing interference with the gauge or workpieces.

8 **Be mindful of sharp edges:** Some workpieces or components may have sharp edges or protrusions. Be cautious when handling such items to avoid injuries.

9 **Store properly:** After use, store the Vernier height gauge in a clean and dry environment, protected from dust, moisture, and other contaminants. Follow manufacturer recommendations for storage to prolong the life of the equipment.

10 **Training:** Ensure that personnel using the Vernier height gauge are adequately trained in its operation, safety procedures, and maintenance requirements.

By following these safety precautions, you can minimize the risk of accidents and ensure safe and accurate use of Vernier height gauges in various applications.



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Outside micrometer (metric)

Definition of outside micrometer

A micrometer is a precision instrument used to measure a job, generally within an accuracy of 0.01 mm. Micrometers used to take the outside measurements are known as outside micrometers.

The parts of a micrometer are listed here.

Frame: The frame is made of drop-forged steel or malleable cast iron. All other parts of the micrometer are attached to this.

Barrel/Sleeve: The barrel or sleeve is fixed to the frame. The datum line and graduations are marked on this.

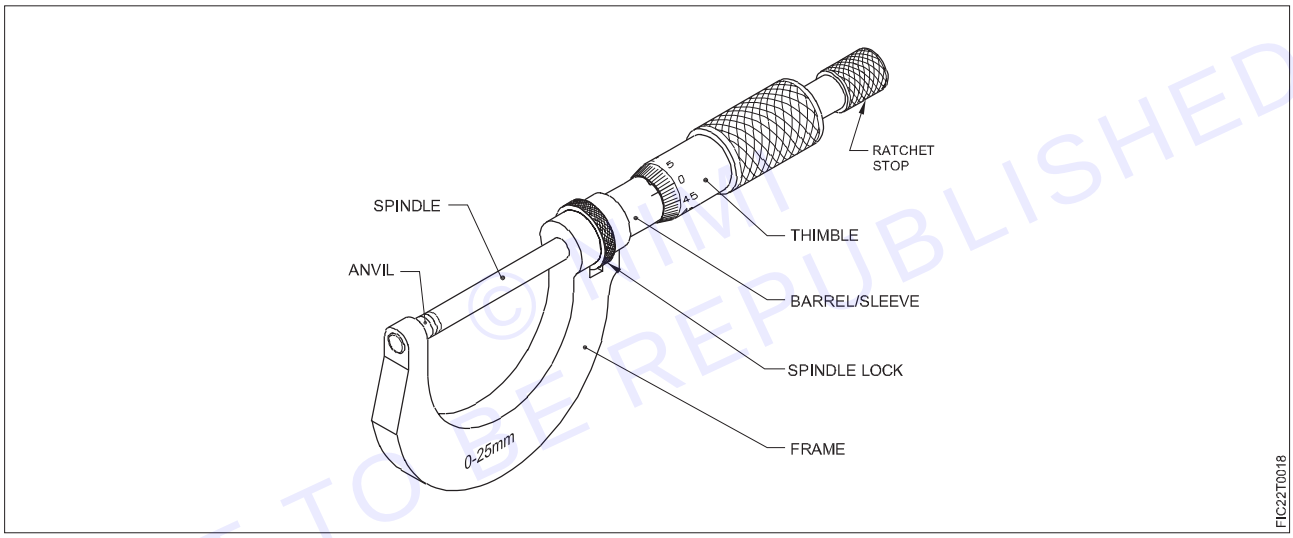
Thimble On the bevelled surface of the thimble also, the graduation is marked. The spindle is attached to this.

Spindle: One end of the spindle is the measuring face. The other end is threaded and passes through a nut. The threaded mechanism allows for the forward and backward movement of the spindle.

Anvil: The anvil is one of the measuring faces which is fitted on the micrometer frame. It is made of alloy steel and finished to a perfectly flat surface.

Spindle lock nut: The spindle lock nut is used to lock the spindle at a desired position.

Ratchet stop: The ratchet stop ensures a uniform pressure between the measuring surfaces.



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Working principle of outside micrometre

The micrometer works on the principle of screw and nut. The longitudinal movement of the spindle during one rotation is equal to the pitch of the screw. The movement of the spindle to the distance of the pitch or its fractions can be accurately measured on the barrel and thimble. On the barrel a 25 mm long datum line is marked. This line is further graduated to millimetres and half millimetres (i.e. 1 mm & 0.5 mm). The graduations are numbered as 0, 5, 10, 15, 20 & 25 mm. The circumference of the bevel edge of the thimble is graduated into 50 divisions and marked 0-5-10-15..... 45-50 in a clockwise direction.

In metric micrometers the pitch of the spindle thread is 0.5 mm. Thereby, in one rotation of the thimble, the spindle advances by 0.5 mm

The distance moved by the spindle during one rotation of the thimble is 0.5 mm. Movement of one division of the thimble = 0.5 x 1/50 = 0.01 mm

Least count of an outside micrometer

- Pitch of a spindle thread is 0.5 mm in one rotation of thimble spindle advances 0.5 mm.
- On barrel 25 mm datum line is further graduated to mm and half mm and numbered as 0,5,10,15,20,25 mm.
- Circumference of bevel edge of thimble is graduated into 50 equal divisions.

  = Movement of one division of thimble.

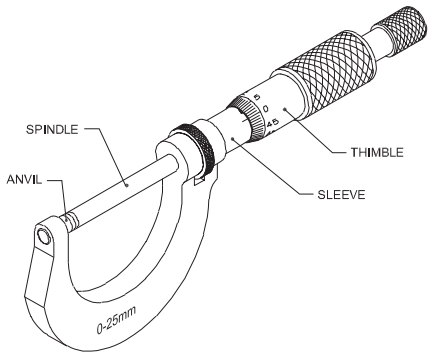
  0.5 ×1 ÷ 50 = 0.01 mm

Various types of micrometres

Micrometres are precision measuring instruments used to measure dimensions with high accuracy'

Parts of micrometre

- Frame,
- Anvil,
- Locking device,
- Barrel,
- Spindle,
- Thimble,
- Ratchet stop



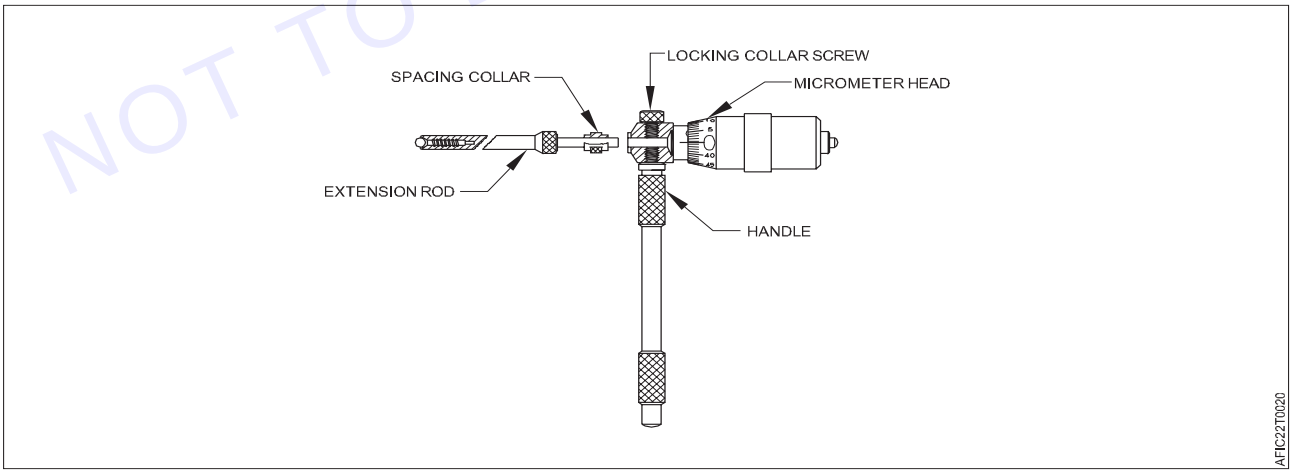
There are various types of micrometers available, each designed for specific measurement tasks and applications. Here are some common types of micrometres.

1 Outside micrometre

- **Description:** Also known as a micrometre calliper, an outside micrometre is used to measure the external dimensions of objects such as diameters, thicknesses, or lengths.
- **Features:** It consists of a C-shaped frame with a calibrated screw mechanism that moves a measuring spindle perpendicular to the object being measured. The spindle has a flat anvil on one end and a measuring face on the other.
- **Applications:** Outside micrometres are commonly used in machining, engineering, manufacturing, and quality control for precise measurements of cylindrical or rectangular objects.

2 Inside micrometre

- **Description:** An inside micrometre is used to measure the internal dimensions of objects such as bores, holes, or cylinders.
- **Features:** It consists of a C-shaped frame with a calibrated screw mechanism that moves a set of measuring rods or anvils outward when turned. The rods have flat measuring faces on one end.
- **Applications:** Inside micrometres are commonly used in machining, automotive, and precision engineering for measuring the diameter or internal dimensions of holes, cylinders, and other hollow objects.



3 Depth micrometre

- **Description:** A depth micrometre is used to measure the depth of holes, slots, or recesses.
- **Features:** It consists of a base, a calibrated rod or blade with a measuring face, and a thimble or dial gauge for reading the measurement. The rod or blade is lowered into the hole or recess until it contacts the bottom surface.
- **Applications:** Depth micrometres are commonly used in metalworking, woodworking, and machining for measuring the depth of holes, counter bores, counter sinks, and other features.

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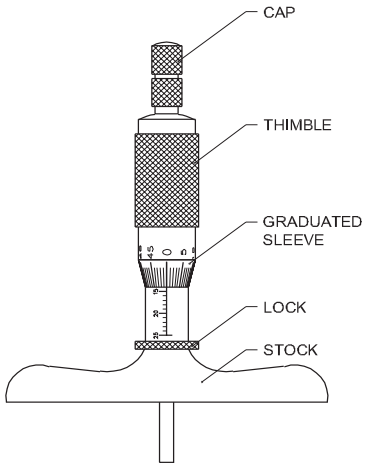

DEPTH MICROMETER

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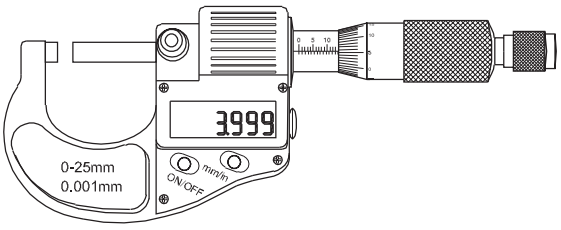
4 Thread micrometre

- **Description:** A thread micrometre is used to measure the pitch diameter or major diameter of screw threads.
- **Features:** It has specially shaped measuring faces designed to fit the profile of screw threads. The micrometre is placed over the thread, and the measuring faces are brought into contact with the thread crests.
- **Applications:** Thread micrometres are commonly used in manufacturing, automotive, and aerospace industries for measuring the pitch diameter of screw threads to ensure proper fit and functionality.

5 Digital micrometre

- **Description:** A digital micrometre is a modern variation of traditional micrometres that features a digital readout for easier and more precise measurements.
- **Features:** It typically has an LCD display that shows the measurement in digital format, eliminating the need to read scale divisions manually. Some digital micrometres also offer additional features such as data output, zero-setting, and inch/metric conversion.
- **Applications:** Digital micrometres are used in various industries and applications where precise measurements are required, offering faster and more accurate readings compared to traditional micrometres.



FEATURE OF DIGITAL MICROMETERS

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Principal of micrometre

Micrometres is a precision instrument operating on the principle of Nut-bolt

Safety precautions

1 The micrometres should be selected according to work

2 Micrometres should never be kept with other hand tool.

3 After use the micrometre should be cleaned & placed in the box with light oil.

4 Before using the micrometre it's L.C zero error should be detected.

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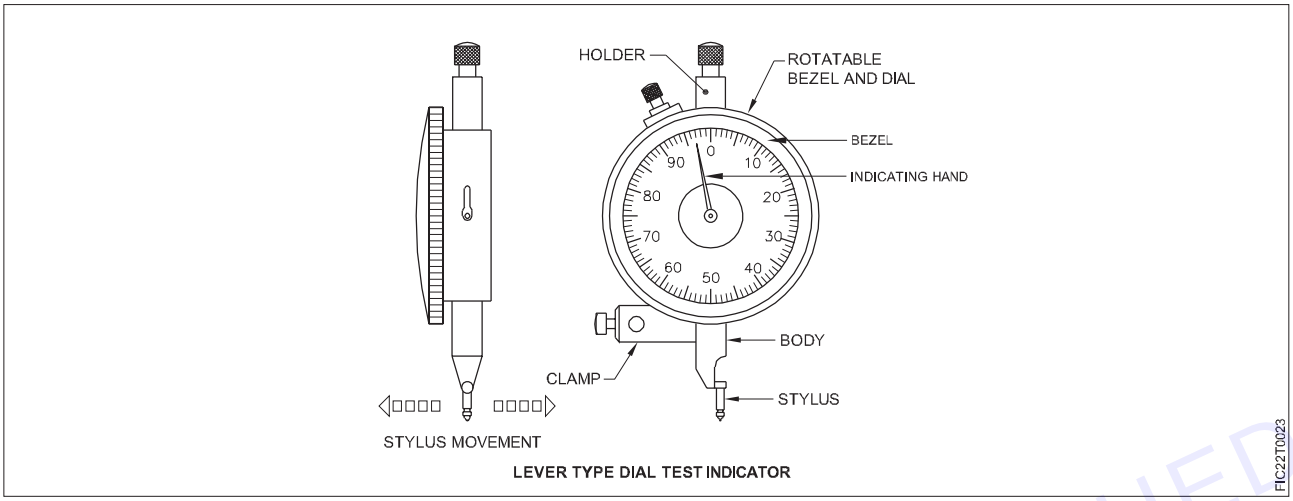
Dial test indicator

Definition of dial test indicator:

Dial test indicators are instruments of high prescision, used for comparing and determining the variation in the sizes of a component. (Fig 1) These instruments cannot give the direct reading of the sizes like micrometres and Vernier callipers. A dial test indicator magnifies small variations in sizes by means of a pointer on a graduated dial. This direct reading of the deviations gives an accurate picture of the conditions of the parts being tested.



LEVER TYPE DIAL TEST INDICATOR

Types of dial test indicator

Two types of dial test indicator are in use:

1 Plunger type dial test indicator.

2 Lever type dial test indicator.

1 Plunger type dial test indicator: As described earlier, a plunger type dial test indicator features a probe or stylus mounted on a spring-loaded plunger mechanism. The movement of the object being measured causes the stylus to move, which in turn compresses or extends the plunger against a spring. This linear motion of the plunger is then translated into rotational motion, which is indicated by the dial.

2. Lever type dial test indicator: In a lever type dial test indicator, the stylus is connected to a lever mechanism rather than a plunger. As the stylus makes contact with the object being measured, it causes the lever to pivot. The movement of the lever is then amplified and transferred to the dial indicator via a system of gears or linkages, resulting in the indication of the measurement on the dial face.

Parts of dial test indicator

It's part's:

1 Pointer

2 Rotatable bevel

3 Bezel clamp

4 Back lug

5 Transparent dial cover

6 Stem

7 Plunger

8 Anvil

9 Revolution counter

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1 **Plunger or lever mechanism:** This mechanism translates the linear motion of the stylus into rotational motion, which is then indicated on the dial face. In plunger-type indicators, the stylus is connected to a spring-loaded plunger that moves linearly against a spring. In lever-type indicators, the stylus is connected to a lever that pivots as it makes contact with the object.

2 **Spring:** In plunger-type indicators, a spring is used to apply a constant force to the plunger, ensuring consistent measurements by keeping the stylus in contact with the object.

3 **Dial face:** The dial face is typically a circular disc marked with graduations that represent units of measurement, such as thousandths of an inch or hundredths of a millimetre. The indicator needle moves along this dial to indicate the measurement being taken.

4 **Indicator needle or pointer:** The indicator needle is attached to the plunger or lever mechanism and moves across the dial face to indicate the measurement being taken. It typically has a fine point for precise readings.

5 **Bezel and crystal:** The bezel is the outer ring that holds the crystal or glass covering the dial face, protecting it from damage and contamination while allowing the user to see the measurements clearly.

Principal

The working system of dial test indicator is the principal of Rack & Pinion.

Least count of dial test indicator

In indicator rake 25mm length with 50teeth fitted on spindle. i.e when one teeth, i.e when one teeth of rake moves upward, rake moves 1/2mm. Pinion 10teeth meshes with it & gear 'B' is fitted on 10teeth pinion axis. Pinion 'C' having 15teeth meshes with gear 'B' having 75teeth No. of revolution=Driver/Driven =50/10×75/15=25.

50teeth of rake=25 revolution Moving on 1teeth=25×1/50=1/2revolution. If dial is divided into 100equal part's, the half dial=50part's =1/2×1/50=1/100mm or L.C=0.01mm

Care and maintenance of dial test indicator

- Keep the dial test indicator spindle and point clean using a soft cloth.
- Store the dial test indicator in a safe, dry place and cover them to keep the dust and moisture out.
- Do the dial test indicator under gaging conditions at intervals during the operating day

Bore gauge

- **Introduction of bore gauge**

A bore gauge is an essential precision measuring instrument utilized across various industries for accurately measuring the internal diameter of holes, cylinders, or bores. Engineered with precision and accuracy in mind, bore gauges provide crucial data for quality control, manufacturing processes, and maintenance procedures.

Bore gauges typically consist of a main body with a measuring head at one end and a dial indicator or digital readout at the other. The measuring head features contact points or anvils that make contact with the inner surface of the bore being measured. As the gauge is inserted into the bore, the contact points expand outward, and the resulting expansion is measured by the dial indicator or digital readout. This measurement provides an accurate representation of the bore diameter.

- **Types of bore gauge**

Bore gauges come in various types to accommodate different applications and bore sizes. Some common types include:

1 **Two-point bore gauges:** These gauges have two contact points and are suitable for measuring simple bores with consistent diameters.

2 **Three-point bore gauges:** Featuring three contact points, these gauges offer more stability and accuracy, making them ideal for measuring bores with uneven surfaces or out-of-roundness.

3 **Telescoping bore gauges:** Consisting of multiple telescoping segments, these gauges are adjustable and versatile, allowing for measurements of bores with varying diameters.

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- **Uses of bore gauge**

Bore gauges have numerous uses across various industries due to their ability to accurately measure the internal diameters of bores, holes, or cylinders. Some common uses of bore gauges include:

1 **Engine cylinder measurement:** Bore gauges are extensively used in the automotive industry to measure the internal diameters of engine cylinders. This ensures that the cylinders meet specific tolerances and dimensions required for optimal engine performance.

2 **Quality control in manufacturing:** Bore gauges play a crucial role in quality control processes during manufacturing. They are used to verify the dimensions of machined parts, ensuring they meet precise specifications and tolerances.

3 **Bearings and bushings inspection:** Bore gauges are employed to measure the internal diameters of bearings, bushings, and other rotating components. This helps ensure proper fits and clearances for smooth operation and longevity of the machinery.

4 **Valve guides and sleeves measurement:** In industries such as aerospace and marine, bore gauges are utilized to measure valve guides, sleeves, and other cylindrical components critical for engine and machinery performance.

5 **Gun barrel inspection:** Bore gauges are used in firearms manufacturing and maintenance to measure the internal diameter of gun barrels. This ensures accuracy, consistency, and safety in firearms operation.

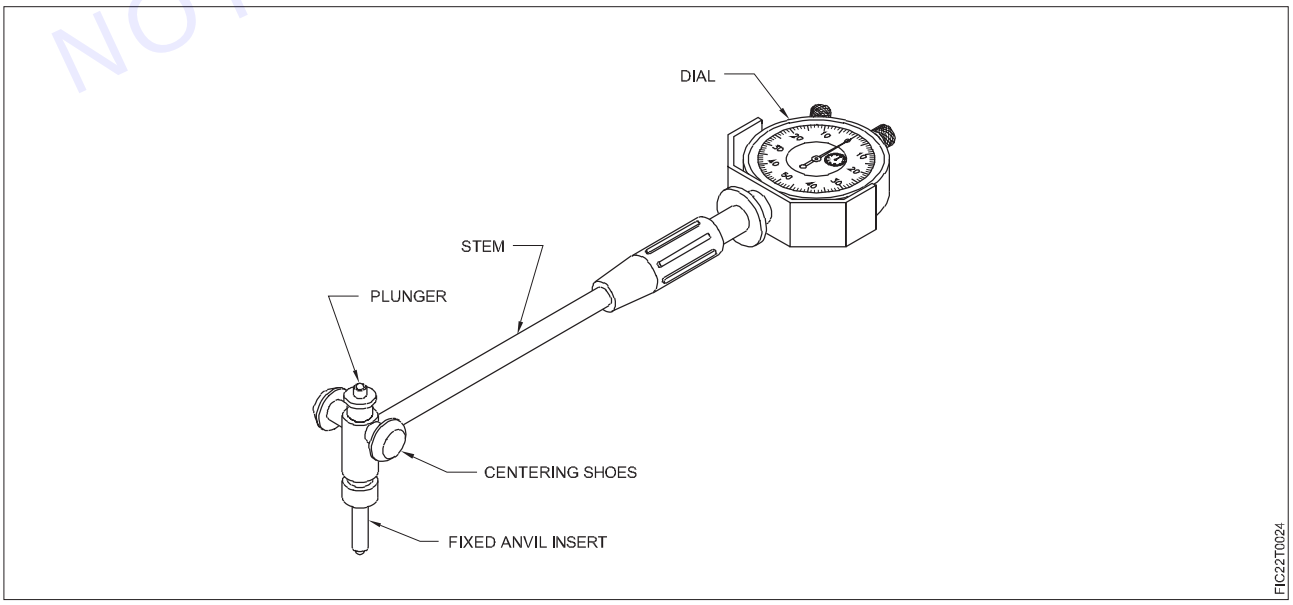
6 **Hydraulic and pneumatic components:** Bore gauges are employed to measure the internal diameters of hydraulic cylinders, pneumatic valves, and other fluid or gas handling components. This helps ensure proper functioning and efficiency of hydraulic and pneumatic systems.

7 **Tool and die making:** Bore gauges are used in tool and die making industries to verify the internal dimensions of molds, dies, and other tooling components, ensuring precision in manufacturing processes.

8 **Aerospace applications:** In aerospace engineering, bore gauges are used to measure the internal diameters of components such as turbine blades, engine housings, and critical structural elements, ensuring adherence to strict tolerances and safety standards.

9 **Maintenance and repair:** Bore gauges are essential tools for maintenance and repair operations across various industries. They are used to assess the wear and tear of machinery components, detect defects, and determine if reconditioning or replacement is necessary.

10 **General engineering applications:** Bore gauges find use in a wide range of general engineering applications where precise measurement of internal diameters is required, such as in the fabrication of gears, shafts, couplings, and other mechanical components.



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Vernier bevel protector

- **Introduction of vernier bevel protector**

The Vernier bevel protector is a precision instrument commonly used in various technical and mechanical fields, particularly in woodworking, metalworking, and engineering. It is designed to accurately measure and set angles, ensuring precise cutting, machining, or joining of materials.

This tool is named after the Vernier scale, a graduated scale invented by Pierre Vernier in the 17th century, which allows for highly accurate measurements. The bevel protector incorporates this Vernier scale mechanism along with a bevel protractor, creating a versatile device for angle measurement and adjustment.

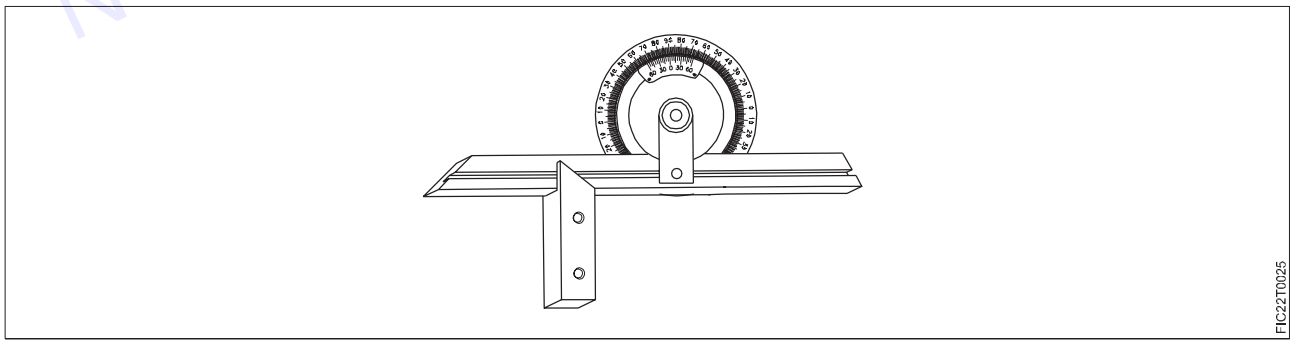
The Vernier bevel protector typically consists of a protractor base with a pivoting arm that holds a blade or a reference surface. The protractor base is marked with angular graduations, usually in degrees, allowing users to set and measure angles with precision. The pivoting arm can be locked into position at a desired angle using clamps or screws.

- **Parts of vernier bevel protector**

The Vernier bevel protector typically consists of several key parts that work together to facilitate accurate angle measurement and adjustment. These parts may vary slightly depending on the specific design and manufacturer, but the following are common components found in most Vernier bevel protectors:

1. **Protractor base:** The main body of the tool, usually made of metal or durable plastic, which serves as the foundation for angle measurement. It features a graduated scale marked with angular divisions, often in degrees, allowing users to read the angle being measured.
2. **Vernier scale:** A secondary scale that enhances the precision of angle measurement. The Vernier scale is typically located adjacent to the main scale and consists of finer divisions than the main scale. It enables users to make more accurate readings by aligning the Vernier scale with the closest marking on the main scale.
3. **Pivoting arm:** A movable arm or blade attached to the protractor base, allowing for the adjustment of angles. The arm can usually be locked into position at a desired angle using clamps, screws, or other securing mechanisms.
4. **Locking mechanism:** A mechanism, such as a screw or clamp, that secures the pivoting arm in place once the desired angle is set. This prevents unintentional movement and ensures the accuracy of the measurement.
5. **Reference surface or blade:** The part of the pivoting arm that contacts the workpiece or serves as a reference point for angle measurement. It may be a flat surface or a blade-like structure, depending on the specific application and design of the Vernier bevel protector.
6. **Magnifying lens:** Some Vernier bevel protectors feature a magnifying lens or loupe to aid in reading the Vernier scale more accurately, especially when measuring very small angles or fractions of a degree.

- **Least count of vernier bevel protector**



The least count of a Vernier bevel protector refers to the smallest angle that can be accurately measured using the device. It is determined by the graduations on both the main scale and the Vernier scale, and it represents the difference between one division on the main scale and one division on the Vernier scale.

To calculate the least count of a Vernier bevel protector, you need to know the number of divisions on the main scale (N) and the number of divisions on the Vernier scale (V). The formula for calculating the least count (LC) is:

LC = (Value of one division on main scale) - (Value of one division on Vernier scale)

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When the zero of the Vernier scale coincides with the zero of the main scale, the first division of the Vernier scale will be very close to the 2nd main scale division.

Hence, LC = 2MSD – 1VSD

LC =2°=24/12 – 23°/12

=1°/12 Or 5'.

- **Reading of vernier bevel protector**

To read a Vernier bevel protractor, follow these steps:

1 **Align the protractor:** Place the protractor on the surface or edge whose angle you want to measure. Ensure it sits flat and stable.

2 **Identify the main scale:** Locate the main scale, which typically consists of a semi- circle marked with angular divisions, usually in degrees. Note the zero mark on the main scale, which represents the starting point for angle measurement.

3 **Locate the vernier scale:** Look for the Vernier scale, which is a secondary scale adjacent to the main scale. It consists of smaller divisions compared to the main scale.

4 **Align the zeroes:** Ensure that the zero mark on the Vernier scale aligns with a mark on the main scale. This ensures proper calibration for accurate readings.

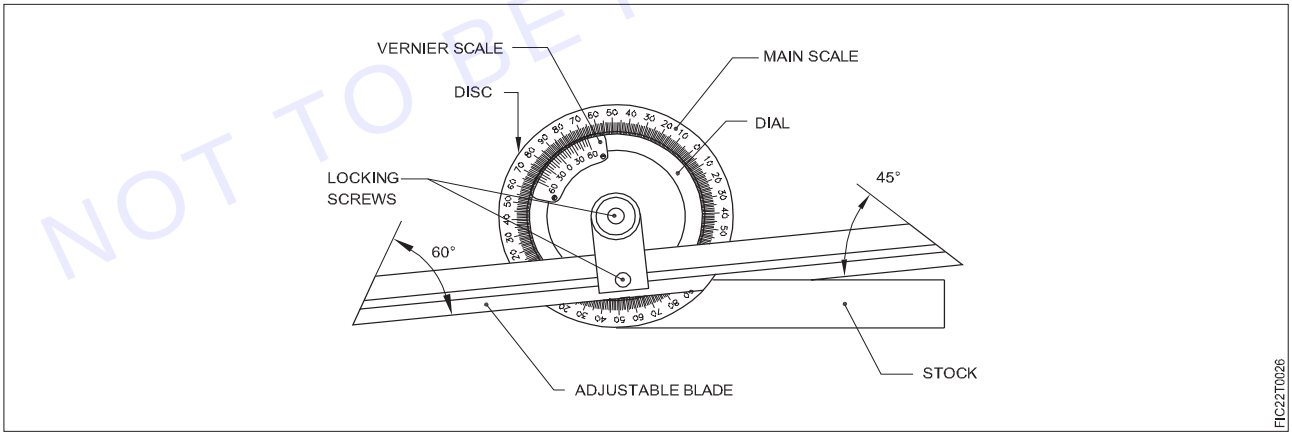
5 **Read the main scale:** Identify the main scale reading by noting the closest division to the left of the zero mark on the Vernier scale. This represents the whole number of degrees.

6 **Read the vernier scale:** Determine which mark on the Vernier scale aligns perfectly with a mark on the main scale. The value of this Vernier mark represents the fraction of a degree.

7 **Combine the readings:** Add the main scale reading to the Vernier scale reading to obtain the final angle measurement. Ensure to include the correct sign (positive or negative) depending on the direction of the angle.

8 **Record the measurement:** Note down the angle measurement obtained from the Vernier bevel protractor.

By following these steps, you can accurately read angles using a Vernier bevel protractor, ensuring precise measurements for various applications in engineering, woodworking, metalworking, and other fields.



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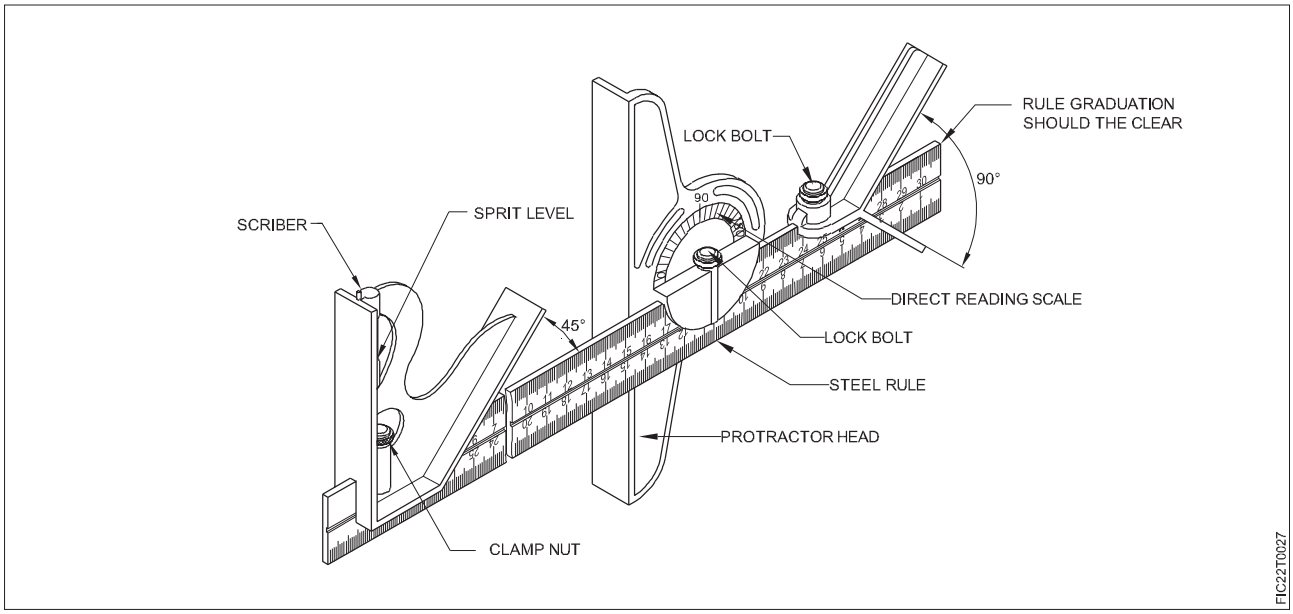
Combination set

Introduction to Combination Set

A combination set is a versatile tool used in various fields such as engineering, woodworking, metalworking, and construction. It consists of several precision measurement tools combined into a single set, providing users with a comprehensive solution for layout, measurement, and inspection tasks.

Combination sets are valued for their versatility and convenience, as they consolidate multiple essential measurement and layout tools into a single compact kit. With a combination set, users can perform a wide range of tasks, including marking out angles, finding centers, checking squareness, and ensuring level or plumb surfaces. Whether in a workshop, on a construction site, or in a manufacturing facility, the combination set remains an indispensable tool for achieving precision and accuracy in various applications.



- **Parts of combination set**

The primary components of a combination set typically include:

1. **Steel rule:** A straight ruler typically made of stainless steel, often with both metric and imperial (inch) graduations. It serves as a basic measuring tool for linear distances.
2. **Square head:** A square-shaped component attached to the steel rule, used for marking or measuring right angles. It allows for precise layout and checking of

   Level vial: Some combination sets may include a small spirit level vial attached to the square head or protractor head. This enables users to check for level or plumb surfaces, ensuring accuracy in layout and construction tasks.

   Scriber: A sharp pointed tool used for marking or scribing lines on various materials,
3. **Center head:** A center-finding attachment that can be attached to the steel rule. It helps locate the center of cylindrical or round objects accurately, facilitating drilling or machining operations.
4. **Protractor head:** A protractor-like attachment used for measuring and setting angles. It allows for precise angle measurements, often with graduations in degrees or minutes. such as metal or wood. It is often included in combination sets to facilitate precise marking during layout work.

- **Use of combination set**

A combination set is a versatile tool that finds applications across a wide range of industries and professions. Here are some common uses of a combination set:

1. **Layout and marking:** Combination sets are invaluable for laying out and marking precise measurements on various materials such as wood, metal, or plastic. The square head allows for marking right angles and perpendicular lines accurately, while the steel rule and scriber enable precise measurements and marking of distances.
2. **Setting angles:** With the protractor head attachment, combination sets are used for measuring and setting angles with high precision. This is particularly useful in carpentry, metalworking, and machining tasks where accurate angles are crucial for proper fit and function of components.
3. **Finding centers:** The center head attachment in a combination set allows users to locate the center of cylindrical or round objects accurately. This is essential for drilling holes, machining operations, or layout work where symmetrical placement is required.
4. **Checking for squareness:** Combination sets are commonly used to verify the squareness of components, assemblies, or structures. By using the square head, users can quickly check if corners are perfectly square, ensuring proper alignment and fit.

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5 **Measuring levels and plumb:** Some combination sets include a level vial, which enables users to check for level or plumb surfaces. This is useful in construction, carpentry, and other applications where ensuring proper alignment and orientation is critical.

6 **Quality control and inspection:** In manufacturing and engineering settings, combination sets are used for quality control and inspection purposes. They help ensure that components and products meet specified dimensional and geometric tolerances.

7 **General purpose measurement:** Beyond specific applications, combination sets serve as general-purpose measurement tools for various tasks requiring accurate measurements, such as layout, fabrication, assembly, and repair work.

- **Precautions and safety of combination**

While combination sets are versatile and useful tools, it's important to observe proper precautions and safety measures to prevent accidents and ensure the longevity of the equipment. Here are some precautions and safety guidelines to follow when using a combination set:

1 **Handle with care:** Combination sets often contain delicate components such as precision scales and measurement heads. Handle the set with care to avoid dropping or mishandling, which can lead to damage or inaccuracies.

2 **Avoid excessive force:** When using the scriber or other components to mark materials, avoid applying excessive force. Applying too much pressure can cause the scriber to slip or damage the material, and it can also result in inaccurate measurements.

3 **Keep components clean and lubricated:** Regularly clean and lubricate the moving parts of the combination set to ensure smooth operation and prevent rust or corrosion. Use a soft cloth to wipe down the components and apply a small amount of lubricant to the moving parts as needed.

4 **Store properly:** When not in use, store the combination set in a clean, dry place away from moisture, dust, and extreme temperatures. Proper storage helps prevent damage and ensures the accuracy of the tool over time.

5 **Inspect before use:** Before using the combination set, inspect it for any signs of damage or wear. Check that all components are functioning properly and that there are no loose or missing parts.

6 **Use safety equipment:** Depending on the specific task, use appropriate personal protective equipment (PPE) such as safety glasses or gloves to protect against injuries from sharp edges or flying debris.

7 **Follow manufacturer's instructions:** Familiarize yourself with the manufacturer's instructions and recommendations for the safe use and maintenance of the combination set. Adhering to these guidelines can help prevent accidents and ensure optimal performance.

8 **Avoid improper use:** Use the combination set only for its intended purposes and avoid using it in ways that could cause damage or compromise accuracy. For example, do not use the combination set as a hammer or pry bar.

9 **Keep away from children:** Store the combination set out of reach of children to prevent accidental misuse or injury.

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LESSON 11 : Metal and non-metal

Objectives

At the end of this lesson you shall be able to

- define the metals and non metals
- state the properties and classification of metal and non metals
- state the difference between metal and non metal.

Introduction of metal

Metal is a diverse and essential material that has played a significant role in human civilization for thousands of years. Here's an introduction to metal:

1 **Definition:** Metals are a class of materials characterized by their ability to conduct electricity and heat, as well as their typically shiny appearance. They are solid at room temperature (with the exception of mercury) and have a crystalline atomic structure.

2 **Properties:**

- **Conductivity:** Metals are excellent conductors of electricity and heat due to the mobility of electrons within their atomic structure.
- **Malleability and Ductility:** Metals can be easily shaped and formed into various shapes without breaking. Malleability refers to the ability to be hammered or rolled into thin sheets, while ductility refers to the ability to be drawn into wires.
- **Strength:** Metals generally possess high strength and stiffness, making them suitable for structural applications.
- **Lustre:** Many metals have a shiny, reflective surface known as metallic lustre.
- **Density:** Metals are typically dense materials with high mass per unit volume.
- **Melting Point:** Metals have high melting points compared to other materials.

3 **Classification:** Metals are classified into two main categories:

- **Ferrous Metals:** Ferrous metals contain iron as their primary constituent. Examples include steel and cast iron.
- **Non-Ferrous Metals:** Non-ferrous metals do not contain iron as their primary constituent. Examples include aluminium, copper, brass, and titanium.

4 **Extraction:** Metals are often extracted from naturally occurring ores through processes such as mining, smelting, and refining. These processes involve extracting the metal from its ore and refining it to remove impurities.

5 **Applications:** Metals have a wide range of applications across various industries and sectors, including

- **Construction:** Structural frameworks, bridges, and building materials.
- **Transportation:** Automobiles, aircraft, ships, and trains.
- **Manufacturing:** Machinery, tools, appliances, and consumer goods.
- **Electronics:** Electrical wiring, components, and circuitry.
- **Aerospace:** Aircraft components, engines, and aerospace structures.
- **Energy:** Power generation, transmission, and storage systems.

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6 **Alloys:** Many metals are combined with other elements to form alloys, which often exhibit improved properties compared to pure metals. Alloys can be tailored to specific applications based on their composition and properties.

Example Of Metals

1 **Iron (Fe):** Iron is one of the most abundant metals on Earth and is widely used in construction, manufacturing, and infrastructure. It is the primary constituent of steel, which is used in buildings, bridges, machinery, and vehicles.

2 **Aluminium (Al):** Aluminium is a lightweight and corrosion-resistant metal with excellent strength-to-weight ratio. It is used in aerospace, transportation, packaging, construction, and consumer goods.

3 **Copper (Cu):** Copper is valued for its excellent electrical conductivity and corrosion resistance. It is used in electrical wiring, electronics, plumbing, roofing, and industrial machinery.

4 **Gold (Au):** Gold is highly valued for its rarity, beauty, and malleability. It is used in jewellery, currency, electronics, and dentistry.

5 **Silver (Ag):** Silver is valued for its lustre, conductivity, and antibacterial properties. It is used in jewellery, tableware, electronics, and photography.

6 **Steel:** Steel is an alloy of iron and carbon, with additional elements such as chromium, nickel, and manganese added to enhance its properties. It is used in construction, automotive manufacturing, machinery, and infrastructure.

7 **Titanium (Ti):** Titanium is a lightweight and corrosion-resistant metal with high strength-to-weight ratio. It is used in aerospace, medical implants, sporting goods, and marine applications.

8 **Nickel (Ni):** Nickel is used primarily as an alloying element in stainless steel and other alloys. It provides corrosion resistance, heat resistance, and strength to alloys used in aerospace, chemical processing, and electronics.

9 **Zinc (Zn):** Zinc is used primarily as a protective coating for steel (galvanization) to prevent corrosion. It is also used in batteries, alloys, and pharmaceuticals.

10 **Lead (Pb):** Lead is dense, malleable, and corrosion-resistant. It is used in batteries, ammunition, radiation shielding, and construction materials.

Difference Between Metals and Non-Metals:

Metals and non-metals are two distinct categories of elements on the periodic table, each characterized by unique properties and behaviors. Here are some key differences between metals and non-metals:

1 **Physical Properties:**

- **Metals:** Metals typically have a shiny or metallic luster, are solid at room temperature (with the exception of mercury), and have high melting and boiling points. They are generally good conductors of heat and electricity, and they are malleable and ductile, meaning they can be hammered or rolled into thin sheets (malleability) and drawn into wires (ductility).
- **Non-metals:** Non-metals can exhibit a variety of physical properties. They may be solids, liquids, or gases at room temperature. They tend to have lower melting and boiling points compared to metals. Non-metals are generally poor conductors of heat and electricity, and they are brittle in nature, meaning they break or shatter easily when subjected to stress.

2 **Chemical Properties:**

- **Metals:** Metals typically form positive ions (cations) by losing electrons during chemical reactions. They tend to react with acids to produce hydrogen gas and with oxygen to form metal oxides. Many metals exhibit corrosion or tarnishing when exposed to air or moisture.
- **Non-metals:** Non-metals can form negative ions (anions) by gaining electrons during chemical reactions. They may react with metals to form ionic compounds or with other non-metals to form covalent compounds. Non-metals often participate in oxidation-reduction reactions, where they gain electrons (reduction) or lose electrons (oxidation).

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3 **Appearance and Texture:**

- **Metals:** Metals typically have a shiny or reflective surface (metallic lustre) and a dense, opaque appearance. They may have a smooth or rough texture, depending on factors such as surface treatment or alloy composition.
- **Non-metals:** Non-metals can exhibit a wide range of appearances and textures. They may appear translucent, opaque, or transparent, and their textures may vary from brittle and powdery to waxy or crystalline.

4 **Occurrence in Nature:**

- **Metals:** Metals are abundant in the Earth's crust and can be found in various ores and minerals. Some common metal ores include iron ore (hematite), aluminium ore (bauxite), and copper ore (chalcopyrite).
- **Non-metals:** Non-metals are also abundant in the Earth's crust, but they are typically found in different mineral forms compared to metals. Examples of non- metallic minerals include sulphur, graphite, and quartz.

Various type property of metal

Objectives: At the end of this lesson, you will be able to

- define the metal
- state the various types properties of metal
- state the about various properties like physical, chemical and mechanical.

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Introduction:

Metals are made by raw material which we distract from mines, Which we say ore. There are different impurities in ores.

Pure metal we can distract by metallurgy.

Definition:

Solid material which has property of heat and electricity conductor, malleability, ductility and have melting temperature is called metal.

Types: There are three type property of metal.

1 Physical Property

2 Chemical Property

3 Mechanical property

1 Physical Property

Metals physical properties are natural; we should recognize metals by its physical property.

These are permanent in metal.

As- color, structure, weight, fusibility, magnetism, conductivity etc.

Some of the main physical properties of metals are given below.

- Metals can be hammered into thin sheets. It means they possess the property of malleability.
- Metals are ductile. They can be drawn into wires.
- Metals are a good conductor of heat and electricity.
- Metals are lustrous which means they have a shiny appearance.
- Metals have high tensile strength. It means they can hold heavyweights.

- Metals are sonorous. It means when we strike them, they make a ringing sound.
- Metals are hard. It means they cannot be cut easily.

2 Chemical Property

Metals are chemically reactive with different chemicals.

As- corrosion of metal, oxide layer(rust).

Some of the chemical properties of metals are given below.

- Reaction with Oxygen – Metals react with oxygen and form metallic oxides which are basic in nature.

  Metal + Oxygen Metal oxide

  Metal oxide + water Base

  Example –Magnesium is metal and when it reacts with oxygen, it forms magnesium oxide. When we dissolve magnesium oxide in water, it gives magnesium hydroxide. The reactions are given below.

  $2Mg + O_2$ $2MgO$

  $MgO + H_2O$ $Mg(OH)_2$
- An aqueous solution of metal oxide turns red litmus paper into blue.
- Reaction with water - Metals react with water. When a metal reacts with water, metal hydroxide and hydrogen gas are formed.

  Metal + Water Metal hydroxide + hydrogen

  Example – Sodium metal reacts with water and forms sodium hydroxide and hydrogen gas. The reaction is given below –

  Na + H2O NaOH + H2
- Reaction with Acid - Metals react with acids and form salt and hydrogen gas. Some metals vigorously react with acids.

  Metal + Acid Metal salt + hydrogen

  Example – Magnesium metal reacts with hydrochloric acid and forms magnesium chloride and hydrogen. The reaction is given below –

  Mg + 2HCl MgCl2 + H2
- Reaction with Base - Metals react with bases such as sodium hydroxide and form salt and hydrogen gas.

  Metal + Base Metal salt + hydrogen

  Example – Aluminium metal reacts with Sodium hydroxide and forms sodium aluminate and hydrogen gas. The reaction is given below –

  Al + NaOH NaAlO2 + H2
- Displacement Reaction - A more reactive metal displaces a less reactive metal from its salt solution. These types of reactions are called displacement reactions.

  Example – Iron is more reactive than copper. So, it displaces copper from its salt. The reaction is given below –

  CuSO4 + Fe FeSO4 + Cu

3 Mechanical property

a Malleability:

Metals can convert into thin sheet due to these properties.

As- Gold

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b Ductility:

Under this property metal can convert into thin wire.

As- Platinum

c Hardness

Metals that property by which it's oppose scratch, abration, cuts on it As- Diamond.

d Elasticity:

When we apply external force on metal it deforms, but after removing external force regain its original property.

As- Steel

e Plasticity: Plasticity is the property of metal, when applying external force metal deform but after removing force metal cannot regain its original shape.

f Toughness: Metals that property under which metal can easily absorb shock, vibration and impact load.

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MODULE 4

LESSON 12: Introduction to welding and metal cutting

Objectives

At the end of this lesson you shall be able to

- explain the various welding process like arc welding and its application and types
- state the gas welding process and its accessories
- state the gas tungsten arc welding and its application
- state the different types of metal cutting process like slotter machine, milling machine and jig boring machine.

Arc welding process and its applications

Various Welding Process

1 **Forge Welding:** Forge welding is a traditional method where two metal pieces are heated to a high temperature and then hammered together to form a bond without the use of additional filler material.

2 **Metallic Arc Welding:** Metallic arc welding encompasses various arc welding processes where an electric arc is used to melt and join metals together. This includes shielded metal arc welding (SMAW), gas metal arc welding (GMAW), and gas tungsten arc welding (GTAW).

3 **Oxy Acetylene Welding:** Oxy-acetylene welding (OAW) uses a flame generated by the combustion of oxygen and acetylene gases to melt and join metals together. It is versatile and can be used for various metal types and thicknesses.

4 **Tungsten Inert Gas Welding (TIG):** Tungsten inert gas welding (TIG) or gas tungsten arc welding (GTAW) uses a non-consumable tungsten electrode and an inert gas (usually argon) to create a weld. It is commonly used for welding thin materials and in applications requiring high-quality welds.

5 **Gas Metal Arc Welding (GMAW):** Gas metal arc welding (GMAW) or metal inert gas welding (MIG) uses a consumable wire electrode and a shielding gas (usually inert or semi-inert) to create a weld. It is versatile, high-speed, and suitable for various metals and thicknesses.

6 **Electro Slag Welding:** Electro slag welding (ESW) is a welding process that uses a consumable electrode and a granulated flux to create a molten slag pool, which shields the weld zone and facilitates the joining of thick materials in a single pass.

7 **Thermite Welding:** welding is a process that uses a chemical reaction between a powdered metal oxide and aluminium to generate intense heat, melting the parent metals and forming a weld joint. It is often used for joining railway tracks and large steel structures.

8 **Submerged Arc Welding (SAW):** Submerged arc welding (SAW) involves the formation of an arc between a continuously fed wire electrode and the workpiece, while a granular flux covers the arc and weld zone. It is known for its high deposition rates and deep penetration capabilities.

9 **Frictionwelding:** Friction welding is a solid-state welding process that generates heat through friction between two workpieces, causing them to plasticize and form a bond.

when pressure is applied. It is commonly used for joining similar or dissimilar metals.

10 **Electron Beam Welding:** Electron beam welding (EBW) uses a high-velocity beam of electrons to generate heat and melt metals together. It is capable of producing precise, high-quality welds in a vacuum environment and is often used in aerospace and precision engineering applications.

- **Definition Of Various Welding Process:**

1 **Solid State Welding with Pressure:**

Solid state welding processes join materials without melting them, using heat and pressure to create a bond. Examples include friction welding, ultrasonic welding, and explosion welding.

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2 Fusion Welding without Pressure by Using Flux Coated Stick Electrode:

This refers to Shielded Metal Arc Welding (SMAW), where a flux-coated electrode creates an arc that melts the base metal and the electrode, forming a weld without the need for external pressure.

3 **Fusion Welding without Pressure Source of Heat from Mixture of Fuel Gas and Supporter of Combustion with Consumable Filler Rod:**

This describes Oxy-Acetylene Welding (OAW), where a flame produced by burning acetylene gas with oxygen melts the base metals, and a consumable filler rod may be added to create the weld joint.

4 Arc Welding Process by Using Non-consumable Tungsten Electrode in an Atmosphere of Shielding Gas (Argon):

This is Gas Tungsten Arc Welding (GTAW), also known as Tungsten Inert Gas (TIG) welding, where a non-consumable tungsten electrode produces an arc in an inert gas atmosphere, typically argon.

5 Arc Welding Process by Using Consumable Continuously Fed Metallic Electrode and in an Atmosphere of Shielding Gas (CO2, Argon):

This refers to Gas Metal Arc Welding (GMAW), also known as Metal Inert Gas (MIG) welding, where a continuously fed consumable electrode creates an arc in a shielding gas atmosphere, typically a mixture of CO2 and argon.

6 Arc is Initiated Source of Heat - Covering of Molten Slag - Bare Wire Electrode:

This describes Submerged Arc Welding (SAW), where an arc is initiated beneath a covering of granular flux, which shields the arc and weld zone. A bare wire electrode is continuously fed into the weld pool.

7 Liquid State Chemical Welding Process by Using Thermite Mixture:

This is Thermite Welding, a process where a chemical reaction between a powdered metal oxide and aluminium generates heat, melting the base metals and forming a weld.

8 Arc Welding Process by Using Bare Electrode and Granular Flux Arc and Molten Metal Are Hidden by Flux:

This is Flux-Cored Arc Welding (FCAW), where a tubular electrode filled with flux is used. The flux shields the arc and weld pool, providing protection from atmospheric contamination.

9 Heat by Friction No Filler Metal:

This describes Friction Welding, where heat is generated by friction between the two workpieces, causing them to plasticize and form a bond without the need for filler metal.

10 Welding by Using Concentrated Electron Beam:

This is Electron Beam Welding (EBW) a process where a high-velocity beam of electrons is used to generate heat, melting the base metals and forming a weld in a vacuum environment.

- **Application Of Various Welding Process:**

1 Hand tools and Hardware Manufacturing:

Gas Metal Arc Welding (GMAW/MIG) or Shielded Metal Arc Welding (SMAW/ Stick Welding) may be suitable for joining various types of metals commonly used in hand tools and hardware manufacturing.

2 Construction of Steel Structures and Industrial Fabrication:

Shielded Metal Arc Welding (SMAW/ Stick Welding), Gas Metal Arc Welding (GMAW/MIG), and Flux-Cored Arc Welding (FCAW) are commonly used for their versatility, suitability for outdoor applications, and ability to weld thick materials.

3 Fabrication of Sheet Metal, Automobile, and Aircraft Industries:

Gas Metal Arc Welding (GMAW/MIG) and Gas Tungsten Arc Welding (GTAW/TIG) are commonly used for their ability to weld thin materials with precision and control.

4 Thin Sheets (Ferrous & Non-Ferrous):

Gas Metal Arc Welding (GMAW/MIG) and Gas Tungsten Arc Welding (GTAW/TIG) are preferred for their ability to produce high-quality welds on thin materials.

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5 **Thin and Thick Metal Fabrication Work:**

Gas Metal Arc Welding (GMAW/MIG), Gas Tungsten Arc Welding (GTAW/TIG), and Flux-Cored Arc Welding (FCAW) are versatile processes suitable for both thin and thick metal fabrication.

6 **Welding of Thick-Walled Large Diameter Pipes, Pressure Vessels, Storage Tanks, Ships:**

Submerged Arc Welding (SAW) and Flux-Cored Arc Welding (FCAW) are preferred for their high deposition rates, deep penetration capabilities, and suitability for welding thick materials.

7 **Rail Welding:**

Thermite Welding is commonly used for welding railroad tracks due to its ability to produce high-strength welds in situ without the need for electricity.

8 **Shipbuilding, Pressure Vessel Fabrication Work:**

Submerged Arc Welding (SAW) and Gas Metal Arc Welding (GMAW/MIG) are commonly used for their high productivity and ability to weld thick materials in various positions.

9 **Thicker Pipe, Camshaft, Cutting Tools:**

Gas Tungsten Arc Welding (GTAW/TIG) and Shielded Metal Arc Welding (SMAW/ Stick Welding) are preferred for their ability to produce high-quality welds on thicker material.

10 **Highly Reactive Material Welding Aerospace:**

Electron Beam Welding (EBW) and Laser Beam Welding (LBW) are preferred for their ability to weld highly reactive materials with precision in a controlled environment.

Different Types Of Arc Welding Machine

- **Introduction Of an ARC Welding Machine:**

An arc welding machine is a device used to create an electric arc between an electrode and the workpiece to generate the intense heat required for welding. This heat melts the base metal and the filler material (if used), creating a strong bond between the pieces being joined. Arc welding machines come in various types, such as stick welding, MIG welding, TIG welding, and others, each tailored for specific welding applications and materials. These machines are vital tools in fabrication, construction, manufacturing, and repair industries, offering versatility, efficiency, and precision in joining metal components.

- **Necessity Of an ARC Welding Machine:**

The necessity of an arc welding machine is evident in its ability to fulfil several crucial functions and meet various requirements essential for arc welding processes. Here's why an arc welding machine is indispensable:

1 **AC or DC Welding Supply:** Arc welding machines provide either AC (Alternating Current) or DC (Direct Current) welding supply, allowing flexibility to weld different types of materials and accommodate various welding techniques.

2 **Higher Voltage for Arc Striking:** Arc welding machines deliver a higher Open Circuit Voltage (OCV) to initiate the arc, providing the necessary energy for arc formation and ignition.

3 **Lower Voltage for Arc Maintenance:** After striking the arc, the machine adjusts the voltage to a lower level (Arc Voltage - AV), ensuring a stable arc and consistent welding performance.

4 **Voltage Conversion:** Arc welding machines are equipped with transformers or rectifiers to convert the high voltage from the main power supply (AC) into a lower voltage suitable for welding operations. In the case of DC welding, rectification converts AC to DC.

5 **Relationship between Arc Voltage and Welding Current:** Arc welding machines establish a direct relationship between Arc Voltage and Welding Current, ensuring proper arc stability, penetration, and control during the welding process.

6 **Control and Adjustment of Welding Current:** The welding machine allows operators to control and adjust the welding current as needed, ensuring optimal performance and weld quality for different welding applications and materials.

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7 **Compatibility with Various Electrode Gauges:** Arc welding machines are designed to weld with electrodes of different gauges, providing the necessary current output to accommodate varying electrode sizes and types.

8 **Welding of Thin and Thick Plates, Ferrous and Non-Ferrous Metals:** Arc welding machines are versatile, capable of welding a wide range of materials, including thin and thick plates, ferrous and non-ferrous metals, providing the necessary current and voltage settings for each specific application.

1 **Oil-Cooled Transformer Welding Machine:**

- Oil-cooled transformer welding machines utilize a transformer that is immersed in oil for cooling purposes. This type of welding machine is commonly used in heavy-duty welding applications where high currents are required for welding thick materials or in continuous welding operations. The oil-cooled transformer helps dissipate heat generated during welding, ensuring optimal performance and longevity of the welding machine. These machines are suitable for various welding processes, including Shielded Metal Arc Welding (SMAW) and Gas Metal Arc Welding (GMAW).

2 **Air-Cooled Transformer Welding Machine:**

- Air-cooled transformer welding machines rely on air circulation for cooling the transformer. Unlike oil-cooled transformers, air-cooled transformers do not require immersion in oil and instead use fans or other air circulation methods to dissipate heat generated during welding. These machines are typically more compact and portable compared to oil-cooled transformer welding machines, making them suitable for mobile or field welding applications where portability is essential. Air-cooled transformer welding machines are commonly used in construction, repair, and maintenance applications.

- **Care And Maintenance:**

- **Arc Welding Machines:**

1 **Regular Inspection:** Perform regular visual inspections of the welding machine to check for signs of damage, wear, or loose connections. Inspect cables, connectors, switches, and other components for any visible damage or corrosion.

2 **Cleaning:** Keep the welding machine clean by removing dust, dirt, and debris from the exterior surfaces regularly. Use compressed air or a soft brush to clean. ventilation ports, cooling fans, and other areas prone to accumulation of dirt.

3 **Cooling System Maintenance:** If the welding machine has a cooling system (such as fans or liquid cooling), ensure that it is functioning properly. Clean or replace air filters as needed to maintain proper airflow and cooling efficiency.

4 **Electrode Holder Maintenance:** Check the condition of the electrode holder regularly. Inspect the jaws for wear or damage, and replace them if necessary. Ensure that the electrode holder is clean and free from debris to maintain a good electrical connection.

5 **Ground Clamp Maintenance:** Inspect the ground clamp for signs of wear, damage, or corrosion. Clean the contact surfaces of the ground clamp and workpiece to ensure a good electrical connection and minimize resistance.

6 **Electrical Connections:** Check all electrical connections, including cables, terminals, and connectors, for tightness and corrosion. Loose or corroded connections can cause voltage drops, overheating, and reduced welding performance.

7 **Storage:** When not in use, store the welding machine in a clean, dry, and well- ventilated area. Protect it from moisture, dust, and extreme temperatures that can damage internal components.

8 **Periodic Maintenance:** Follow the manufacturer's recommendations for periodic maintenance tasks, such as lubrication of moving parts, calibration of controls, and inspection of internal components. Schedule routine maintenance according to the machine's usage and operating conditions.

9 **Safety Checks:** Prioritize safety by ensuring that all safety features, such as thermal overload protection and circuit breakers, are functional. Test emergency stop buttons and other safety mechanisms regularly to verify their proper operation.

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10 **Professional Servicing:** If any issues arise or if the welding machine requires repair or servicing beyond routine maintenance, consult a qualified technician or service provider. Avoid attempting repairs or modifications unless properly trained and authorized.

Arc Welding Accessories:

- **Electrode Holder:**

- **Inspection:** Regularly inspect the electrode holder for signs of wear, damage, or overheating. Check the jaws for proper alignment and functionality.
- **Cleaning:** Keep the electrode holder clean by removing any spatter, flux residue, or debris that may accumulate during welding. Use a wire brush or compressed air to clean the jaws and contact surfaces.
- **Replacement:** Replace worn or damaged electrode holders promptly to maintain a secure grip on the electrode and ensure a stable electrical connection.

- **Ground Clamp:**

- **Inspection:** Periodically inspect the ground clamp for signs of wear, damage, or corrosion. Check the contact surfaces for cleanliness and tightness.
- **Cleaning:** Clean the contact surfaces of the ground clamp and workpiece to ensure a good electrical connection. Remove any dirt, paint, or rust that may interfere with conductivity.
- **Replacement:** Replace damaged or corroded ground clamps to maintain reliable grounding and prevent electrical resistance.

- **Welding Cables:**

- **Inspection:** Regularly inspect welding cables for cuts, abrasions, or exposed wires. Check connectors and terminals for tightness and corrosion.
- **Cleaning:** Keep welding cables clean and free from dirt, grease, or oil. Wipe down the cables with a clean, dry cloth regularly to prevent contamination and maintain flexibility.
- **Repair or Replacement:** Repair or replace damaged welding cables promptly to prevent electrical hazards and ensure reliable current flow.

- **Shielding Gas Regulator and Hoses:**

- **Inspection:** Inspect the shielding gas regulator and hoses for leaks, cracks, or damage. Check the pressure gauge for accuracy and proper functioning.
- **Cleaning:** Clean the regulator and hoses regularly to remove dirt, dust, or debris. Check hose connections for tightness and security.
- **Leak Testing:** Perform leak tests on the regulator and hoses periodically to ensure that there are no leaks in the gas system. Use a leak detection solution or soapy water to identify leaks and repair them promptly.

- **Welding Helmet:**

- **Inspection:** Inspect the welding helmet for cracks, damage, or signs of wear. Check the filter lens for scratches or discoloration.
- **Cleaning:** Clean the outer shell and lens of the welding helmet regularly to remove dirt, spatter, or debris. Replace the filter lens if it becomes scratched or obstructed.
- **Adjustment:** Ensure that the welding helmet fits securely and comfortably on the operator's head. Adjust the headgear and straps as needed for a proper fit.

- **Protective Clothing and Gear:**

- **Cleaning:** Clean protective clothing, such as welding jackets, gloves, and aprons, regularly to remove dirt, grease, or welding spatter.
- **Inspection:** Inspect protective gear for signs of wear, damage, or deterioration. Replace any worn-out or damaged clothing or gear to maintain adequate protection.
- **Storage:** Store protective clothing and gear in a clean, dry area away from heat, moisture, or sunlight when not in use to prevent degradation.

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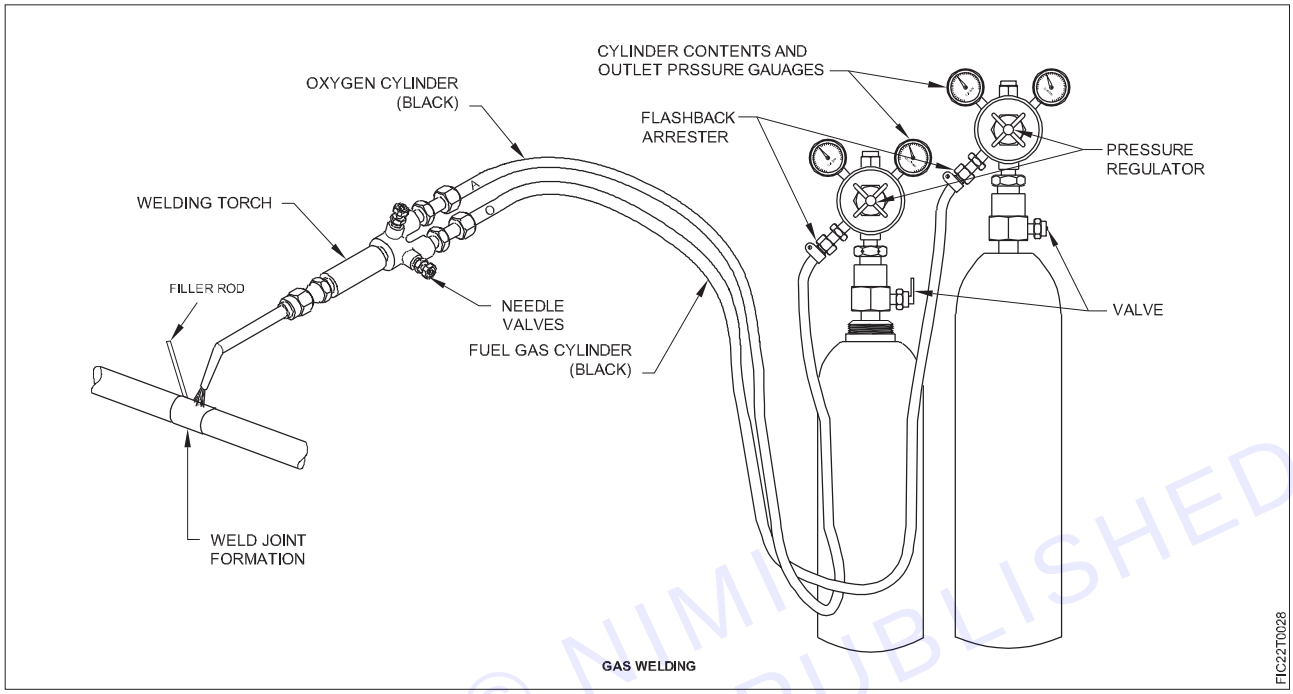
Gas Welding Process And ITS Accessories

1 Introductions to Gas Welding:

Gas welding encompasses several welding processes that use fuel gases, such as acetylene, propane, or natural gas, combined with oxygen to produce a flame capable of melting and fusing metals. One of the most common forms of gas welding is oxy-acetylene welding (OAW), where acetylene and oxygen are the primary gases used.



2 Accessories Used in Gas Welding:

1 **Gas Cylinders:** Gas cylinders contain the fuel gas (e.g., acetylene) and oxygen used in the welding process. These cylinders are typically made of steel and are filled and pressurized with the respective gases.

2 **Regulators:** Regulators are devices attached to the gas cylinders to control the pressure and flow of the gases being supplied to the welding torch. They ensure that the gases are delivered at the correct pressure and flow rate for the welding operation.

3 **Welding Torch:** The welding torch is a handheld device that mixes the fuel gas and oxygen in precise proportions and directs the resulting flame onto the workpiece. It contains valves and tips to control the flow of gases and adjust the characteristics of the flame.

4 **Hoses:** High-pressure hoses connect the gas cylinders to the welding torch and regulators, allowing the gases to flow from the cylinders to the torch under controlled conditions. These hoses are typically made of durable materials such as rubber or reinforced synthetic materials.

5 **Welding Tips:** Welding tips, also known as welding nozzles, are interchangeable components of the welding torch that determine the size and shape of the flame. Different tips are used for various welding applications and metal thicknesses.

6 **Striker or Igniter:** A striker or igniter is used to ignite the mixed gases at the welding torch tip, creating a flame for welding operations. This can be a handheld device with a flint or a built-in igniter mechanism on the torch.

7 **Welding Goggles or Helmet:** Welding goggles or a welding helmet with a suitable shade lens are essential for protecting the welder's eyes from harmful UV radiation, intense light, and sparks generated during welding.

8 **Welding Gloves:** Welding gloves provide protection for the welder's hands from heat, sparks, and molten metal splatter. They are typically made of heat-resistant materials such as leather or Kevlar.

9 **Welding Apron or Jacket:** An apron or welding jacket made of flame-resistant material protects the welder's body from heat, sparks, and splatter during welding operations.

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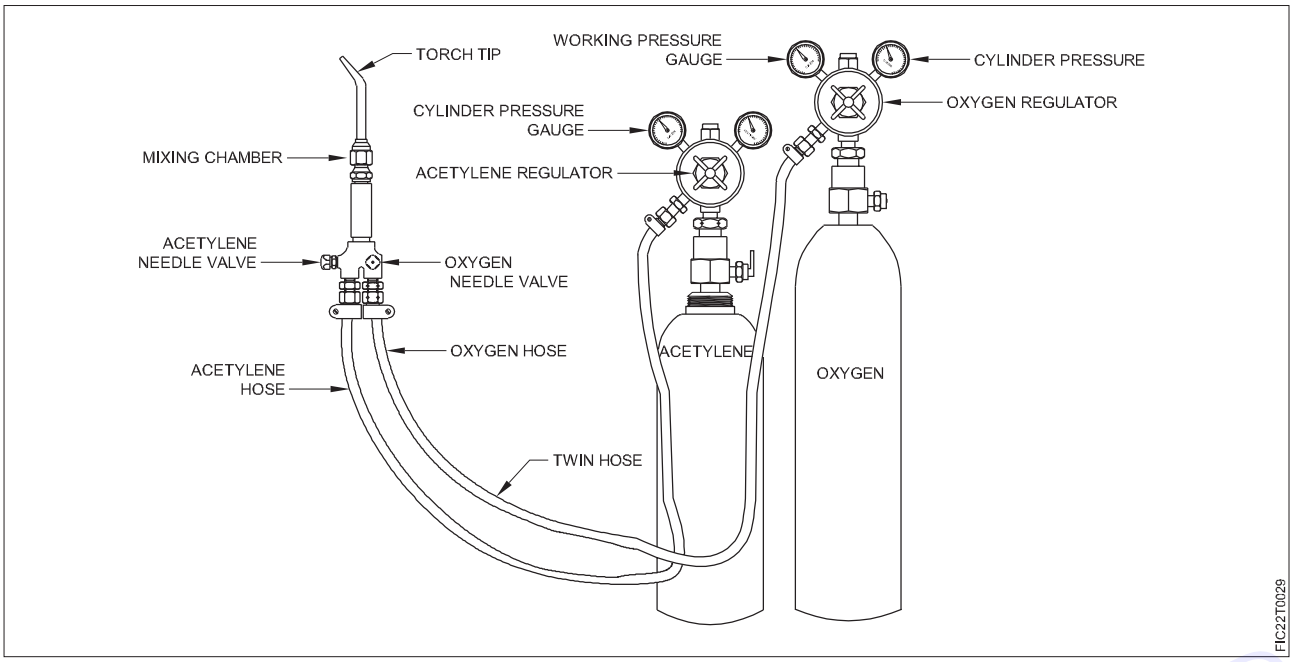

3 Applications of Gas Welding:

Gas welding, particularly oxy-acetylene welding (OAW), finds applications across various industries due to its versatility and capability to weld a wide range of metals. Here are some common applications of gas welding:

- **Metal Fabrication and Repair:** Gas welding is widely used in metal fabrication shops and repair workshops for joining and repairing metal components. It is suitable for welding various metals and alloys, including carbon steel, stainless steel, aluminium, copper, and brass.
- **Automotive Repair:** Gas welding is commonly used in automotive repair and restoration for tasks such as panel replacement, frame repair, exhaust system fabrication, and general metal repair work. It allows for precise control and manipulation of the weld pool, making it suitable for intricate repairs.
- **Plumbing and HVAC:** Gas welding is utilized in the plumbing and HVAC (Heating, Ventilation, and Air Conditioning) industries for joining metal pipes, fittings, and components. It is particularly useful for welding copper pipes in plumbing systems and fabricating HVAC ductwork.
- **Metal Sculpture and Artwork:** Gas welding is popular among artists and sculptors for creating metal sculptures, artwork, and decorative pieces. Its versatility allows artists to manipulate metal with precision, enabling intricate designs and unique forms.
- **Shipbuilding and Marine Repair:** Gas welding is used in shipbuilding and marine repair industries for joining and repairing metal structures, hulls, and components of ships, boats, and offshore platforms. It is suitable for welding marine-grade materials such as stainless steel and aluminium alloys.
- **Construction and Structural Fabrication:** Gas welding is employed in construction and structural fabrication for welding metal components, beams, columns, and frameworks used in buildings, bridges, and infrastructure projects. It provides strong and durable welds for structural applications.
- **Acetylene Gas Cylinder:** The acetylene gas cylinder is typically maroon or red and contains pressurized acetylene gas dissolved in acetone within a porous material. Acetylene is the fuel gas used in the oxy-acetylene process.
- **Oxygen Gas Cylinder:** The oxygen gas cylinder is usually black and contains pressurized oxygen gas. Oxygen serves as the oxidizing agent in the oxy-acetylene process, supporting combustion and increasing flame temperature.
- **Acetylene Pressure Regulator:** The acetylene pressure regulator is attached to the acetylene gas cylinder and regulates the pressure of acetylene gas supplied to the welding torch. It ensures a consistent and safe flow of acetylene to the torch.

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- **Artisanal Metalwork:** Gas welding is utilized by artisans and craftsmen for creating custom metalwork, including gates, railings, fences, furniture, and decorative elements. It allows for precise control over the welding process, enabling intricate designs and fine details.
- **Jewellery Making:** Gas welding is used in jewellery making and metalworking for soldering, brazing, and welding precious metals such as gold, silver, and platinum. It enables jewellers to create intricate and delicate jewellery pieces with strong and durable joints.
- **Agricultural Equipment Repair:** Gas welding is employed in agricultural equipment repair for welding and fabricating metal components, machinery parts, and farm implements. It provides versatility and durability for repairing agricultural equipment subjected to heavy use and harsh conditions.

4 Oxy Acetylene welding and Cutting process:

The oxy-acetylene welding and cutting process, also known as oxy-fuel welding and cutting, is a versatile and widely used method for joining and cutting metals. It involves the controlled combustion of acetylene and oxygen gases to produce a high- temperature flame capable of melting and welding metals or cutting through them. Here's a breakdown of the process and the equipment involved:

1 Equipment Setup:

- **Oxygen Pressure Regulator:** Similarly, the oxygen pressure regulator is attached to the oxygen gas cylinder and controls the pressure of oxygen gas supplied to the welding torch. It allows for precise adjustment of oxygen flow rates.
- **Gas Hoses:** High-pressure gas hoses, color-coded for easy identification (blue for oxygen, red for acetylene), connect the gas cylinders to the welding torch. These hoses deliver the gases from the cylinders to the torch under controlled pressure and flow rates.
- **Welding Torch or Blowpipe:** The welding torch or blowpipe is the handheld device that mixes the acetylene and oxygen gases in precise proportions and directs the resulting flame onto the workpiece. It contains valves, tips, and nozzles for adjusting flame characteristics and welding parameters.
- **Nozzles and Tips:** The welding torch is equipped with interchangeable nozzles and tips of various sizes to produce different flame sizes and shapes suitable for welding or cutting operations.
- **Gas Lighter:** A gas lighter or spark igniter is used to ignite the mixed gases at the welding torch tip, creating a flame for welding or cutting.

2 Protective Clothing and Equipment:

- **Protective Clothing:** Welders must wear appropriate protective clothing, including flame-resistant garments such as an asbestos apron, gloves, and long sleeves, to protect against heat, sparks, and molten metal splatter.
- **Eye Protection:** Welding goggles or a welding helmet with a suitable shade lens are essential for protecting the welder's eyes from harmful UV radiation, intense light, and sparks generated during welding or cutting operations.
- **Respiratory Protection:** In confined spaces or poorly ventilated areas, respiratory protection may be required to prevent inhalation of fumes and gases produced during welding or cutting.

3 Consumables:

- **Filler Rods and Fluxes:** Filler rods and fluxes may be used in oxy-acetylene welding to fill gaps, provide additional material, or protect the weld pool from atmospheric contamination. The choice of filler metal and flux depends on the base metal being welded and the welding process.

4 Process Overview:

- **Welding:** In oxy-acetylene welding, the torch flame is directed onto the workpiece, heating it to the melting point. The molten metal is then fused together, forming a weld joint. Filler metal may be added to enhance the weld strength and fill gaps.
- **Cutting:** In oxy-acetylene cutting, the torch flame is used to preheat the workpiece to ignition temperature. A jet of pure oxygen is then directed onto the preheated metal, causing it to react with the oxygen and form metal oxides. The exothermic reaction generates additional heat, melting through the metal and producing a clean, precise cut.

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Gas Tungsten Arc Welding (Tig Welding)

- **Introduction Of Gas Tungsten ARC Welding:**

  Gas Tungsten Arc Welding (GTAW), commonly referred to as Tungsten Inert Gas (TIG) welding, is a versatile and precise welding process used in various industries, including aerospace, automotive, and manufacturing. Developed in the 1930s, TIG welding involves creating an arc between a non-consumable tungsten electrode and the workpiece, while a shielding gas, typically argon or helium, protects the weld area from atmospheric contamination.

- **Definition:**

  Gas Tungsten Arc Welding (GTAW), commonly known as Tungsten Inert Gas (TIG) welding, is a welding process that uses a non-consumable tungsten electrode to produce an arc between the electrode and the workpiece. The welding area is shielded from atmospheric contamination by an inert gas, typically argon or helium, which flows through the welding torch.

- **Applications:**

  Gas Tungsten Arc Welding (GTAW), or Tungsten Inert Gas (TIG) welding, finds extensive applications across various industries due to its ability to produce high-quality welds with precision and control. Here are some specific applications of TIG welding in different industries:

1 **Aerospace Industries:**

- TIG welding is commonly used in the aerospace industry for joining components made of lightweight materials such as aluminium, titanium, and magnesium.
- It is employed in the fabrication of aircraft structures, engine components, fuel tanks, and other critical aerospace parts where weld quality and integrity are paramount.

2 **Nuclear Industries:**

- TIG welding is utilized in the nuclear industry for welding components of nuclear reactors, pressure vessels, piping systems, and other critical infrastructure.
- The process ensures precise and defect-free welds in materials used for nuclear applications, such as stainless steel and nickel alloys, meeting stringent safety and quality standards.

3 **Chemical and Fertilizer Industries:**

- TIG welding is applied in the chemical and fertilizer industries for fabricating equipment such as reactors, storage tanks, pipelines, and heat exchangers.
- It allows for the welding of corrosion-resistant materials like stainless steel and exotic alloys, ensuring the integrity and longevity of the equipment in corrosive environments.

4 **Power Plant Industries:**

- TIG welding plays a crucial role in the fabrication and maintenance of power plant components, including boilers, turbines, heat exchangers, and piping systems.
- It is used to weld materials such as carbon steel, stainless steel, and high-temperature alloys, ensuring reliable performance and longevity of power generation equipment.

5 **Food and Beverage, Oil and Natural Gas Storage Tanks:**

- TIG welding is employed in the fabrication of storage tanks for food and beverage industries, as well as for oil and natural gas storage.
- The process ensures hygienic and leak-free welds in stainless steel tanks used for storing food products, beverages, pharmaceuticals, and corrosive substances.

- **Equipment:**

  In Gas Tungsten Arc Welding (GTAW), commonly known as Tungsten Inert Gas (TIG) welding, several essential pieces of equipment are required to perform the welding process effectively. Here's a breakdown of the equipment typically used:

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1 **Power Source:**

- The power source supplies the electrical current needed to generate the welding arc. It can provide either direct current (DC) or alternating current (AC), depending on the material being welded and the welding requirements.

2 **TIG Welding Torch:**

- The TIG welding torch holds the tungsten electrode and directs the flow of shielding gas to the weld area. It also provides a means for the welder to control the arc length and manipulate the weld pool.

3. **Shielding Gas Unit (Argon/Helium):**

- A supply of inert shielding gas, typically argon or helium, is essential to protect the weld area from atmospheric contamination. The choice of gas depends on the material being welded and the specific welding requirements.

4. **Water Cooling System:**

- In high-amperage TIG welding applications, where the torch may become hot during prolonged use, a water cooling system is employed to prevent overheating. It circulates water through the torch to dissipate heat and maintain proper operating temperatures.

5. **Filler Wires for TIG Welding:**

- Filler wires are used to add material to the weld joint, if necessary, to achieve the desired weld size and strength. The filler wire material should match or be compatible with the base metal being welded.

6. **Tungsten Electrodes:**

- Tungsten electrodes are non-consumable electrodes used to initiate and maintain the welding arc. Tungsten is chosen for its high melting point and stability at high temperatures. Various types of tungsten electrodes are available, each with specific characteristics suited for different welding applications.

- **Advantages of TIG welding:**

  Gas Tungsten Arc Welding (GTAW), or Tungsten Inert Gas (TIG) welding, offers numerous advantages, making it a preferred choice for various welding applications. Here's a summary of the advantages:

1 **High-Quality Welds:** TIG welding produces welds of exceptional quality with excellent precision and control, ensuring superior mechanical properties and weld integrity.

2 **Versatility:** TIG welding can be used to weld a wide range of metals and alloys, including stainless steel, aluminium, copper, titanium, nickel alloys, and more.

3 **Narrow Heat-Affected Zone and Deeper Penetration:** TIG welding results in a narrow heat-affected zone (HAZ), deeper penetration into the base material, and minimal distortion, making it suitable for welding thin sections and heat-sensitive materials.

4 **No Post-Weld Cleaning Necessary:** TIG welds typically require minimal post-weld cleaning, reducing the need for additional labour and improving efficiency.

5 **Less Smoke or Fumes:** TIG welding produces minimal smoke and fumes, creating a healthier work environment and reducing the need for extensive ventilation systems.

6 **Simple Filler Metal Control:** TIG welding allows for precise control over the deposition of filler metal, enabling welders to achieve the desired weld profile and mechanical properties.

7 **No Spattering:** TIG welding produces welds without spatter, resulting in cleaner welds and minimizing the risk of weld defects.

8 **Possible to Weld Thin Sections:** TIG welding is well-suited for welding thin materials, thanks to its ability to control heat input and minimize distortion.

1 **Welding of High-Thickness Components:** TIG welding can weld components of significant thickness, making it suitable for welding heavy-duty structures and components.

Easy to Learn: While mastering TIG welding requires practice and skill, the process itself is relatively straightforward, making it accessible to beginners.

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Simple Edge Preparation: TIG welding typically requires minimal edge preparation, saving time and effort in the welding preparation process.

Automation is Easy: TIG welding can be easily automated, allowing for increased productivity and consistency in welding operations.

All-Position Welding: TIG welding can be performed in various positions, including flat, horizontal, vertical, and overhead, providing flexibility in welding applications.

Produces Desirable Root Penetration in Pipe Welding: TIG welding is favoured for pipe welding due to its ability to produce desirable root penetration, ensuring strong and reliable weld joints.

Slotting Machine

Introduction to slotting machine:

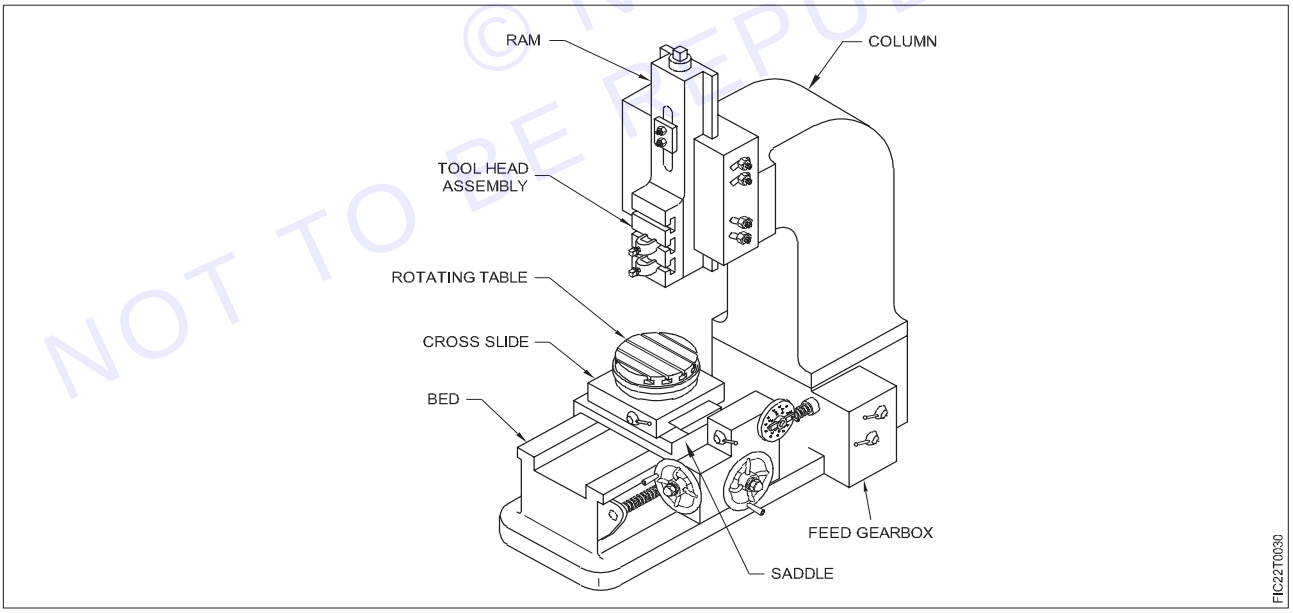
A machine tool with a vertically reciprocating single point cutting tool used for performing internal operations or shaping the side in metal machining. A slotting machine, also known as a slotter, is a specialized machine tool used for machining slots, keyways, grooves, and other internal or external features in workpieces. It operates by vertically reciprocating a single-point cutting

tool called a slotting tool or ram against the workpiece to remove material and create desired slots or features. Slotting machines are commonly used in manufacturing, metalworking, and toolmaking industries for producing components with precise slots and keyways.

Principal of slotting machine:

The principle of operation of a slotting machine involves the vertical reciprocating motion of a single-point cutting tool, known as the slotting tool or ram,

against a stationary workpiece to create slots, keyways, grooves, or other internal or external features.



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Parts of slotting machine:

1 **Base:** The base is the foundation of the slotting machine, providing support and stability to all other components. It is usually made of cast iron or welded steel and provides a rigid platform for the entire machine.

2 **Column:** The column is a vertical structure mounted on the base and supports the ram and other moving components of the slotting machine. It may contain guideways or tracks to guide the vertical movement of the ram.

3 **Ram:** The ram is a vertical component that reciprocates up and down along the column. It supports the slotting tool and provides the means for cutting slots, keyways, or grooves in the workpiece. The ram is driven by a mechanism that controls its vertical movement.

4 **Slotting Tool:** The slotting tool, also known as the cutter or ram, is a single-point cutting tool mounted on the ram. It features a cutting edge that removes material from the workpiece as it reciprocates vertically. The slotting tool may be made of high-speed steel or carbide, depending on the material being machined.

5 **Feed Mechanism:** The feed mechanism controls the rate at which the slotting tool advances into the workpiece during the slotting operation. It determines the depth of cut and the speed at which material is removed from the workpiece. The feed mechanism may be manual, semi-automatic, or automatic, depending on the machine's design.

6 **Worktable:** The worktable is a flat, horizontal surface mounted on the base and supports the workpiece during the slotting operation. It may have T-slots, clamping fixtures, or rotary tables for securing the workpiece in position. The worktable can be adjusted vertically and horizontally to align the workpiece with the slotting tool.

7 **Cross Slide:** Some slotting machines may feature a cross slide that allows for precise positioning of the workpiece relative to the slotting tool. The cross slide can be adjusted horizontally and vertically to align the workpiece with the slotting tool and ensure accurate machining.

8 **Control Mechanism:** The control mechanism includes switches, levers, and knobs for operating the slotting machine. It allows operators to control the vertical movement of the ram, adjust the feed rate, and start or stop the machining process.

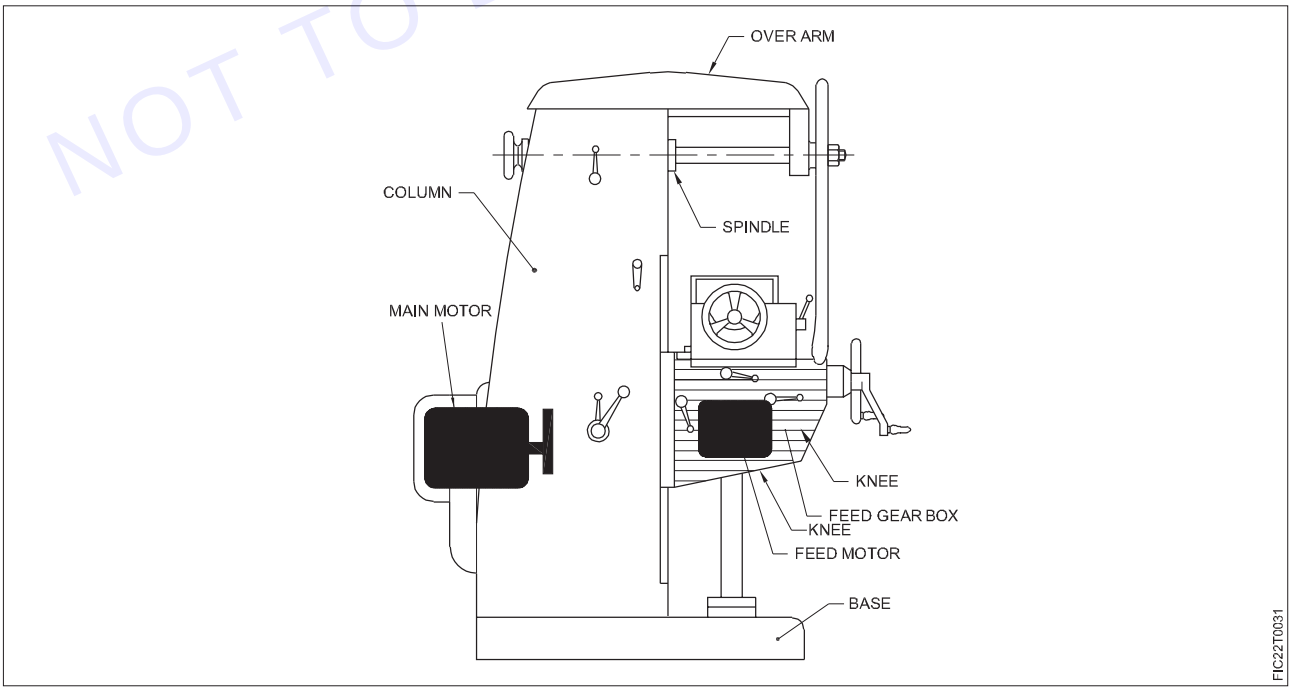
9 **Coolant System:** Some slotting machines may be equipped with a coolant system to lubricate and cool the slotting tool and workpiece during the machining operation. Coolant helps reduce heat generation, chip formation, and tool wear, resulting in improved machining efficiency and surface finish.

Milling Machine

Introduction of the milling machine:

A milling machine is a versatile machine tool used in manufacturing, machining, and metalworking industries for shaping solid materials such as metal, wood, plastic, and composites. It operates by rotating a cutting tool against a stationary workpiece to remove material and create precise features, shapes, and surfaces. Milling machines are essential equipment in various applications, ranging from small-scale hobby projects to large-scale industrial production.

Types of milling machine:



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1 **Vertical Milling Machine:**

- In a vertical milling machine, the spindle axis is vertically oriented.
- The cutting tool moves up and down along the Z-axis.
- Vertical milling machines are commonly used for face milling, end milling, drilling, and tapping operations.
- They are suitable for machining workpieces with vertical surfaces or features.

2 **Horizontal Milling Machine:**

- In a horizontal milling machine, the spindle axis is horizontally oriented.
- The cutting tool moves side to side along the X-axis.
- Horizontal milling machines are suitable for slotting, slab milling, and contouring operations.
- They are ideal for machining workpieces with horizontal surfaces or features.

3 **Universal Milling Machine:**

- A universal milling machine combines the features of both vertical and horizontal milling machines.
- It offers greater versatility and flexibility in machining operations.
- Universal milling machines can accommodate workpieces of varying sizes and shapes.
- They are capable of performing a wide range of milling tasks, including face milling, end milling, and boring.

4 **CNC Milling Machine:**

- CNC milling machines are equipped with computer numerical control (CNC) systems for precise control of machining operations.
- They offer automation, programmability, and high accuracy in milling operations.
- CNC milling machines can be vertical, horizontal, or universal in configuration, depending on the machining requirements.

Working Principle of milling machine:

The workpiece can be fed vertically, longitudinally, or diagonally. The spindle speed, table feed, depth of cut, and direction of cutter rotation are the most important process factors.

1 **Setup and Preparation:** The workpiece is securely clamped or mounted onto the machine table using various workholding devices such as clamps, vises, or fixtures. Proper setup ensures that the workpiece is stable and positioned accurately for machining.

2 **Tool Selection of Cutting:** A suitable cutting tool is selected based on the desired machining operation, material type, geometry, and surface finish requirements. Common types of cutting tools used in milling machines include end mills, face mills, drills, reamers, and taps.

3 **Tool Mounting:** The selected cutting tool is mounted onto the spindle of the milling machine using a tool holder such as a collet, chuck, or tool holder. The tool holder securely holds the cutting tool in place and allows for precise positioning and orientation during machining.

4 **Selection of Machining Parameters:** Machining parameters such as cutting speed, feed rate, depth of cut, and coolant usage are selected based on the material being machined, tool geometry, and desired

machining outcomes. These parameters determine the efficiency, accuracy, and surface finish of the machining process.

5 **Movement of Cutting Tool:** The milling machine's spindle rotates the cutting tool at high speeds while the workpiece remains stationary or moves relative to the tool. Depending on the type of milling machine and machining operation, the cutting tool may move along multiple axes to achieve the desired machining path and geometry.

6 **Material Removal:** As the rotating cutting tool engages with the workpiece, it removes material by shearing, cutting, or scraping. The cutting edges of the tool generate chips or swarf, which are evacuated from the machining area by the coolant or chip conveyor.

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7 **Control of Machine Movements:** The movement of the cutting tool and workpiece is controlled by the milling machine's axes of motion, which include the X-axis (horizontal), Y-axis (vertical), and Z-axis (depth). These axes allow for precise positioning and movement of the cutting tool relative to the workpiece to create the desired features and shapes.

8 **Complex Machining Operations:** Milling machines are capable of performing a wide range of machining operations, including face milling, end milling, slotting, drilling, boring, contouring, and thread milling. Complex machining operations involve coordinated movements of the cutting tool along multiple axes to create intricate geometries and features.

9 **Surface Finish and Accuracy:** The milling machine's rigidity, precision, and control systems contribute to the achievement of high surface finish and dimensional accuracy in machined components. Proper selection of cutting tools, machining parameters, and machine setup ensures consistent and reliable machining results.

10 **Quality Control and Inspection:** Machined components are inspected using precision measurement tools such as micrometers, calipers, and coordinate measuring machines (CMMs) to verify dimensional accuracy and compliance with specifications. Quality control measures ensure that machined parts meet quality standards and customer requirements.

Parts of milling machine:

1 **Base:** The base is the foundation of the milling machine, providing support and stability to all other components. It is usually made of cast iron or welded steel and provides a rigid platform for the entire machine.

2 **Column:** The column is a vertical structure mounted on the base and supports the other machine components such as the spindle, table, and saddle. It may contain guideways or tracks to allow vertical movement of the saddle along the column.

3 **Saddle:** The saddle is a movable component that travels vertically along the column. It supports the table and provides the means for precise positioning of the workpiece during machining operations.

4 **Table:** The table is a flat, horizontal surface mounted on the saddle and supports the workpiece during machining. It may have T-slots, clamping fixtures, or rotary tables for securing the workpiece in position.

5 **Spindle:** The spindle is the main rotating component of the milling machine and holds the cutting tool. It is mounted vertically or horizontally depending on the type of milling machine and rotates at high speeds to remove material from the workpiece.

6 **Spindle Motor:** The spindle motor provides the power necessary to rotate the spindle and cutting tool at the required speeds. It may be an electric motor, geared motor, or other types of drive mechanisms depending on the machine's design and capabilities.

7 **Tool Holder:** The tool holder is a component that holds and secures the cutting tool in place during machining operations. It may be a collet, chuck, or tool holder, and ensures proper tool alignment and concentricity with the workpiece.

8 **Guideways:** Guideways are precision-machined surfaces that guide the movement of the saddle and table along the column and base, respectively. They ensure smooth and accurate motion of machine components and help maintain machining accuracy and repeatability.

9 **Control Panel:** The control panel contains the machine's control interface, including switches, buttons, and indicators for operating the machine. It may include manual controls for adjusting spindle speed, feed rate, and axis movement, as well as digital displays or readouts for monitoring machining parameters.

10 **Coolant System:** A coolant system is often integrated into the milling machine to lubricate and cool the cutting tool and workpiece during machining. Coolant helps reduce heat generation, chip formation, and tool wear, resulting in improved machining efficiency and surface finish.

11 **Power Drive Mechanism:** The power drive mechanism provides the means for driving the spindle and moving the saddle and table during machining operations. It may consist of electric motors, gears, belts, or hydraulic/pneumatic systems, depending on the machine's design and capabilities.

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Jig Boring Machine

Introduction of the jig boring machine:

A jig boring machine, often referred to as a jig borer, is a precision machine tool used in manufacturing and toolmaking industries for producing highly accurate bores, holes, and contours with tight tolerances.

Working Principle of jig boring machine:

The working principle of a jig boring machine involves precise positioning and machining of holes, bores, and contours in work pieces with exceptionally tight tolerances. The machine operates on the basis of accurate guiding mechanisms and controlled movements to achieve the desired machining outcomes.

Parts of jig boring machine:

1 **Base:** The base of the jig boring machine provides a stable foundation and supports the entire machine structure. It is usually made of heavy cast iron or steel to minimize vibration and ensure rigidity during machining operations.

2 **Column:** The column is a vertical structural component mounted on the base and provides support for the other machine components, including the spindle assembly and the cross-slide. It may feature guideways or tracks to allow vertical movement of the cross-slide along the column.

3 **Cross-Slide:** The cross-slide, also known as the saddle, is a movable component that travels along the column in the vertical direction. It carries the spindle assembly and allows for precise positioning of the cutting tool relative to the work piece. The cross-slide may be equipped with hand wheels or motorized drives for manual or automatic control of vertical movement.

4 **Spindle Assembly:** The spindle assembly houses the cutting tool and provides the means for rotating it at high speeds. It typically consists of a spindle, bearings, drive mechanism, and tool holder. The spindle may have provisions for vertical and horizontal movement to facilitate drilling, boring, and milling operations.

5 **Table:** The table is a flat, horizontal surface located below the spindle assembly and serves as the work piece support during machining. It may have T-slots, clamping fixtures, or other means for securing the work piece in position. The table can be adjusted vertically and horizontally to align the work piece with the cutting tool.

6 **Tool Holder:** The tool holder is a component that holds and secures the cutting tool in place during machining operations. It may be a collet, chuck, or tool turret, depending on the type of tool and machining requirements. The tool holder ensures proper tool alignment and concentricity with the work piece.

7 **Control Panel:** The control panel contains the machine's control interface, including switches, buttons, and indicators for operating the machine. It may include manual controls for adjusting spindle speed, feed rate, and axis movement, as well as digital displays or readouts for monitoring machining parameters.

8 **Coolant System:** A coolant system is often integrated into the jig boring machine to lubricate and cool the cutting tool and work piece during machining. Coolant helps reduce heat generation, chip formation, and tool wear, resulting in improved machining efficiency and surface finish.

9 **Power Drive Mechanism:** The power drive mechanism provides the means for driving the spindle and moving the cross-slide and table during machining operations. It may consist of electric motors, gears, belts, or hydraulic/pneumatic systems, depending on the machine's design and capabilities.

10 **Guideways:** Guideways are precision-machined surfaces that guide the movement of the cross- slide and table along the column and base, respectively. They ensure smooth and accurate motion of machine components and help maintain machining accuracy and repeatability.

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MODULE 5

LESSON 13: Introduction To CNC Turning Machine

Objectives

At the end of this lesson you shall be able to

- explain the CNC turning lathe its principles and advantages
- state the classification of CNC system and designation of axis
- state the part programming of CNC turning.

Introduction To Cnc Turning (Lathe) And Advantages

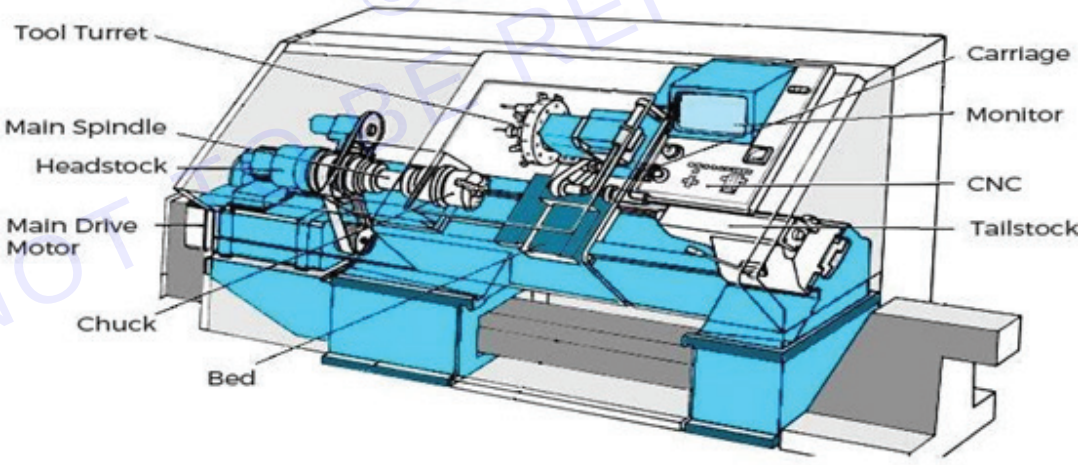
- **Introduction of CNC lathe and operations:**

CNC (Computer Numerical Control) lathes are advanced machine tools used for precision machining operations in manufacturing industries. Unlike manual lathes, which require manual operation by skilled machinists, CNC lathes are automated machines controlled by computer programs to perform various turning operations with high accuracy and repeatability.

Here's an introduction to CNC lathes:

1 Basic Principle:

- CNC lathes operate on the principle of rotating a workpiece while a cutting tool removes material from its surface to create cylindrical or conical shapes.
- The cutting tool is mounted on a tool post and moves along the workpiece's length to remove material according to programmed instructions.



Diag. Main parts of a CNC lathe machine

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Components:

- **Bed:** The main structural component of the lathe, providing support for the workpiece and other machine components.
- **Headstock:** Houses the spindle, which rotates the workpiece at high speeds.
- **Tailstock:** Supports the opposite end of the workpiece and may contain a centre for additional support.
- **Carriage:** Holds the cutting tool and moves along the length of the bed to perform machining operations.
- **Control Panel:** Contains the interface for programming and operating the CNC lathe, typically using a control unit with a display screen and keypad.

Operation:

- CNC lathes are programmed using G-code, a standardized programming language that specifies tool movements, spindle speeds, feed rates, and other machining parameters.
- Machinists create CNC programs using CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) software, which generates toolpaths based on the part design.
- Once the program is loaded into the CNC lathe's control unit, the machine automatically executes the programmed instructions to perform turning, facing, drilling, threading, and other operations.
- During operation, sensors and feedback mechanisms ensure precise control of tool movements, spindle speeds, and cutting forces to achieve the desired part geometry and surface finish.
- **Advantages and Disadvantages of CNC lathe:**

➢ **Advantages:**

1 **High Precision:** CNC lathes offer exceptional accuracy and repeatability, leading to precise machining of complex geometries with tight tolerances. This result in consistent part quality and reduced scrap rates.

2 **Increased Productivity:** Automation of machining processes reduces manual intervention, setup time, and idle time between operations. CNC lathes can run continuously, leading to higher productivity and throughput compared to manual lathes.

3 **Versatility:** CNC lathes can perform a wide range of turning operations, including facing, contouring, threading, drilling, and grooving. They can machine various materials such as metals, plastics, and composites, making them suitable for diverse manufacturing applications.

4 **Flexibility:** CNC programs can be easily modified to accommodate design changes or produce different parts without the need for extensive retooling. This flexibility allows manufacturers to adapt quickly to evolving production requirements and market demands.

5 **Reduced Labour Costs:** CNC lathes require less skilled labour compared to manual lathes. Operators primarily focus on programming, setup, and monitoring, reducing labour costs and dependency on highly skilled machinists.

6 **Automation Features:** CNC lathes often feature automatic tool changers, part probing systems, and coolant systems, further enhancing productivity and efficiency. These automation features streamline machining processes and minimize downtime.

➢ **Disadvantages:**

1 **Initial Investment:** CNC lathes are expensive to purchase and install, requiring a significant initial investment in machine acquisition, training, and infrastructure. This cost may be prohibitive for small-scale or budget-constrained manufacturers.

2 **Complex Programming:** Programming CNC lathes requires specialized skills and knowledge of CAD/CAM software and G-code programming. The complexity of programming can pose a learning curve for operators and programmers, leading to longer setup times and potential errors.

3 **Dependency on Electricity and Software:** CNC lathes rely on electricity to power their motors, controls, and peripherals. Power outages or electrical issues can halt production and require backup systems or contingency plans. Additionally, reliance on software introduces the risk of software glitches, compatibility issues, or cybersecurity threats.

4 **Maintenance and Downtime:** CNC lathes require regular maintenance to ensure optimal performance and prevent breakdowns. Downtime for maintenance, repairs, or troubleshooting can disrupt production schedule sand lead to lost revenue.

5 **Limited Manual Control:** While CNC lathes offer automation and precision, they may lack the flexibility and tactile feedback of manual lathes. Operators have limited manual control over tool movements and machining parameters, which can be a disadvantage for certain applications or machining techniques.

6 **Specialized Training Requirements:** Operating and programming CNC lathes require specialized training and expertise. Manufacturers must invest in training programs to ensure their workforce has the necessary skills to operate CNC equipment effectively and safely.

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Classification Of Cnc System And Designation Of Axis

Introduction Of CNC Machines Used In industries:

CNC (Computer Numerical Control) machines are advanced manufacturing tools that have revolutionized various industries by offering precise, efficient, and automated machining capabilities. Here's an overview of CNC machines and their applications in industries:

CNC machines are automated manufacturing devices controlled by computer programs. They use numerical data input to control the movement of cutting tools and workpieces, allowing for highly accurate and repeatable operations.

- **Different Types Of CNC Machines Used In Industries:**

1 CNC Lathe Machine:

- A CNC lathe machine, also known as a turning centre, is used for cylindrical machining operations.
- It rotates a workpiece on its axis while various cutting tools are applied to shape the material.
- CNC lathes are commonly used for tasks such as facing, turning, grooving, threading, and parting.
- They are widely utilized in industries such as automotive, aerospace, and general manufacturing for producing cylindrical components like shafts, bushings, and fittings with high precision.

2 CNC Milling Machine:

- CNC milling machines use rotary cutters to remove material from a workpiece by advancing it into a rotating cutter.
- They can perform a wide range of operations, including drilling, slotting, contouring, and 3D surface machining.
- CNC mills are capable of producing complex shapes, pockets, and contours with high accuracy and repeatability.
- They find applications in industries such as meld making, prototyping, aerospace, and automotive manufacturing for producing components like melds, dies, engine parts, and tooling.

3 CNC Drilling Machine:

- CNC drilling machines are specialized for creating holes in a workpiece with precision and accuracy.
- They use drill bits or other cutting tools to bore holes of various sizes and depths.
- CNC drills can perform drilling operations in a wide range of materials, including metal, wood, plastic, and composites.
- They are commonly used in industries such as construction, metal fabrication, woodworking, and electronics manufacturing for applications like hole drilling in structural components, circuit boards, and assemblies.

4 CNC Grinder Machine:

- CNC grinder machines are used for precision grinding operations to achieve tight tolerances and surface finishes.
- They use abrasive wheels to remove material from a workpiece, producing fine finishes and precise geometries.
- CNC grinders are utilized in industries such as aerospace, automotive, tool and die making, and medical device manufacturing for grinding operations on components like bearings, gears, shafts, and cutting tools.

5 CNC Plasma Cutting Machine:

- CNC plasma cutting machines use a high-velocity jet of ionized gas (plasma) to cut through electrically conductive materials.
- They are capable of cutting a wide range of materials, including steel, aluminium, stainless steel, and copper, with high precision and speed.
- CNC plasma cutters find applications in industries such as metal fabrication, automotive, shipbuilding, and construction for cutting intricate shapes, parts, and components from sheet metal and plate materials.

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- **CNC Machine Axis designation (By Right Hand Thumb Rule):**

The right-hand thumb rule is commonly used in engineering and physics to determine the direction of various vectors. When applied to CNC machine axis designation, the rule helps establish the orientation of the axes based on the movement of the machine.

Here's how the right-hand thumb rule is typically applied to CNC machine axes:

1 X-Axis (Horizontal Direction):

- Extend your right hand with your thumb pointing to the right (parallel to the X-axis).
- Curl your fingers towards the positive direction. Your fingers will point in the direction of positive X-axis movement.

2 Y-Axis (Vertical Direction):

- Extend your right hand with your thumb pointing upwards (parallel to the Y-axis).
- Curl your fingers towards the positive direction. Your fingers will point in the direction of positive Y-axis movement.

3 Z-Axis (Depth or Vertical Direction):

- Extend your right hand with your thumb pointing upwards (parallel to the Z-axis).
- Extend your index finger forward (parallel to the X-axis).
- Extend your middle finger to the right (parallel to the Y-axis).
- Your thumb, index finger, and middle finger should form a right- handed coordinate system.
- The direction in which your thumb points indicates the positive direction of the Z-axis (depth or vertical movement).
  - Right hand thumb rule :
  - Middle finger = 'z' axis
  - Index finger = 'y' axis Thumb finger = 'x' axis
- **Axis Used In CNC Lathe:**
  - X-axis = cross slide movement
  - Z-axis = carriage movement
  - Linear axis/primary axis: X,Y,Z
  - Supplementary axis :U,V,W
  - Rotary axis: A, B, C

Here's a breakdown of the axis designations commonly used in CNC machines:

1 Linear Axes (Primary Axes):

- These are the main axes responsible for linear movement along the X, Y, and Z directions.
- The X-axis typically represents horizontal movement, the Y-axis represents vertical movement, and the Z-axis represents depth or axial movement.
- Linear axes are essential for positioning the cutting tool or workpiece accurately in three-dimensional space.

2 Supplementary Axes:

- These axes are additional linear axes that provide supplemental movement in directions other than X, Y, and Z.
- They are designated as U, V, and W axes.
- Supplementary axes are used for complex machining operations that require additional degrees of freedom beyond the primary axes.

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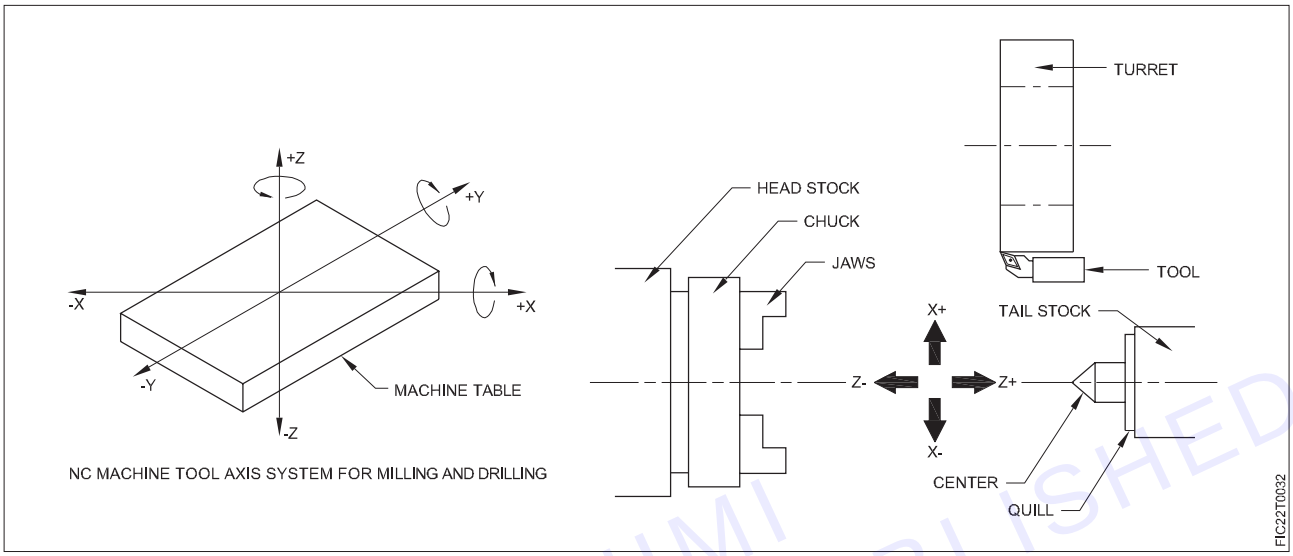
3. Rotary Axes:

- Rotary axes allow for rotational movement of the cutting tool or workpiece around specific axes.
- They are designated as A, B, and C axes.
- Rotary axes are commonly used for tasks such as indexing, contouring, and machining features on cylindrical or contoured surfaces.

When 'c' axis add in CNC machine for rotary axis then this machine is called Turn Mill Centre (TMC) Axis :X,Z,C



NC MACHINE TOOL AXIS SYSTEM FOR MILLING AND DRILLING

Introduction To Part Programming Of Cnc Turning

Introduction Of Part Programming In CNC (turning):

Part programming in CNC turning involves creating a set of instructions, typically in the form of G-code, to control the movements of the cutting tool and the rotation of the workpiece on a lathe machine. Here's an overview of the key steps involved in part programming for CNC turning:

1 Design the Part: Begin by designing the part you want to manufacture using computer-aided design (CAD) software. This involves specifying the dimensions, features, and tolerances of the part.

2 Select the Cutting Tools: Choose the appropriate cutting tools for the turning operation based on the geometry of the part, material type, and desired surface finish.

3 Generate Toolpaths: Use computer-aided manufacturing (CAM) software to generate toolpaths for the CNC lathe. Toolpaths define the tool's trajectory as it removes material from the workpiece to create the desired shape.

4 Create the Part Program: Write the part program, which consists of a series of G-code commands that instruct the CNC machine on how to execute the turning operation. This includes commands for tool movements, spindle speed, feed rate, coolant usage, tool changes, and other machining parameters.

5 Consider Tool Offsets: Account for tool offsets to ensure the tool cuts the workpiece at the correct dimensions. Tool offsets compensate for differences between the programmed toolpath and the actual cutting tool dimensions.

6 Simulation and Verification: Before running the part program on the CNC lathe, simulate the machining operation using CAM software or a CNC simulator. This allows you to verify the toolpaths, detect any collisions or errors, and ensure the program will produce the desired part accurately.

7 Run the Part Program: Once the part program has been verified, transfer it to the CNC lathe's controller and execute the machining operation. The CNC machine will follow the programmed instructions to turn the workpiece into the final part.

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8 Inspect the Finished Part: After machining is complete, inspect the finished part using precision measurement tools to verify that it meets the specified dimensions and quality requirements.

By following these steps, you can effectively program a CNC lathe to produce precision turned parts according to your design specification.

G-Code :

In CNC turning, G-code is used to control the movement of the cutting tool and the rotation of the workpiece on a lathe machine. Here are some common G-codes used in CNC turning operations:

1 G00: Rapid Traverse - Moves the tool or machine axes at maximum speed to a specified position.

2 G01: Linear Interpolation - Moves the tool along a straight path at a controlled feed rate.

3 G02: Circular Interpolation (Clockwise) - Moves the tool along a circular arc in a clockwise direction.

4 G03: Circular Interpolation (Counter clockwise) - Moves the tool along a circular arc in a counter clockwise direction.

5 G04: Dwell - Pauses the machine for a specified duration.

6 G08: Acceleration/Deceleration Control - Controls the acceleration and deceleration of the machine.

7 G09: Exact Stop - Stops the machine exactly at the specified position.

8 G17: Select XY Plane - Selects the XY plane as the plane of operation.

9 G18: Select XZ Plane - Selects the XZ plane as the plane of operation.

10 G19: Select YZ Plane - Selects the YZ plane as the plane of operation.

11 G20: Inch Units - Sets the machine to use inches for linear measurements.

12 G21: Metric Units - Sets the machine to use millimetres for linear measurements.

13 G28: Return to Home - Returns the machine to the home position.

14 G40: Cutter Compensation Cancel - Cancels cutter radius compensation.

15 G41: Cutter Compensation Left - Applies cutter radius compensation to the left of the tool path.

16 G42: Cutter Compensation Right - Applies cutter radius compensation to the right of the tool path.

17 G70: Inch Programming - Sets the machine to use inch units for programming.

18 G71: Metric Programming - Sets the machine to use metric units for programming.

19 G74: Peck Drilling (Left-hand) - Initiates left-hand peck drilling cycle.

20 G75: Peck Drilling (Right-hand) - Initiates right-hand peck drilling cycle.

21 G72: Tapping Cycle (Right-hand) - Initiates right-hand tapping cycle.

22 G73: Tapping Cycle (Peck) - Initiates peck tapping cycle.

23 G76: Fine Boring Cycle - Initiates fine boring cycle.

24 G81: Drilling Cycle - Initiates drilling cycle.

25 G82: Counter boring Cycle - Initiates counter boring cycle.

26 G83: Peck Drilling (Deep Hole) - Initiates deep hole peck drilling cycle.

27 G84: Tapping Cycle (Rigid Tapping) - Initiates rigid tapping cycle.

28 G85: Boring Cycle (Rough) - Initiates rough boring cycle.

29 G86: Boring Cycle (Finish) - Initiates finish boring cycle.

30 G87: Back Boring Cycle - Initiates back boring cycle.

31 G89: Boring Cycle (Dwell) - Initiates boring cycle with dwell.

32 G88: Boring Cycle (Stop) - Initiates boring cycle with stop.

33 G90: Absolute Programming - Specifies that coordinates are interpreted as absolute positions from the program origin.

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34 G91: Incremental Programming - Specifies that coordinates are interpreted as incremental distances from the current position.

35 G92: Coordinate System Offset - Sets a temporary offset for coordinate values.

36 G93: Inverse Time Feed Rate - Specifies feed rate as inverse time for each move.

37 G95: Feed Per Revolution - Specifies feed rate as distance per spindle revolution.

38 G96: Constant Surface Speed Control - Controls spindle speed to maintain a constant surface speed.

39 G97: Spindle Speed Control Off - Cancels constant surface speed control.

➢ **Modal command:**

Modal commands remain active until explicitly changed or canceled by another command. Once set, modal commands retain their settings for subsequent tool movements until modified or overridden. Common modal commands used in CNC lathes include:

1 G00-G03 (Rapid Traverse and Interpolation): These commands specify rapid traverse or interpolation modes for tool movement and remain in effect until changed or cancelled.

2 G17-G19 (Plane Selection): These commands specify the plane of operation (XY, XZ, or YZ) and remain active until modified or cancelled.

3 G20/G21 (Unit Selection): These commands specify the units of measurement (inch or millimetre) and remain in effect until changed.

4 G40/G41/G42 (Cutter Compensation): These commands activate cutter compensation modes (left, right, or off) and remain active until cancelled or modified.

5 G90/G91 (Absolute/Incremental Programming): These commands specify whether subsequent coordinates are interpreted as absolute positions from the program origin or incremental distances from the current position.

6 G94/G95 (Feed Rate Mode): These commands specify the feed rate mode (units per minute or units per spindle revolution) and remain in effect until changed.

➢ **Non-Modal Commands:**

Non-modal commands affect only the operation immediately following them and do not remain active for subsequent operations. They must be explicitly included for each operation where they are desired. Some common non-modal commands used in CNC lathes are:

1 G00/G01 (Rapid Traverse/Linear Interpolation): Although these commands can be modal, they can also be used as non-modal commands to specify the desired movement for a single operation.

2 G04 (Dwell): Specifies a pause or delay for a specified duration, affecting only the operation immediately following it.

3 G28 (Return to Home): Commands the machine to return to the home position once, but does not remain active for subsequent operations.

4 G53 (Machine Coordinate System): Specifies the use of machine coordinates for the subsequent operation, useful for referencing positions relative to the machine's origin.

- **M-Code:**

  In CNC turning, M-codes are special functions or commands used to control auxiliary functions or operations on the lathe machine. While G-codes primarily control tool movements and machining operations, M-codes handle miscellaneous functions such as tool changes, coolant control, spindle rotation, and other machine-specific operations. Here are some common M-codes used in CNC turning:

1 **M00:** Program Stop - Pauses the program execution, allowing the operator to perform setup tasks or make manual adjustments.

2 **M01:** Optional Stop - Pause the program execution at designated optional stop points, typically used for operator intervention or inspection.

3 **M02:** Program End - Marks the end of the program, typically used for the last block of a program.

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4 **M03:** Spindle on Clockwise (CW) - Starts the spindle rotation in the clockwise direction, usually used for machining operations.

5 **M04:** Spindle on Counter clockwise (CCW) - Starts the spindle rotation in the counter clockwise direction, if supported by the machine.

6 **M05:** Spindle Stop - Stops the spindle rotation, ending the machining operation.

7 **M07:** Mist Coolant On - Activates the mist coolant system, which delivers a fine spray of coolant to the cutting area to lubricate and cool the tool and workpiece.

8 **M08:** Flood Coolant On - Activates the flood coolant system, which floods the cutting area with coolant to remove chips and dissipate heat during machining.

9 **M09:** Coolant Off - Deactivates the coolant system, stopping the flow of coolant to the cutting area.

10 **M10/M11:** Chuck Open/Close - Controls the opening and closing of the chuck jaws, used for workpiece clamping.

11 **M16:** Spindle Orientation - Rotates the spindle to a predefined orientation, aligning specific features of the workpiece with the tool.

12 **M18/M19:** Tailstock Retract/Advance - Controls the movement of the tailstock, used for workpiece support and centring.

13 **M20:** Tool Change - Initiates an automatic or manual tool change process, allowing the operator to replace cutting tools.

14 **M27/M28/M29:** Return Home - Commands the machine to return to the home position or reference point.

15 **M72/M73:** Program Stop/Cycle Start - Pauses or resumes program execution, commonly used for manual intervention or automatic operation.

16 **M88/M89:** Bar feed Control - Controls the operation of a bar feeder for automatic loading of workpieces.

17 **M98/M99:** Subprogram Call/Subprogram End - Calls a subprogram (a separate section of code) or marks the end of a subprogram.

- **co-ordinate system G90 and G91:**

  In CNC (Computer Numerical Control) machining, G90 and G91 are G-codes used to specify the coordinate system mode for programming tool movements and machining operations. They

  control how coordinates are interpreted and used to define the tool's position relative to the workpiece.

Here's a breakdown of G90 and G91:

1 **G90 - Absolute Programming:**

- When G90 is activated, it sets the machine to use absolute coordinates for positioning.
- In absolute programming mode, coordinates specify positions relative to a fixed reference point, typically the origin (0,0) of the machine's coordinate system.
- Each coordinate value represents the exact position of the tool or workpiece in relation to the reference point.
- Absolute programming mode is useful for specifying precise positions and movements, as coordinates are defined in relation to a known starting point.

2 **G91 - Incremental Programming:**

- When G91 is activated, it sets the machine to use incremental coordinates for positioning.
- In incremental programming mode, coordinates specify distances or movements relative to the tool's current position.
- Each coordinate value represents a change in position or movement from the tool's current location, rather than an absolute position.
- Incremental programming mode is useful for specifying relative movements and distances, as coordinates are defined based on the tool's current position.

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MODULE 6

LESSON 14: Limit, Fits & Tolerance

Objectives

At the end of this lesson you shall be able to

- define the limit, fit and tolerance and their application
- state the importance of limit, fit and tolerance
- state the hole basics system and shaft basic system.

Limit Fit Tolerance And Their Application

- **Define Limit, Fit, And Tolerance:**

In engineering and manufacturing, "limit," "fit," and "tolerance" are terms used to describe the allowable variation in dimensions of parts and components. Here are their definitions:

1 **Limit:** A limit refers to the maximum and minimum dimensions or conditions that a part must meet in order to be acceptable for its intended use. Limits are often specified as numerical values or ranges within which a dimension, such as length, diameter, or angle, must fall.

2 **Fit:** Fit describes the relationship between two mating parts or components in an assembly. It specifies how snugly or loosely parts fit together when assembled. There are various types of fits, including clearance fits (where there is intentional clearance between mating parts), interference fits (where parts are intentionally pressed together with interference), and transition fits (where parts have a combination of clearance and interference).

3 **Tolerance:** Tolerance refers to the allowable deviation from a specified dimension or condition. It represents the acceptable amount of variation permitted in the dimensions or features of a part. Tolerances are typically specified as numerical values and can be unilateral (allowable deviation in one direction) or bilateral (allowable deviation in both directions).

- **Importance of Limit, Fit, And Tolerance:**

Limit, fit, and tolerance are fundamental concepts in engineering and manufacturing with critical importance for ensuring the quality, functionality, and interchangeability of parts. Here's why they are significant:

1 Quality Assurance: Limit, fit, and tolerance specifications establish clear criteria for the dimensions and conditions of parts. By adhering to these specifications, manufacturers can ensure that parts meet the required standards for quality and performance. This helps in preventing defects and ensuring consistency in production.

2 Interchangeability: Standardized limit, fit, and tolerance specifications facilitate interchangeability of parts within assemblies and across different manufacturers. When parts are produced with consistent dimensions and fits, they can be easily replaced or interchanged without the need for custom adjustments or modifications. This is particularly crucial in industries where components need to be readily available and compatible, such as automotive, aerospace, and machinery manufacturing.

3 Functionality and Performance: Properly defined limits, fits, and tolerances are essential for ensuring that parts function as intended within assemblies. For example, tight fits may be necessary to prevent leakage or to maintain alignment, while clearance fits might be required to allow for smooth movement or assembly. By specifying appropriate fits and tolerances, engineers can optimize the performance and reliability of mechanical systems.

4 Cost Efficiency: Effective management of tolerances can impact manufacturing costs

significantly. Tighter tolerances generally require more precise manufacturing processes, which may involve higher costs.

However overly loose tolerances can lead to functional issues or increased wear and tear over time, resulting in higher maintenance or replacement costs. Balancing tolerances based on functional requirements and cost considerations is crucial for optimizing manufacturing processes and overall product cost

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5 Compliance and Standards: Many industries have specific standards and regulations governing the tolerances and fits of parts, particularly in safety-critical applications. Adhering to these standards ensures compliance with industry regulations and requirements, as well as promotes consistency and reliability across different manufacturers and suppliers.

6 Design Flexibility: Limit, fit, and tolerance considerations play a vital role in the design process, allowing engineers to balance competing requirements such as functionality, manufacturability, and cost. By understanding the implications of different fits and tolerances, designers can make informed decisions to optimize part designs for performance, ease of manufacturing, and cost-effectiveness.

- **Different Types Of Fits And Their Applications:**

There are several types of fits used in engineering and manufacturing, each serving specific purposes based on the requirements of the application. Here are some of the different types of fits commonly employed:

1 Clearance Fit:

- In a clearance fit, there is intentional clearance between the mating parts when assembled. This means that there is space between the mating surfaces, allowing for easy assembly and disassembly.
- Applications: Clearance fits are suitable for applications where ease of assembly, disassembly, and relative movement between parts are required. Examples include shafts rotating within bearings, sliding fits for guides and sliders, and covers or panels that need to be easily removed.

2 Interference Fit:

- An interference fit involves intentionally causing the mating parts to be pressed together with interference, meaning that one or both parts are slightly oversized so that they must be forced together during assembly.
- Applications: Interference fits are used when a tight, secure connection between parts is required without the need for additional fasteners. Common applications include press fits for bearings onto shafts, gear assembly, and joining components in high-stress environments.

3 Transition Fit:

- Transition fits have characteristics of both clearance and interference fits. Depending on the actual dimensions of the parts being assembled, a transition fit may result in either a clearance or interference fit.
- Applications: Transition fits are often used when a balance between clearance and interference is needed. This can be advantageous in applications where a snug fit is required, but some degree of movement or tolerance for variation is also desired.

Explain hole basis system and shaft basis system

The whole basis system and the shaft basis system are two common approaches used in engineering to establish fits between mating parts, particularly in mechanical assemblies where shafts fit into holes. These systems provide a standardized method for specifying tolerances and fits based on the relationship between the dimensions of the hole and the shaft. Here's an explanation of each system.

- **Hole Basis System:**

  In the whole basis system, the size of the hole is considered as the basis for establishing the fit. The tolerance zone for the hole is fixed, while the shaft is designed to fit within this tolerance zone. This means that the shaft's dimensions can vary within a specified range, while the whole remains fixed.

- **Key points:**

- The hole is held to a specified size, and the tolerance is applied to the shaft.
- The shaft can have various sizes within its tolerance range, but it must fit into the hole.
- The fit is determined by the relationship between the size of the shaft and the size of the hole.

- **Applications:**

- This system is often used in applications where the hole is more critical, such as bearings, bushings, or other components that require precise alignment or clearance for rotating shafts.

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- **Shaft Basis System:**

  In the shaft basis system, the size of the shaft is considered as the basis for establishing the fit. The tolerance zone for the shaft is fixed, while the hole is designed to accommodate the shaft within this tolerance zone. This means that the hole's dimensions can vary within a specified range to accept the shaft.

- **Key points:**

- The shaft is held to a specified size, and the tolerance is applied to the hole.
- The hole can have various sizes within its tolerance range, but it must accept the shaft.
- The fit is determined by the relationship between the size of the hole and the size of the shaft.

- **Applications:**

- This system is often used in applications where the shaft is more critical, such as gears, pulleys, or other components where precise shaft dimensions are essential for proper functionality.

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LESSON 15: Introduction To Gauges

Objectives

At the end of this lesson you shall be able to

- define the gauge and its types and uses of different types of gauges
- state the safety precaution while using it
- state the ball and roller gauge and their uses and application.

Different types of Gauge and application

- **Introduction of CNC lathe and operations**

Definition of Gauge

Gauges are used to measure different types of objects having various sizes, shapes, and thicknesses, the gap in space, diameter of materials, or pressure of the flow. Specific types of gauges are used to measure each parameter.

Uses: -

They are generally considered as fixed-type or deviation-type instruments. Fixed-type gauges are designed to showcase if a given dimension is larger or smaller than the standard. They are usually made of soft steel, hard steel, or glass. To prevent rub-down, fixed-type gauges are chrome-plated or tungsten-carbide coated. Now let us know more about the various types of gauges.

Material

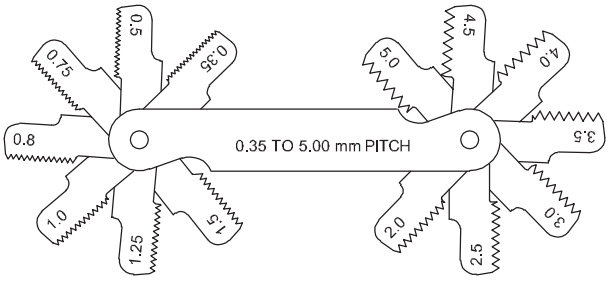
Material is carbon structural steel, Spring Steel.

Types of gauge

- Plug gauge.
- Ring gauge.
- Taper gauge.
- Snap gauge.
- Feeler gauge.
- Thread gauge.

Screw pitch gauge: -

A screw pitch gauge is used to determine the pitch of a thread. It is also used to compare the profile of threads Some screw pitch gauge sets will have blades provided for checking British Standards threads (BSW, BSF etc.) at one end and the metric standard at the other end. The thread profile on each blade is cut for about 25 mm to 30 mm. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case.



SCREW PITCH GAUGE

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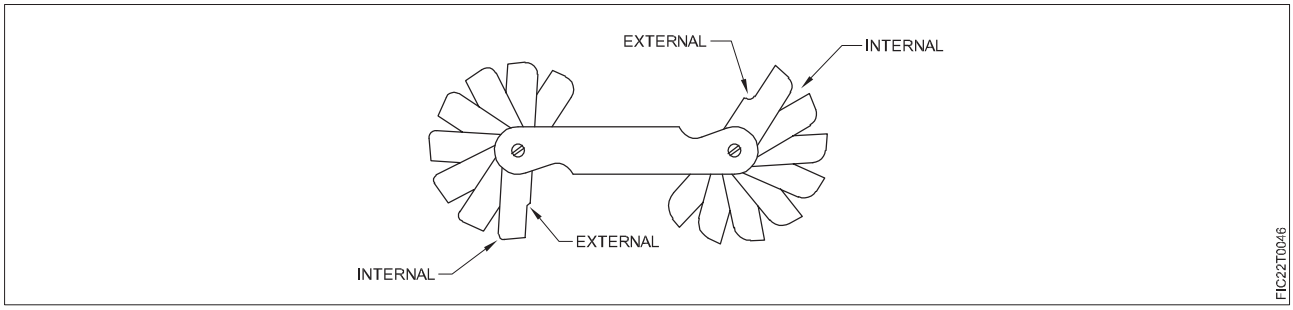
Radius and fillet gauges

Components are machined to have curved formation on the edges or at the junction of two steps. Accordingly, they are called radius and fillets. The size of the radius and radius is normally provided on a drawing. The gauges used to check the radius formed on the edges of diameters are fillet and

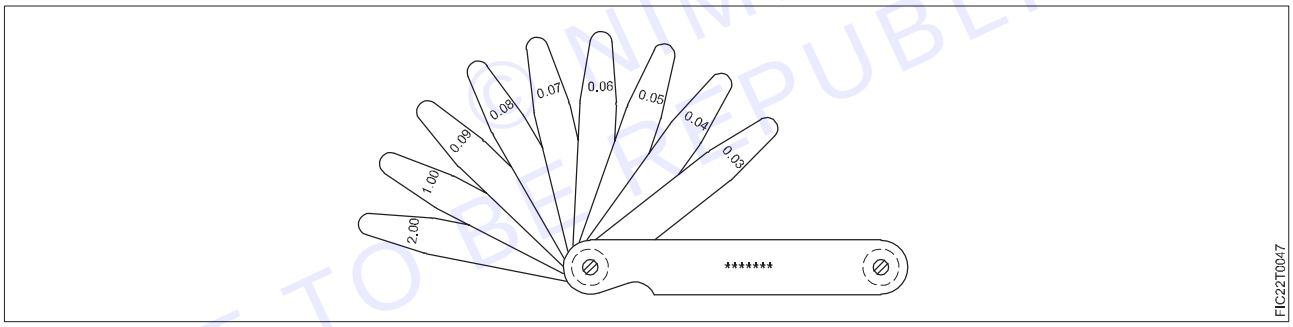
the gauges used to check the fillets are called fillets gauges They are made of hardened sheet metal each to a precise radius. They are used to check the radii by comparing the radius on a part with the radius of the gauges.



Feeler gauge

A feeler gauge consists of a number of hardened and tempered steel blades of various thicknesses mounted in a steel case. The thickness of individual leaves is marked on it.

B.I.S. Set: The Indian Standard establishes four sets of feeler gauges Nos.1,2,3 and 4 which differ by the number of blades in each and by the range of thickness (minimum is 0.03 mm to 1 mm in steps of 0.01 mm). The length of the blade is usually 100 mm.



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Example: - Set No.4 of Indian Standard consist of 13 blades of different thicknesses. 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50. The sizes of the feeler gauges in a set are carefully chosen in order that a maximum number of dimensions can be formed by building up from a minimum number of leaves. The dimension being tested is judged to be equal to the

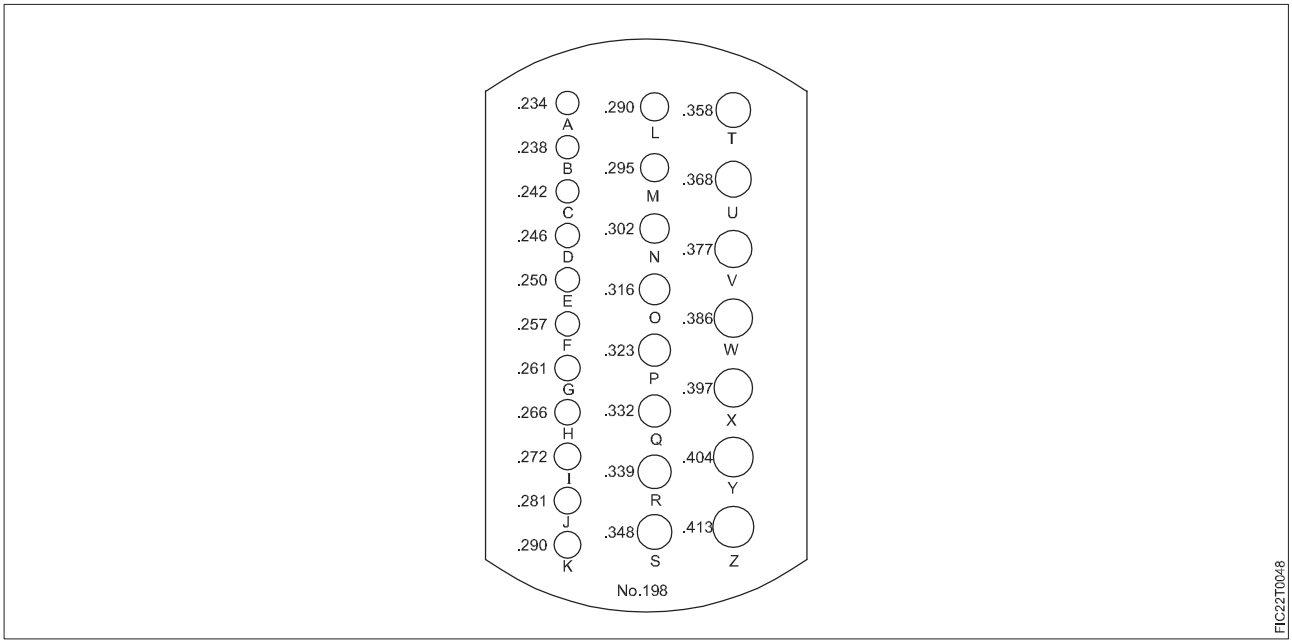
thickness of the leaves used, when a slight pull is felt while withdrawing them. Accuracy in using these gauge requires a good sense of feel.

Drill gauge: -

A drill gauge is a rectangular or square shaped metal piece containing a number of different diameter holes. The size of the hole is stamped against each hole In the number drill and letter drill series, the diameter of the drill is gauged with the help of the respective drill gauge

Drill point grinding gauge:-

Drill point grinding gauge having an angle 118°. In the 118° angle/side/0.5 graduations are marked to check the length of the cutting edge. In inches version this tool is calibrated with 1/32 parts of an inch. It consists of a sliding head mounted on a steel rule. The head may be positioned on the rule and clamped by a knurled nut. This gauge is used to check the correctness of the cutting angle 118°, of the twist drill after re-sharpening by hand.



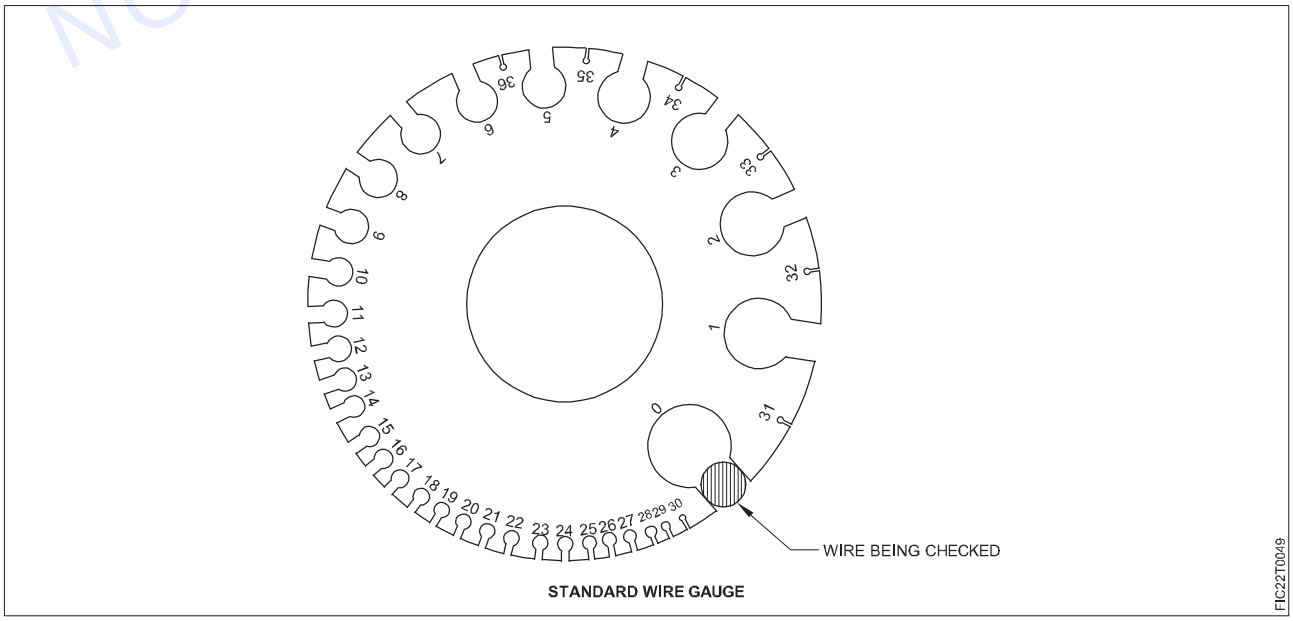
Centre gauge: -

A centre gauge is made up of spring steel hardened and tempered and is used mainly for grinding and setting single point thread cutting tool. These gauges have graduation for checking the number of threads per inch. Some gauges have a table giving the double depth of various threads and also used to check the included angle 60° of ground lathe centres.

The notches on the edge of the gauge are for checking the correct width of point of the tool according to the number of threads per inch specified for acme thread. It is made of spring steel and hardened. Similarly, a metric thread gauge is also available.

Standard Wire Gauge (SWG): -

It is used to measure the size of a wire and thickness of sheet shown in. The standard wire gauge is a circular metal disc with varying hole and slot size on its circumference. Each slot size corresponds to a gauge number which is written just below the hole. The gauge numbers specify the size of a round wire in terms of its diameter.As the gauge number increase from 0 to 36, the dia size decrease. The thickness of sheet metal and the diameter of wires confirm to various gauging num bers and the following Table 1 give the decimal equivalents of the different gauge numbers for the diameter of wires, and the thickness of sheets



STANDARD WIRE GAUGE

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Limit Gauges: -

Faster checking of the product is within the specified limits. Less dependence on operator skill and getting affected by operator judgement. Gauges are economical when compared to measuring instruments

- **Plug gauges Types of cylindrical: -**

- **Double-ended plug gauge: -**

A plug gauge, also known as a pin gauge or a GO gauge, is a cylindrical tool used to check the diameter and depth of a hole or a bore. It consists of a smooth cylindrical rod with precise dimensions. Plug gauges are typically made to tolerance standards and come in various sizes to match different hole diameters.

To use a plug gauge, you insert it into the hole or bore being measured. If the hole is within tolerance and properly sized, the plug gauge should fit snugly without any play. If the hole is too small or too large, the plug gauge will not fit correctly, indicating that the hole is out of tolerance.

Plug gauges are commonly used in manufacturing and machining processes to ensure the accuracy and quality of drilled or machined holes. They are essential tools for quality control and maintaining tight tolerances in production.

- **Progressive plug gauge: -**

Plain cylindrical gauges are used for checking the inside diameter of a straight hole. The 'Go' gauge checks the lower limit of the hole and the 'No- Go' gauge checks the upper limit. The plugs are ground and lapped

- Taper plug gauge: -

These gauges made with standard or special tapers are used to check the size of the hole and the accuracy of the taper. The gauge must slide into the hole for a prescribed depth and fit perfectly. An incorrect taper is evidenced by a wobble between the plug gauge and the hole.

- **Thread plug gauge: -**

Internal threads are checked with thread plug gauges of 'Go' and `No-Go' variety which employ the same principle as cylindrical plug gauges.

- **Ring gauges: -**

A ring gauge, also known as a ring or snap gauge, is a cylindrical tool used to check the outside diameter of cylindrical parts, such as shafts or rods. It consists of a fixed or adjustable ring with precise dimensions. Ring gauges are typically made to tolerance standards and come in various sizes to match different part diameters.

To use a ring gauge, you slide it over the part being measured. If the part's diameter is within tolerance and properly sized, the ring gauge should slide smoothly over the part without any play. If the part's diameter is too large or too small, the ring gauge will not fit properly, indicating that the part is out of tolerance.

Ring gauges are commonly used in manufacturing and machining processes to ensure the accuracy and quality of machined parts. They are essential tools for quality control and maintaining tight tolerances in production.

- **Plain ring gauge:** -

Plain ring gauges are used to check the outside diameter of pieces. Separate gauges are used for checking 'Go' and 'No- Go' sizes. A `No-Go' gauge is identified by an annular groove on the knurled surface.

- **Taper ring gauges: -**

They are used to check both the accuracy and the outside diameter of a taper. Ring gauges often have scribed lines or a step ground on the small end to indicate the 'Go' and 'No- Go' dimensions.

- **Thread ring gauges: -**

  These gauges are used to check the accuracy of an external thread. They have a threaded hole in the centre with three radial slots and a set screw to permit small adjustments.

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- **Snap gauges**

Snap gauges, also known as ring gauges, are precision measurement tools used to verify the outside diameter of cylindrical parts. They consist of two anvils or jaws—one fixed and one movable—that are brought together to measure the diameter of the part being inspected.

Snap gauges are typically designed to be adjustable to accommodate a range of part diameters within a specified tolerance. The movable jaw can be adjusted using a screw mechanism or a spring-loaded mechanism, allowing it to be set to the desired diameter.

To use a snap gauge, the part being measured is placed between the anvils, and the movable jaw is closed until it makes contact with the part. If the part's diameter falls within the acceptable tolerance range, the anvils will "snap" into place around the part, indicating that the part is within spec. If the part's diameter is too large or too small, the anvils will not close properly, indicating that the part is out of tolerance.

Snap gauges are commonly used in manufacturing and quality control processes to quickly and accurately measure the diameter of cylindrical parts, ensuring that they meet the required specifications.

Safety Precaution of gauges

1 Handle with Care*: Gauges are precision instruments and should be handled gently to avoid damage to their delicate components.

2 Keep Clean*: Ensure that gauges are free from dirt, debris, and oil, as these can affect measurements. Clean gauges regularly with a soft cloth or brush.

3 Store Properly*: Store gauges in a clean, dry environment to prevent corrosion and damage. Avoid storing them in areas with extreme temperatures or humidity.

Ball & Roller gauges and their uses

Features:

1 Ball Gauges:

Description:

- Ball gauges consist of precision spherical balls made from materials like tungsten carbide, ceramic, or hardened steel.
- These balls are manufactured with extremely accurate and consistent diameters.

Uses:

- Measurement Verification: Ball gauges are utilized to verify the diameter of cylindrical holes or bores. By inserting the ball into the hole, the user can determine if the diameter is within specified tolerances. A proper fit without play indicates that the hole meets the required diameter.
- Go/No-Go Gauging: They are commonly employed as Go/No-Go gauges for quick assessment of whether a hole's diameter meets specific tolerances. A ball gauge with a known diameter serves as the Go gauge, while a slightly larger one acts as the No-Go gauge.

2 Roller Gauges:

Description:

- Roller gauges consist of precision cylindrical rollers made from materials such as carbide, ceramic, or hardened steel.
- These rollers are precisely machined to have consistent diameters along their length.

Uses:

- **Measurement Verification:** Roller gauges are employed to verify the diameter and roundness of cylindrical components like shafts and pins. By rolling the gauge along the length of the component and measuring at various points, dimensional consistency can be assessed.

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- Checking Runout: They are utilized to detect runout or eccentricity in rotating components. When rolled along the surface of a rotating component, roller gauges can identify deviations from concentricity.

Common Applications for Both:

- **Manufacturing Quality Control:** Ball and roller gauges play a crucial role in manufacturing processes to ensure that machined components meet precise dimensional requirements.
- **Aerospace and Automotive Industries:** These industries rely heavily on accurately machined cylindrical and spherical components for critical applications. Ball and roller gauges are extensively used in quality control procedures to adhere to strict standards.
- **Maintenance and Repair:** They are valuable tools in maintenance and repair operations for assessing the condition of worn or damaged cylindrical components and ensuring proper fit and alignment during reassembly.

Formula for measuring the angle of the taper

$$Tangent\,\theta = \frac{AB}{AC}$$

For Computing the taper angle the following trigonometrical ratio is applied.

From the two measurements taken and the height of the slip packs the ratio is established by subtracting the measurement 'Y' from 'X' and dividing it by two. This corresponds to the distance AB.

The length AC corresponds to the size of the slip pack used on one side.

$$AB = \frac{x-y}{2}$$

Then the tangent of the taper angle is

$$Tan\,\theta = \frac{AB}{AC} = \frac{x-y}{2H}$$

Where X is the measurement

over the rollers placed on the slip gauge height, Y is the measurement over the rollers at the smaller end and H is the slip gauge height. The included angle of the taper will be double the above angle.

Calculate the included angle of the tapered component shown in Fig 1

X=69.3mm

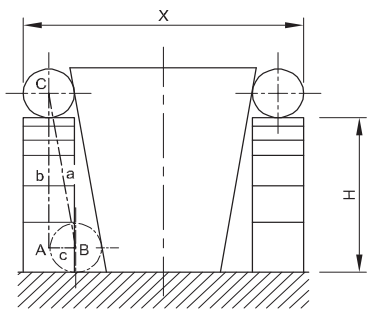
Y = 61.5mm

Height = 70mm

Tan $\theta = (69.3) - (61.5)\ /2x70$

= 7.8/2x70)

$$= \frac{3.9}{70} = \frac{0.39}{7} = 0.0557$$



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LESSON 16: Introduction To Inspection & Quality Control

Objectives

At the end of this lesson you shall be able to

- state the need and importance of inspection in our field or industries
- state the stages of inspection
- state the purpose of quality control and its concepts.

Inspection And Its Importance

Inspection is part of quality- inspection is the checking, verification of raw material, in-process, semi-finished or finished components. It is the first step to distinguish between accepted or rejected components.

- Inspection is the most common method of attaining standardization, uniformity, and quality of workmanship. It is the cost art of controlling the product quality after comparison with the established standards and specifications.
- It is the function of quality control. If the said item does not fall within the zone of acceptability it will be rejected and the corrective measures will be applied to see that the items in future conform to specified standards.
- An inspection is an indispensable tool of the modern manufacturing process. It helps to control quality, reduces manufacturing costs, eliminates scrap losses, and assignable causes of defective work.

Inspection basically involves:

1 Interpretation of specifications/ drawings.

2 Measurement of dimensions or other related parameters.

3 Selection of proper instruments, gauges.

4 Selection of units of measurements.

5 Comparison between specified and measured values.

6 Based on the act of comparison proper decisions to be taken.

Inspection is the first and basic act to towards achieving the quality defined from customer's requirements, hence inspection is part of quality.

Objectives of Inspection:

1 To collect information regarding the performance of the product with established standards for the use of engineering production, purchasing, and quality control, etc.

2 To sort out the poor quality of manufactured products and thus to maintain standards.

3 To establish and increase their reputation by protecting customers from receiving poor quality products.

4 Detect the source of weakness and failure in the finished products and thus check the work of the designer.

Need of Inspection in Industry:

Needs of the inspection in manufacturing:-

1 To ensure that the part, material, or component confirms the established standard.

2 To meet the interchangeability of the manufacturer.

3 To maintain customer relationships by ensuring that no faulty product reaches the customer.

4 Provide the means of finding out shortcomings in manufacture.

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5 It helps to purchase a good quality of raw material, tools, equipment which governs the quality of the finished product.

6 It helps to coordinate the functions of quality control, production, purchasing, and other departments of the organization.

7 To take decisions on the defective parts.

Purpose of Inspection:

1 To distinguish good lots from bad lots

2 To distinguish good pieces from bad pieces.

3 To determine if the process is changing.

4 To determine if the process is approaching the specification limits.

5 To rate the quality of the product.

6 To rate the accuracy of inspectors.

7 To measure the precision of the measuring instrument.

8 To secure products – design information.

9 To measure process capability.

Stages of Inspection:

1 Inspection of incoming materials:

It is also called receiving inspection. It consists of inspecting and checking of all the purchased raw materials and parts that are supplied before they are taken on to the stock or used in actual manufacturing. The inspection may take place either at the supplier's end or at the manufacturer's gate. If the incoming materials are large in quantity and involve huge transportation cost it is economical to inspect them at the place of vendor or supplier.

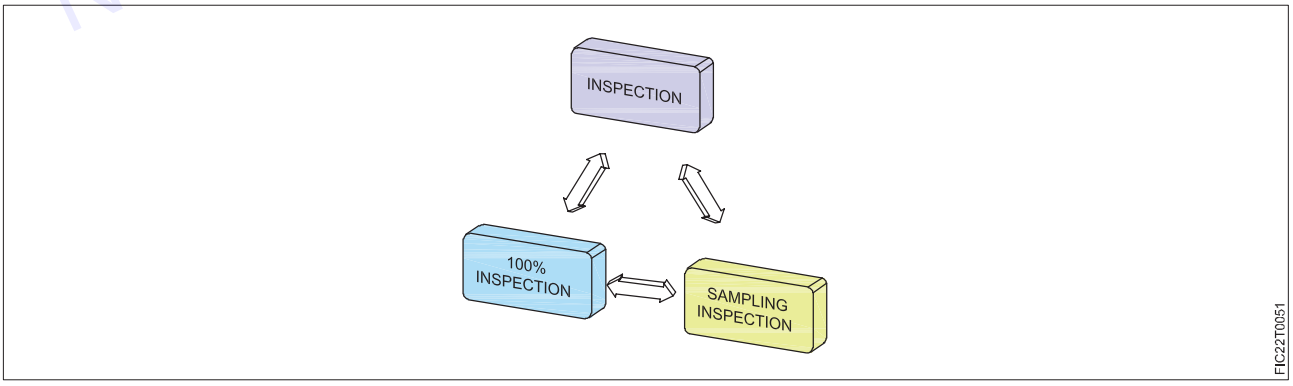
2 Inspection of the production process:

The work of inspection is done while the production process is simultaneously going on. Inspection is done at various work centers of men and machines and at the critical production points. This had the advantage of preventing wastage of time and money on defective units and preventing delays in assembly.

3 Inspection of finished goods:

This is the last stage when finished goods are

inspected and carried out before marketing to see that poor quality products may be either rejected or sold at reduced prices.



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Quality Control & Its Concepts

Quality Control and its role:

Quality control is the process of ensuring that products or services meet certain standards and specifications. Its role is to maintain consistency and reliability in what is produced or provided, ultimately ensuring customer satisfaction and loyalty.

Fundamental principles of quality control:

1 **Customer Focus:** Quality control begins with a focus on understanding and meeting customer needs and expectations. By identifying customer requirements and preferences, organizations can design products and services that deliver value and satisfaction to customers. Customer feedback and input are essential for continuously improving quality and enhancing customer satisfaction.

2 **Leadership Commitment:** Leadership plays a crucial role in establishing a culture of quality within an organization. Top management must demonstrate commitment to quality by setting clear quality objectives, allocating resources for quality improvement initiatives, and actively supporting quality control efforts throughout the organization. Leadership commitment fosters a sense of accountability and responsibility for quality at all levels of the organization.

3 **Employee Involvement:** Quality control is not solely the responsibility of quality control personnel or management. It requires the active involvement and participation of all employees at every level of the organization. Employees should be empowered to identify quality issues, suggest improvements, and contribute to problem-solving efforts. Engaging employees in quality control initiatives fosters a culture of collaboration, ownership, and continuous improvement.

4 **Process Approach:** Quality control emphasizes the importance of understanding and managing processes to achieve desired quality outcomes. Organizations should adopt a systematic approach to quality management, focusing on identifying, documenting, and continuously improving key processes that impact product or service quality. Process optimization and standardization help minimize variation, reduce defects, and enhance overall quality performance.

5 **Continuous Improvement:** Continuous improvement, also known as Kaizen, is a fundamental principle of quality control. Organizations should strive for ongoing improvement in all aspects of their operations, including products, processes, and systems.

This requires a commitment to identifying opportunities for improvement, implementing corrective actions, and monitoring results to ensure sustained progress over time. Continuous improvement efforts aim to drive efficiency, innovation, and excellence in quality performance.

The importance of quality control across diverse industries:

Quality control is vital across various industries because it

1 ensures products or services meet standards,

2 satisfies customers

3 saves costs,

4 complies with regulations,

5 boosts reputation,

6 stays competitive,

7 reduces risks,

8 drives improvement

Be able to identify and apply basic quality control techniques

Being able to identify and apply basic quality control techniques means knowing how to recognize and use simple methods like checklists, visual inspections, and sampling to ensure products or services meet standards and satisfy customers.

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1 **Checklists:** Checklists are simple yet effective tools for ensuring that key steps and requirements are followed during a process or activity. By systematically checking off items on a checklist, operators can verify that all necessary tasks have been completed and that quality standards have been met.

2 **Visual Inspection:** Visual inspection involves visually examining products, components, or materials for defects, irregularities, or non-conformities. It is a fundamental quality control technique that can be used at various stages of production to identify issues such as surface defects, dimensional variations, or incorrect assembly.

3 **Sampling Inspection:** Sampling inspection involves inspecting a representative sample of products or materials rather than inspecting every individual item. By using statistically valid sampling plans, organizations can efficiently assess the quality of a large batch or population while minimizing inspection costs and time.

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LESSON 17: Introduction Of Locking Device

Objectives

At the end of this lesson you shall be able to

- define a locking devices
- state the different types of locking devices
- state various uses of different types of locking devices.

Introduction Of Locking Device

- **Introduction of Locking Device**

  A locking device is a mechanism designed to secure or restrict access to an object, space, or system. It typically prevents unauthorized individuals from gaining entry, using, or tampering with the secured item. Locking devices come in various forms, ranging from simple mechanical locks such as padlocks and deadbolts to sophisticated electronic systems like keycard readers and biometric scanners.

  The primary function of a locking device is to provide security and control over access. They are commonly used in homes, businesses, vehicles, safes, cabinets, electronic devices, and many other applications where safeguarding against unauthorized access or theft is necessary. Locking devices often require a specific key, code, card, or biometric information to unlock them, ensuring that only authorized individuals can gain entry or use the protected area or item.

- **Types of Locking Device**

1 **Lock nut / chuck nut:** A nut designed with a mechanism to prevent it from loosening unintentionally, commonly used in machinery and automotive applications.

2 **Pin nut:** A nut with a hole drilled through it, allowing a pin to be inserted to prevent it from turning.

3 **Split pin nut:** Similar to a pin nut, but with a split pin (cotter pin) inserted through the nut and bolt to secure them together.

4 **Slotted nut:** A nut with one or more slots or grooves on its face, allowing a locking mechanism such as a cotter pin or a tab washer to be inserted to prevent loosening.

5 **Castle nut:** A nut with notches cut into the top, resembling the battlements of a castle, often used with a cotter pin to secure bolts in place.

6 **Whiz lock nut:** A type of lock nut with a unique design that uses a series of wedges to create tension, preventing the nut from loosening.

7 **Simonds lock nut:** A lock nut designed with multiple threads to provide a more secure locking mechanism.

8 **Up spring washer locking:** A locking mechanism that uses spring washers placed under the nut to create tension and prevent loosening.

9 **Lock plate nut / stop plate:** A nut with a built-in plate or flange that acts as a stopper, preventing it from loosening beyond a certain point.

10 **Ring collar nut:** A nut with a collar or flange attached, providing additional surface area for locking and preventing rotation.

- **Uses of locking devices**

  Locking devices serve a multitude of purposes across various industries and applications, primarily aimed at enhancing security, safety, and control. Here are some common uses of locking devices:

1 **Security:** Locking devices are primarily used to secure doors, gates, cabinets, safes, and other enclosures to prevent unauthorized access and theft.

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2 **Access control:** They are employed to control access to restricted areas such as buildings, rooms, storage facilities, and equipment, ensuring only authorized individuals can enter.

3 **Safety:** Locking devices are utilized in machinery, equipment, and vehicles to prevent accidental operation or movement, thus enhancing workplace safety.

4 **Tamper resistance:** Locking devices are designed to deter tampering and sabotage, ensuring the integrity and functionality of critical systems and components.

5 **Asset protection:** Locking devices safeguard valuable assets such as vehicles, bicycles, electronic devices, and merchandise from theft or unauthorized use.

6 **Inventory control:** They help manage inventory by securing storage areas and limiting access to authorized personnel, reducing the risk of loss, pilferage, and damage.

7 **Compliance:** Locking devices are often employed to meet regulatory requirements and industry standards related to security, safety, and access control.

8 **Personal safety:** Locking devices such as bike locks, padlocks, and personal safes are used by individuals to protect their belongings and ensure personal safety in various settings.

9 **Child safety:** Locking devices like childproof locks and safety gates are installed in homes and childcare facilities to prevent young children from accessing hazardous areas or objects.

10 **Data security:** Locking devices, including encryption keys, password-protected systems, and biometric locks, are used to secure digital data and prevent unauthorized access to sensitive information.

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LESSON 18: Introduction To Rivet And Riveting

Objectives

At the end of this lesson you shall be able to

- define the rivet and its types
- state the uses of different types of rivets
- state the stepwise guide to the riveting process

Introduction to Rivet and its uses

Definition:

A rivet is a popular mechanical fastener to join two or more materials. A rivet consists of a head at one end and a cylindrical body at the other and called its shaft. The tapered end of the shaft is called the rivets tail. The tail looks like a metal pin. Rivets are used to join large structural pieces and small electronic assembles. The shafts are hollow with another internal piece called a mandrel. The mandrel allows the riveter to deformed the tail of the rivet without sticking it directly.

- **Different types of rivet**

1 **Solid rivet:** Solid rivets are one of the oldest and simplest types of rivets. They consist of a solid shaft with a head on one end and a tail on the other. Solid rivets are installed by inserting the shaft through pre-drilled holes in the materials to be joined and then deforming the tail to create a permanent connection.

2 **Split rivet:** It also known as Drive rivets or brazier head rivets, have a semi-tubular shaft with a head on one end. They are installed by driving the shaft through the materials to be joined, causing the shaft to split and flare out on the blind side of the joint.

3 **Blind rivet / pop rivet:** Blind rivets, also known as pop rivets, are used when access to only one side of the joint is available. They consist of a tubular rivet body with a mandrel or stem attached. When the rivet is installed, the mandrel is pulled through the body, causing the body to expand and form a head on the blind side of the joint.

4 **Friction lock rivet:** friction lock rivets, also known as friction-grip rivets or interference lock rivets, are a type of blind rivet designed to provide a secure and vibration-resistant joint. These rivets consist of a tubular body with a mandrel or stem inserted inside. The mandrel has a slightly larger diameter than the rivet body, creating an interference fit when the mandrel is pulled through the body during installation.

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5 **Self – piercing rivet:** Self-piercing rivets (SPRs) are a type of fastener specifically designed to join two or more materials together without the need for pre-drilled holes. These rivets are commonly used in industries such as automotive manufacturing, where they offer significant advantages in terms of efficiency, reliability, and cost-effectiveness.

6 **Threaded rivet:** Threaded rivets, also known as threaded inserts or rivet nuts, are fasteners designed to create a threaded hole in a material where it's not feasible or desirable to tap threads directly. These rivets are particularly useful for applications where a strong, reliable threaded connection is needed in thin or brittle materials.

7 **Semi- tubular rivet:** Semi-tubular rivets, also known as tubular rivets, are fasteners with a hollow or partially hollow shaft. These rivets are commonly used in applications where a strong, permanent joint is required, such as in automotive, construction, and manufacturing industries.

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Types of Rivet	Characteristics	Applications
Threaded Rivet	With a threaded internal mandrel with an external area flat on two sides allowing the tool to hold and rotate it.	Automotive, aerospace, and industrial applications.
Snap-Head Rivet	Provides a solid joint that has a head length of about 0.7 inches and a shank diameter of 1.6 inches.	Ideally used in construction and manufacturing industries with high demand for maximum strength.
Friction-Lock Rivets	They are multipiece rivets comprising a stem and sleeve.	Aircraft manufacturing, automotive industry, rail and transport engineering.
Mushroom Head Rivets	With mushroom-like heads and a lower profile than regular rivets, they offer the locking of the parts.	Facilitate the joining of materials with varying thicknesses.
Pan Head Rivets	Include a unique shape comprising a cylindrical head that slopes downwards from the top.	Heavy structural construction due to their extraordinary grip and strength.

- **Uses of rivets:**

1 **Aerospace:** Rivets are extensively used in the aerospace industry for assembling aircraft structures, including wings, fuselages, and control surfaces. They provide secure joints that can withstand high stress and vibration conditions.

2 **Automotive:** Rivets play a crucial role in automotive manufacturing, where they are used for joining body panels, chassis components, and structural elements. They provide strong and durable connections that contribute to vehicle safety and performance.

3 **Construction:** In the construction industry, rivets are employed in various applications, such as attaching metal cladding, roofing, and architectural elements. They are also used in structural steelwork for joining beams, columns, and trusses.

4 **Shipbuilding:** Rivets have been traditionally used in shipbuilding for assembling hulls, decks, and bulkheads. Although welding has become more prevalent in modern ship construction, rivets are still utilized in certain marine applications due to their reliability and corrosion resistance.

5 **Railroad:** Rivets are utilized in the fabrication and repair of railroad tracks, bridges, and rolling stock. They provide strong and durable connections that can withstand heavy loads and harsh operating conditions.

6 **Appliances:** Rivets are commonly used in the manufacturing of appliances such as refrigerators, washing machines, and ovens. They are employed for joining metal panels, handles, hinges, and other components.

7 **Furniture:** Rivets are used in furniture manufacturing for assembling metal frames, brackets, and joints. They provide secure connections that contribute to the stability and durability of the furniture pieces.

8 **Electronics:** In electronic devices and equipment, rivets are utilized for mounting components, securing enclosures, and providing structural support. They are often used in conjunction with other fastening methods such as screws and adhesives.

9 **Sporting Goods:** Rivets are found in various sporting goods such as bicycles, skis, and camping equipment. They are used for joining metal components, attaching accessories, and reinforcing structural elements.

10 **Art and Design:** Rivets are sometimes incorporated into artistic and design projects for their decorative and functional properties. They can be used to create unique textures, patterns, and structural elements in sculptures, jewellery, and architectural features.

- **Purpose of a rivet:** They are reliable fasteners that facilitate the joining ease of various parts of a structure or machine you can use a rivet joint for connecting any wooden and metal material. These rivets enable the joining of different wooden facilities such as lockers, cabinets, and shelves.
- **Advantages of rivets:**

- Cost of effectiveness. Rivets are a cheap alternative to welding and metal adhesives.
- Increase production output.
- Flexibility in design.
- Easy inspection and maintenance
- Lack of aesthetic finish

- **Disadvantages of rivet**

One major disadvantages of using rivets is that they can only be disassembled without damaging the metal parts it you need to make changes or repairs after the parts are joined together you will need to grind off the rivets before reassembling them with new ones .

A Stepwise Guide to the Riveting Process: To have a firmly installed rivet, here are a few steps to follow:

Step 1: You need to determine the suitable rivet for your parts. It would be best to consider factors such as the ideal rivet material, type, and size to do this successfully.

Step 2: The next step is determining where to install the rivet on your parts. It will help to ensure the efficient joining of the materials or components.

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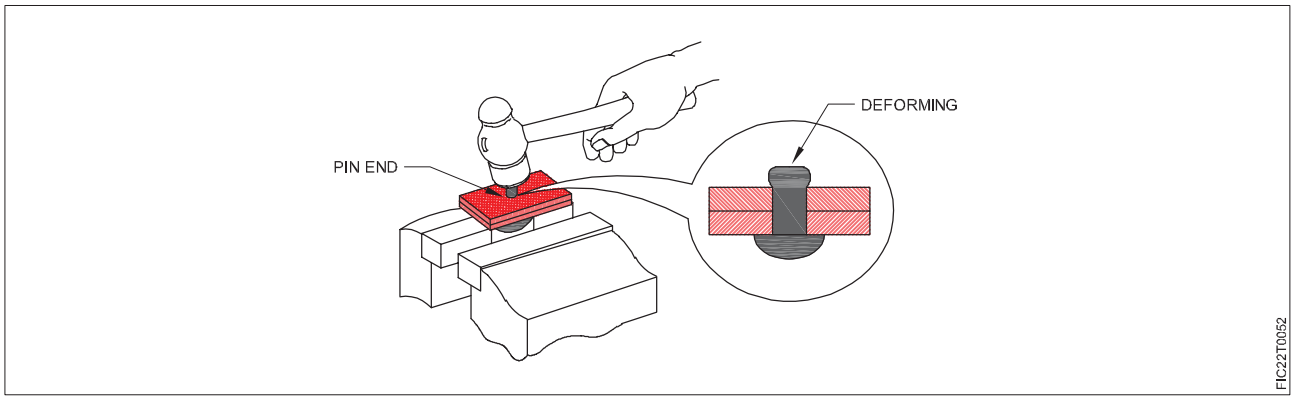
Step 3: You must drill a hole precisely 1.5 mm more than the rivet diameter you want to install.

Step 4: Insert your rivet in the hole drilled through the materials you want to join together.

Step 5: When you install the rivet, the tail/shank comes out at the opposite end of the part where you will deform it.

Step 6: Once you hammer the tail, it flattens the material making the tail spread about one and a half its actual size. More importantly, ensure the rivet's bottom is identical to the workpieces to complete the riveted joint.



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LESSON 19: Power Transmission (Method Of Drives)

Objectives

At the end of this lesson you shall be able to

- state the different types of power transmission drives
- state the key components of belt drive system
- state the advantages and limitation of rope drive system.

Different method of Drives and its application

Introduction of Power

A Machine consists of a power source and a power transmission system, which provides controlled application of the power.

Transmission Drives

Transmission Drives are an assembly of parts including the speed-changing device and the propeller shaft by which the power is transmitted from an engine/motor to a live axle.

Types of Power Transmission Drives

- Shaft & Axles
- Belt Drives
- Rope Drives
- Chain Drives
- Gear Drives

1 Shaft & Axle

Shaft and Axle are the machine members, mostly cylindrical in section which support the revolving part of a machine.

2 Belt Drive

A belt drive is a method of transmitting mechanical power from one rotating shaft to another. It typically consists of a belt, usually made of rubber or other flexible materials, and a set of pulleys or sheaves. The belt wraps around the pulleys, creating friction, which transfers power from the driving shaft to the driven shaft.

Key components of a belt drive system include: -

1 Belt

The belt is the flexible loop that connects the pulleys.

It's often made of materials like rubber, neoprene, or polyurethane, chosen for their flexibility, durability, and resistance to wear and tear.

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2 Pulleys/Sheaves

Pulleys are wheels with grooves around their circumference to hold the belt in place. The driving pulley is connected to the motor or power source, while the driven pulley is connected to the shaft that receives the power. The size and speed ratio of the pulleys determine the speed and torque of the driven shaft relative to the driving shaft.

3 Tensioning Mechanism

A tensioning mechanism is used to maintain the proper tension in the belt. This ensures efficient power transfer and prevents slippage or excessive wear on the belt and pulleys.

4 Bearings

Bearings support the pulleys and allow them to rotate smoothly

Belt drives offer several advantages

- They are relatively simple and economical to design, install, and maintain.
- They can accommodate misalignment between shafts.
- They dampen vibration and reduce noise compared to some other types of power transmission systems.
- They are suitable for applications where the speed ratio needs to be adjusted easily by changing the pulley sizes.

However, belt drives also have limitations

- They are less efficient than some other types of power transmission systems, such as gear drives or direct drives.
- Belts can stretch over time, causing a loss of tension and reduced efficiency.
- They may slip under heavy loads or in wet or oily conditions.
- Belts are subject to wear and require periodic inspection and replacement.

Belt drives are commonly used in applications such as automotive engines, industrial machinery, conveyor systems, and HVAC (heating, ventilation, and air conditioning) systems. They come in various types, including flat belts, V-belts, timing belts, and ribbed belts, each suited to specific applications based on factors like power transmission requirements, speed, and environmental conditions.

3 Rope Drives

A rope drive, also known as a cord or wire rope drive, is a type of power transmission system that uses ropes or cables to transmit mechanical power from one rotating shaft to another. It's similar in function to belt drives but uses ropes instead of belts. Rope drives were commonly used in early industrial machinery before the widespread adoption of belt drives and other transmission systems.

Key components of a rope drive system include

1 Ropes or Cables

The main transmission element of a rope drive system is the rope or cable. These are typically made of materials like cotton, hemp, or wire, chosen for their strength, flexibility, and resistance to wear.

2 Pulleys/Sheaves

Pulleys or sheaves are used to guide and support the ropes, similar to belt drives. The driving pulley is connected to the power source, while the driven pulley is connected to the shaft that receives the power. The size and speed ratio of the pulleys determine the speed and torque of the driven shaft relative to the driving shaft.

3 Tensioning Mechanism

A tensioning mechanism is used to maintain the proper tension in the ropes. This ensures efficient power transfer and prevents slippage or excessive wear on the ropes and pulleys.

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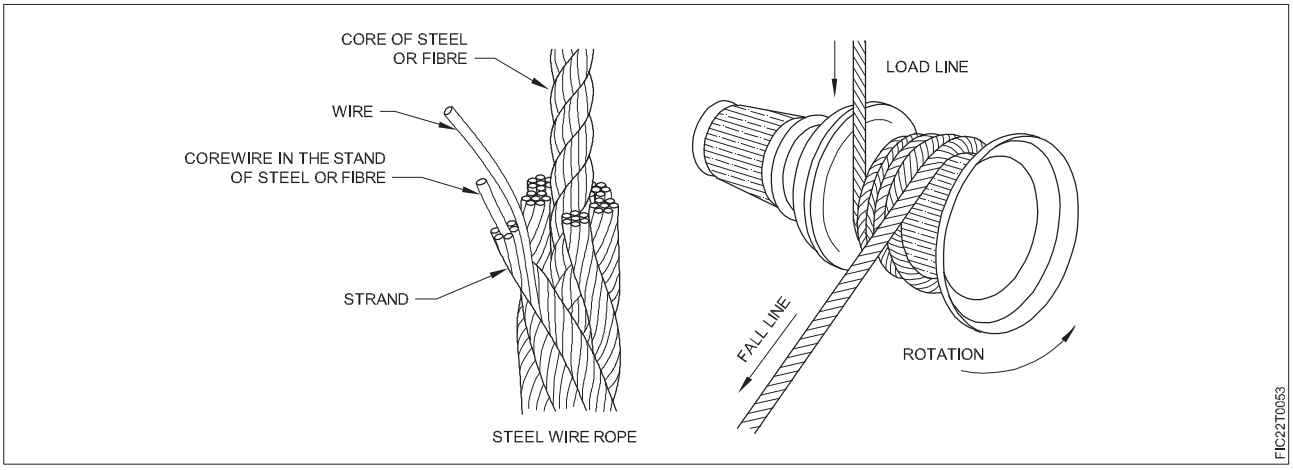

4 Bearings: Bearings support the pulleys and allow them to rotate smoothly.

Advantages of rope drives include:

- They can transmit high power over long distances.
- They are relatively simple and economical to design and install.
- They can accommodate misalignment between shafts.
- They are more resistant to environmental factors such as dust, moisture, and heat compared to some other types of power transmission systems.

However, rope drives also have limitations:

- They are less efficient than some other types of power transmission systems, such as gear drives or direct drives.
- Ropes can stretch over time, causing a loss of tension and reduced efficiency.
- They require periodic inspection and maintenance to ensure proper tension and alignment.
- They are less common and versatile than belt drives, with fewer available materials and configurations.

Rope drives were historically used in applications such as textile mills, agricultural machinery, and early industrial equipment. While they have largely been replaced by belt drives and other modern transmission systems in most industrial applications, rope drives are still occasionally used in specialized applications where their unique advantages are beneficial.

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LESSON 20: Jigs And Fixture

Objectives

At the end of this lesson you shall be able to

- define the jigs and fixture
- state the different types and application of jigs and fixture
- state the difference between jig and fixture

Definition Of Jig & Their Applications

Define the jigs

A jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products

Types of jigs

Jigs are essential tools in manufacturing and machining, designed to guide and hold work pieces during various operations. They come in several types, each tailored to specific tasks. Fixture jigs secure work pieces in a fixed position for tasks like drilling or welding. Template jigs use templates or patterns for shaping work pieces, often seen in woodworking.

Template Jig: Template jigs are the most common and basic type of jigs used to produce and machine a small number of simple parts.

Plate Jigs- Plate jigs are redesigned or upgraded versions of template jigs, as they typically include a method of fastening to the part that's.

- Unlike fixtures, jigs both hold and guide the tool.
- Jigs are lighter for easier handling and often do not require clamping.
- Typically used for drilling, reaming, or tapping operations.

Channel Jigs- As their name implies, channel jigs are formed as channels and allow the machining of parts on three sides, or three surface

- It features a channel-like cross-section.
- The workpiece is fitted within the channel and located using a knob.
- The tool is guided through a drill bush.

Leaf Jigs- Leaf jigs are comprised of a plate jig and a backup plate that provides additional support for thinner parts that would otherwise bend or distort under tool pressure.

- Includes a hinged leaf or plate for easy loading and unloading of the workpiece.
- Work is located by buttons and clamped using set screws.
- The tool is guided through a drill bush.

Box Jigs- These are used in a similar way to channel jigs but are typically formed as a box or a framework around the work piece.

- Box-like construction that locates the component using buttons.
- Work is clamped by rotating a cam handle, which also provides location.
- Drill bushes guide the tool.

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Ring Jigs: Ring Jigs are the box jigs of circular flanged parts, used to drill holes or guide machine tools on circular flanged parts

- Designed for drilling holes in circular flanged parts.
- Work is clamped on the drill body, and holes are drilled using drill bushes.

Application of jigs

- **Metalworking:** Used in machining operations like drilling, milling, and grinding.
- **Welding:** Helps position and hold parts for welding.
- **Assembly:** Aids in assembling various components accurately.
- **Inspection:** Ensures consistent inspection of parts.
- **Woodworking:** Used in woodworking tasks for precision.
- **Automotive:** Essential in manufacturing automotive parts.
- **Electronics:** Used in the production of electronic devices.
- **Aerospace:** Ensures precision in aerospace component fabrication.
- **Medical Devices:** Helps assemble precise medical equipment.
- **Jewellery Making:** Aids in crafting intricate jewellery pieces.

Safety Precaution

1 Always check the equipment before you use it.

2 Performs periodic inspection and maintenance tasks.

3 Ensure your training is up to date.

4 The weight of the load must fit the equipment.

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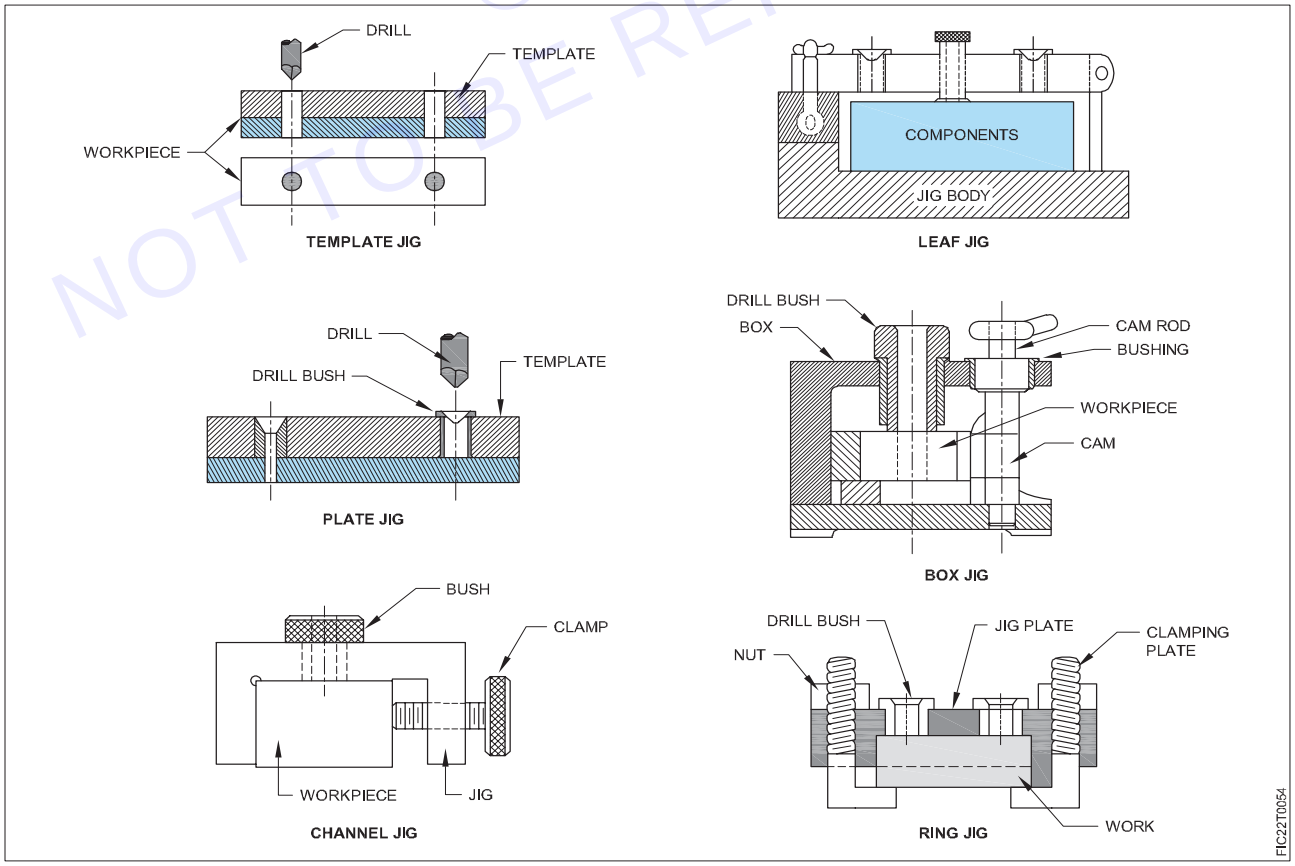

Fixture

Definition of Fixture

A fixture is a work-holding or support device used in the manufacturing industry. Fixtures are used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. Using a fixture improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labour by simplifying how work pieces are mounted, and increasing conformity across a production run.

Types of Fixture

A Milling Fixture:

A Milling fixture is a work holding device which is firmly clamped to the table of the milling machine. It holds the work piece in correct position as the table movement carries it past the cutter or cutters.

- Positioned and secured on the milling machine table.
- Work pieces are located on the fixture base and clamped before milling.

B Drilling Fixture:

Drilling fixtures cover a wider range of different designs and procedures than milling fixtures. Though work holding for drills is more often provided by jigs, fixtures are also used for drilling operations.

C Boring Fixture:

Designed for boring operations with two common designs. May incorporate a drilling jig or focus on work piece positioning.

- Designed for boring operations with two common designs.
- May incorporate a drilling jig or focus on workpiece positioning.

D Turning Fixture: The standard work holding devices or fixtures for lathe are:

- Three and four jaw chucks
- Collars
- Face plate
- Mandrels
- Milling vice

- Used for holding irregularly shaped components during turning operations.
- Provides stability, minimises overhang, and ensures secure clamping.

If the job can be held easily and quickly in the above mentioned standard devices, then there is no need for special work holding devices. However, many jobs particle casting and

forging, because of their shapes, cannot be conveniently held by any of the standard devices. It then becomes necessary to build a special work holding device for the job. Such a device is called lathe fixture

E Assembly Fixture: Used to hold components together during assembly operations. Enables precise positioning and joining of various parts, such as riveting or welding.

- Used to hold components together during assembly operations.
- Enables precise positioning and joining of various parts, such as riveting or welding.

F Welding Fixture: Welding fixtures are used to hold subcomponents of a welded assembly in place for fabrication together into one complete unit. These fixtures are often actuated using manual (hand) clamps or pneumatic clamps if paired with robotic automation. A robust robotic arc welding fixture is a part-holding tool used to constrain components for welding in an automated system. Welding fixtures locate parts using these clamps to secure important aspects of the subcomponent, such as holes, slots, or datum surfaces.

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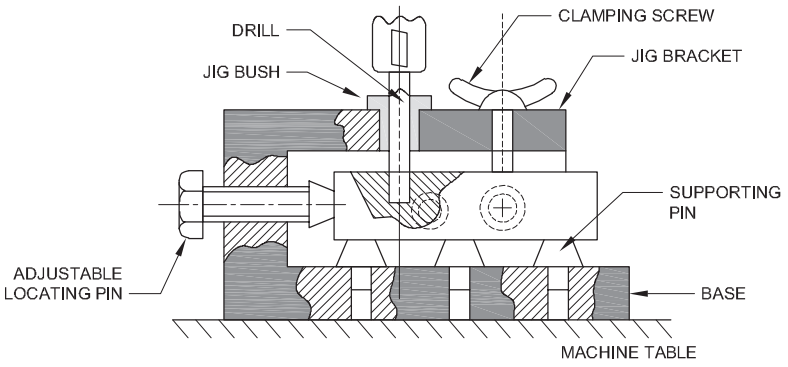
- Carefully designed to prevent distortions during welding.
- Ensure proper component placement and stability to withstand welding stresses.

Main Elements of Jigs and Fixtures

Jigs and fixtures are intricate tools used in manufacturing, comprising several main elements. The primary components include the base or body, which provides stability and support for the workpiece. Clamping elements secure the workpiece firmly in place, ensuring stability during machining. Guide or locator elements precisely position the workpiece in the correct orientation.



ELEMENTS OF JIGS AND FIXTURES

- **The main components of Jigs and Fixtures are:**
- **Body:** The sturdy, often plate or frame-like structure that houses the workpieces to be machined.
- **Locating Elements:** These components ensure precise workpiece positioning relative to the cutting tool.
- **Clamping Elements:** Used to securely hold the workpiece in its located position.
- **Guiding and Setting Elements:** In the case of jigs, these elements guide the cutting tool, while in fixtures, they facilitate proper tool engagement.
- **Positioning Elements:** Various fastening devices that secure the jig or fixture in the correct machine position.
- **Indexing Elements (if applicable):** Sometimes necessary for repositioning workpieces to access different surfaces or locations during machining operations.

Materials Used for Jigs and Fixtures

Materials used for jigs and fixtures need to possess specific qualities to ensure durability and effectiveness. Common materials include hardened steel, cast iron, aluminium, and even plastics like Delrin. Hardened steel is often preferred for its exceptional strength and wear resistance, making it suitable for high-production environments. Cast iron offers stability and vibration dampening, making it suitable for machining fixtures.

Aluminium is chosen for lightweight applications or when corrosion resistance is necessary. Plastics like Delrin are used for non-marring or non-abrasive applications, as they reduce the risk of damaging delicate workpieces. The choice of material depends on factors such as the type of operation, workpiece material, and budget constraints.

Difference between Jig and Fixture

The key distinction between jigs and fixtures lies in their primary functions and applications in manufacturing. Jigs are specialized tools designed to guide and control the cutting or shaping tools during machining operations. They ensure repeatability and precision in tasks like drilling, milling, or boring.

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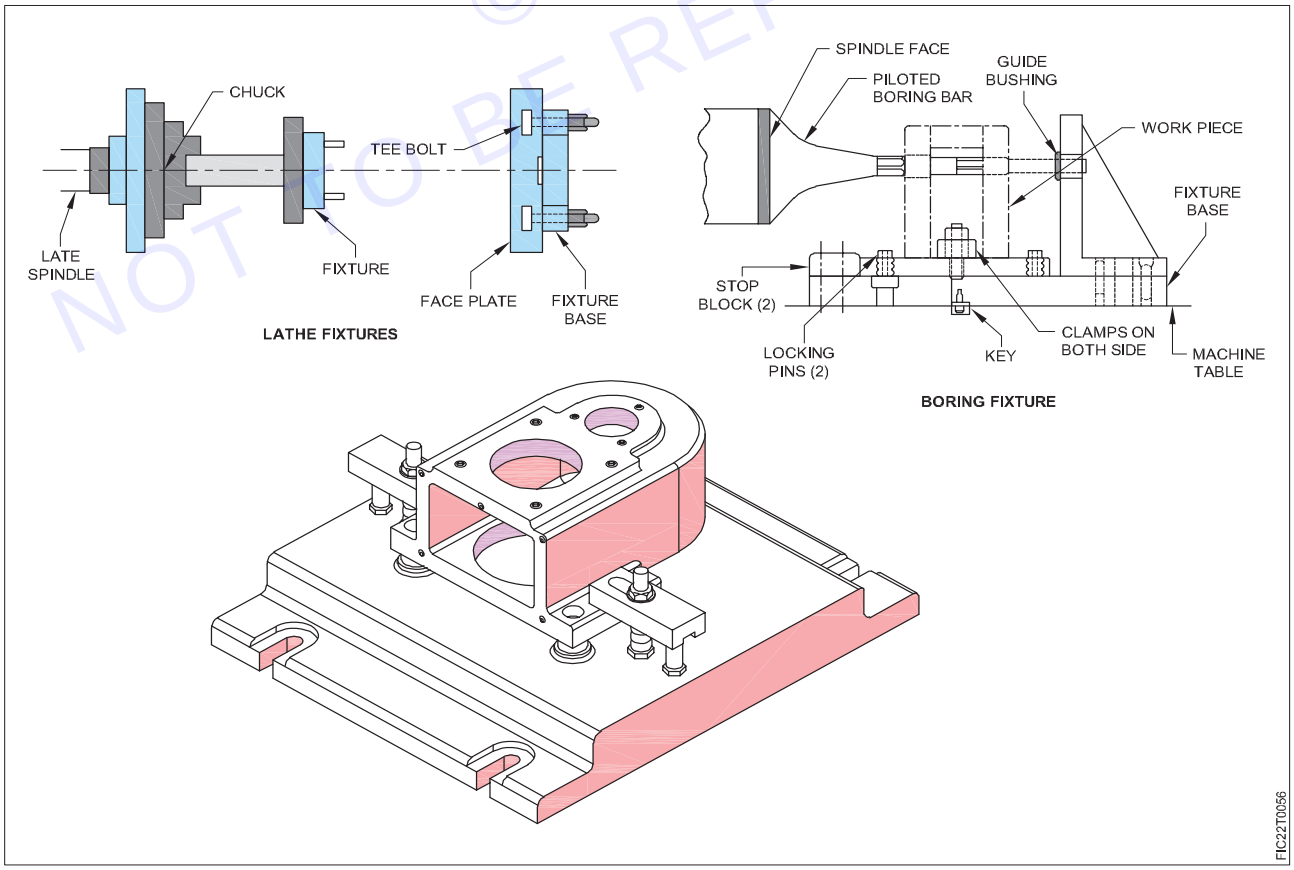
Characteristic	Jig	Fixture
Purpose	Guides and directs the cutting tool	Holds and secures the workpiece in position
Function	Guides the tool and locates the workpiece	Holds and positions the workpiece
Primary Use	Drilling, reaming, or tapping operations	Milling, grinding, turning, or other operations
Weight and Construction	Lighter construction, often made from aluminium	Heavier construction, commonly steel or iron
Clamping	Usually not clamped to the machine table	Rigidly bolted or clamped to the machine table
Load-Bearing	Experiences minimal cutting loads	Supports heavy cutting forces
Key Features	Guide bushings, drill templates, and bushings	Clamps, supports, and locates work pieces
Typical Operations	Hole-making, precision drilling	Workpiece shaping, material removal
Machining Speed	Typically used for high-speed drilling	Suitable for various machining speeds
Examples	Drill jigs, reaming jigs, tapping jigs	Milling fixtures, grinding fixtures, turning fixtures



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LESSON 21 : Introduction about press & their types

Objectives

At the end of this lesson you shall be able to

- introduction to press and its types, description
- state the application, advantages and disadvantages of press
- state the different types of driving mechanism used in power press

Introduction: Press is a machine tool use cut or safe metal by applying force press are used or mass production. Presses are mechanical devices designed to exert force to shape, compress, or mold materials. They have been integral to various industries for centuries, enabling the production of a wide range of products.

Types of press

1 Fly Press or hand press

Description:

- The fly press consists of a heavy cast iron frame, a central screw, a sliding T-handle, and a heavy cast iron flywheel mounted on the screw.
- It operates on the principle of leverage, with the operator manually rotating the handle to move the screw and apply force to the workpiece.
- The flywheel provides additional momentum, allowing for more efficient force application and reducing the effort required by the operator.

Applications:

- **Metalworking:** Fly presses are commonly used for tasks such as punching, bending, embossing, coining, and riveting in metalworking shops and small-scale manufacturing operations.
- **Jewellery Making:** They are utilized in jewellery workshops for tasks such as blanking, forming, and stamping precious metals and alloys.
- **Blacksmithing:** Fly presses are employed by blacksmiths for shaping hot metal, punching holes, and forming decorative elements in wrought ironwork.

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Advantages:

- **Versatility:** Fly presses can perform a wide range of metalworking tasks with the appropriate tooling and setup.
- **Manual Operation:** They do not require external power sources such as electricity or hydraulics, making them suitable for use in locations where power may be limited or unavailable.
- **Precision**: Fly presses allow for precise control over force application, making them suitable for tasks requiring accuracy and attention to detail.

Disadvantages:

- **Limited Force:** Compared to hydraulic or mechanical presses, fly presses typically exert lower amounts of force, limiting their suitability for heavy-duty metalworking tasks.
- **Operator Fatigue:** Continuous manual operation of the fly press can lead to operator fatigue, particularly for tasks requiring prolonged or repetitive use.
- **Slower Speed:** Manual operation of the fly press may result in slower production rates compared to automated or powered presses.

2 Power Press

Description:

- Power presses are equipped with a motorized drive system that provides the force necessary for metalworking tasks.
- They consist of a robust frame, a ram or slide mechanism, a power source (such as an electric motor, hydraulic pump, or pneumatic system), and controls for adjusting force, speed, and stroke length.
- Power presses come in various configurations, including gap-frame presses, straight-side presses, and C-frame presses, each suited to different applications and production requirements.

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Applications:

- **Metal Stamping:** Power presses are commonly used in the automotive, aerospace, appliance, and electronics industries for stamping metal components such as panels, brackets, and connectors.
- **Forming and Bending:** They are employed for bending, folding, and forming sheet metal into desired shapes and configurations, often using specialized tooling and dies.
- **Blanking and Piercing:** Power presses are utilized for cutting or piercing sheet metal blanks to create parts with specific geometries and features.

Advantages:

- **High Force:** Power presses can exert high levels of force, making them suitable for heavy-duty metalworking tasks and mass production.
- **Efficiency:** Motorized operation enables faster production rates compared to manual presses, leading to increased productivity and throughput.
- **Precision:** Power presses offer precise control over force, speed, and stroke length, allowing for consistent and accurate results in metalworking operations.

Disadvantages:

- **Complexity:** Power presses require electrical, hydraulic, or pneumatic systems for operation, adding complexity compared to manual presses.
- **Maintenance:** Power presses may require regular maintenance and servicing of motors, hydraulic pumps, and control systems to ensure optimal performance and safety.
- **Initial Cost:** Power presses typically have higher initial costs compared to manual presses due to the inclusion of power sources and control systems.

Types of Driving Mechanism used in Power Press

Power presses use various driving mechanisms to generate the force required for metalworking operations. The driving mechanism determines how the force is applied to the press tool and ultimately to the workpiece. Here are some common types of driving mechanisms used in power presses:

1 Mechanical Drive:

- Mechanical power presses use a mechanical linkage system to convert rotational motion into linear motion, which is then transmitted to the press tool.
- Mechanical drives typically consist of a motor, flywheel, crankshaft, connecting rods, and a ram or slide.
- The motor drives the flywheel, which stores kinetic energy. When the press is activated, the flywheel's rotational energy is transferred to the crankshaft, causing it to rotate. The crankshaft's movement is then transmitted to the ram or slide through connecting rods, producing the required force.

2 Hydraulic Drive:

- Hydraulic power presses use hydraulic fluid pressure to generate force for metalworking operations.
- A hydraulic system consists of a hydraulic pump, hydraulic fluid reservoir, valves, cylinders, and actuators.
- When the press is activated, the hydraulic pump pressurizes hydraulic fluid, which is then directed to one or more hydraulic cylinders. The pressure exerted by the fluid causes the cylinders to extend, driving the ram or slide downward with considerable force.

3 Screw Drive:

- In a press machine with a screw drive, the force is generated by a threaded screw mechanism.
- The screw drive system typically consists of a threaded screw shaft and a nut or follower that travels along the length of the screw.
- When the screw shaft rotates, it causes the nut or follower to move along the screw, translating rotational motion into linear motion.
- The linear motion of the nut or follower is then used to drive the ram or slide of the press machine, exerting force on the workpiece.

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4 Rack and Pinion Drive:

- In a rack and pinion system, a linear rack (a toothed bar) meshes with a rotating pinion (a toothed wheel).
- The rack is typically fixed in place, while the pinion rotates about its axis.
- As the pinion rotates, it engages with the teeth of the rack, causing linear motion along the length of the rack.
- This linear motion can be used to drive the ram or slide of a power press in a controlled manner, allowing for precise positioning and force application.

5 Knuckle joint drive

- The knuckle joint drive consists of a rotating crankshaft, a connecting rod, and a knuckle joint assembly.
- The crankshaft is driven by a motor or other power source and rotates about its axis.
- The connecting rod is attached to the crankshaft at one end and to the knuckle joint assembly at the other end.
- The knuckle joint assembly consists of two or more arms connected by pivot joints, forming a flexible linkage

6 Eccentric drive

- An eccentric drive consists of an eccentric shaft, which is a circular shaft with an off-centre pivot point, and a connecting rod.
- The eccentric shaft rotates about its axis, causing the off-centre pivot point to move in a circular path.
- The connecting rod is attached to the off-centre pivot point of the eccentric shaft and transmits the eccentric motion to the ram or slide of the power press.

7 Cam drive

- A cam drive consists of a camshaft with one or more cams attached and a follower mechanism.
- The camshaft is a rotating shaft with one or more eccentric lobes, called cams, mounted on it.
- The follower mechanism, which can take various forms such as a roller, lever, or slide, engages with the cam surface and translates its motion into linear motion.

8 Toggle lever

- A toggle lever consists of a linkage system comprised of two or more levers connected by pivot joints.
- The levers are typically arranged in a triangular or parallelogram configuration, with one end fixed in place and the other end connected to the ram or slide of the power press.
- The pivot joints allow the levers to rotate relative to each other, creating a mechanical advantage that amplifies the force applied by the press.

9 Crank and connecting rod drive

- The crank and connecting rod drive consists of a crankshaft, connecting rod, and slide mechanism.
- The crankshaft is a rotating shaft with an eccentric or offset crankpin.
- The connecting rod is attached to the crankpin at one end and to the slide mechanism at the other end.
- The slide mechanism is responsible for translating the linear motion generated by the connecting rod into the desired motion for the press operation.

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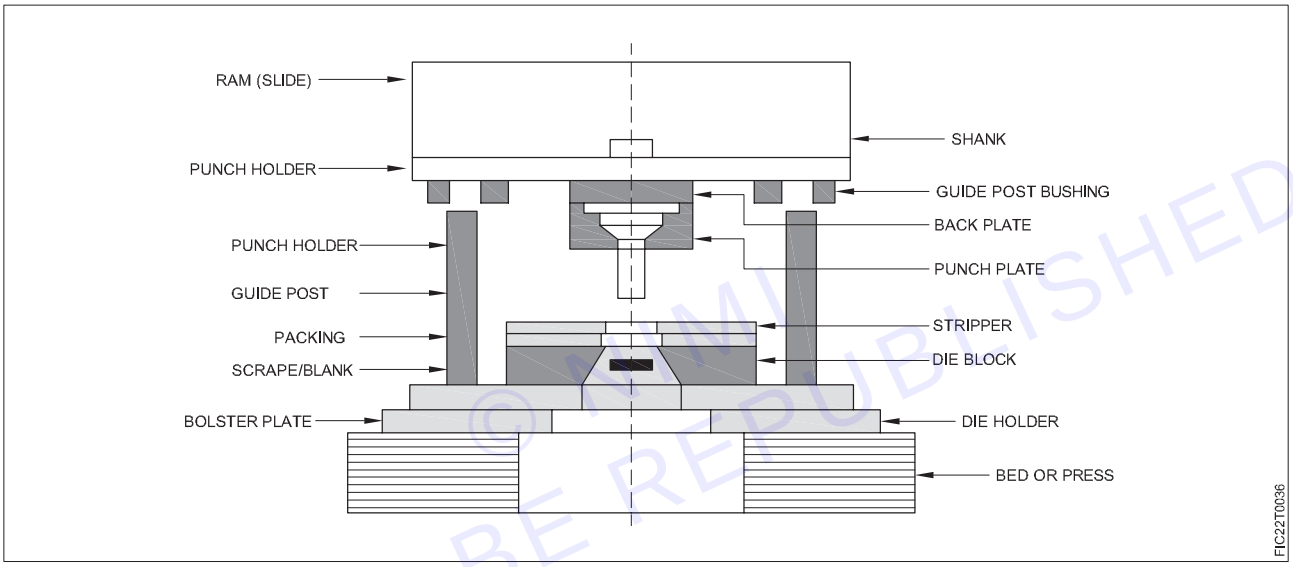
Different types of press tool and operations

Objectives : At the end of this lesson you shall be able to

- state the press tool and its application
- state the components of press tools
- state the different types of press tools and operations
- state the different types of operation performed using press tool

- **Introduction To Press Tool:**

A press tool, also known as a press die or stamping die, is a specialized tool used in manufacturing processes to shape, cut, or form materials under pressure. Press tools are commonly used in metalworking operations but can also be employed with other materials such as plastics and composites. They are essential in industries ranging from automotive and aerospace to electronics and appliance manufacturing.



- **Component of press tool:**

1 **Punch:** The punch is a component of the press tool that directly contacts and applies force to the workpiece. It is often made of hardened steel and is designed to impart the desired shape or feature onto the material being worked on.

2 **Die:** The die serves as a counterpart to the punch and provides support to the workpiece during the forming process. It is typically a hardened steel block with a cavity that matches the shape of the punch. The workpiece is placed between the punch and die, and as the punch descends, it deforms the material into the shape of the die.

3 **Stripper:** In some press tools, especially those used for complex shapes or thin materials, a stripper is employed to help remove the formed part from the punch after the operation is complete. The stripper holds the material down onto the die as the punch is withdrawn, preventing it from sticking to the punch.

4 **Guide Pins and Bushings:** These components ensure proper alignment between the punch and die during operation, helping to maintain accuracy and precision in the formed parts.

5 **Backing Plate or Retainer Plate:** The backing plate provides support to the die assembly and helps distribute the forces applied during the stamping process. It is often bolted to the press bed or ram to ensure stability.

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6 **Shut Height Adjustments:** These mechanisms allow for the adjustment of the distance between the punch and die, known as the shut height. Proper shut height adjustment is essential for achieving accurate and consistent forming results.

7 **Spring Mechanisms:** In some press tools, especially those used for deep drawing or forming operations, spring mechanisms may be incorporated to control the pressure applied during the operation and to facilitate the ejection of the formed part from the die.

8 **Wear Plates and Inserts:** These components, often made of hardened steel or other wear-resistant materials, are used to protect the press tool from wear and damage caused by repeated use and contact with the workpiece.

9 **Ejector System:** In press tools used for high-volume production, an ejector system may be employed to automatically remove the formed parts from the die after the operation is complete, increasing efficiency and reducing cycle times.

- **Types of press tool:**

Press tools, also known as stamping dies, are essential in various manufacturing processes for shaping and forming sheet metal or other materials. Here are some common types of press tools:

1 **Blanking Dies:** Used to cut flat shapes out of sheet metal. The resulting pieces are called blanks and are usually further processed in subsequent operations.

2 **Piercing Dies:** These are similar to blanking dies but are used to punch holes or shapes into the sheet metal without removing the material around the hole.

3 **Forming Dies:** Forming dies are used to bend, stretch, or otherwise shape sheet metal into desired forms. They can include various features like bends, flanges, and embossments.

4 **Drawing Dies:** Used in the process of drawing, where a flat sheet of metal is formed into a three-dimensional shape, such as a cup or a container.

5 **Progressive Dies:** These are complex dies that perform multiple operations on a single sheet of metal as it moves through the die. Each station in the die performs a different operation, such as cutting, bending, or forming.

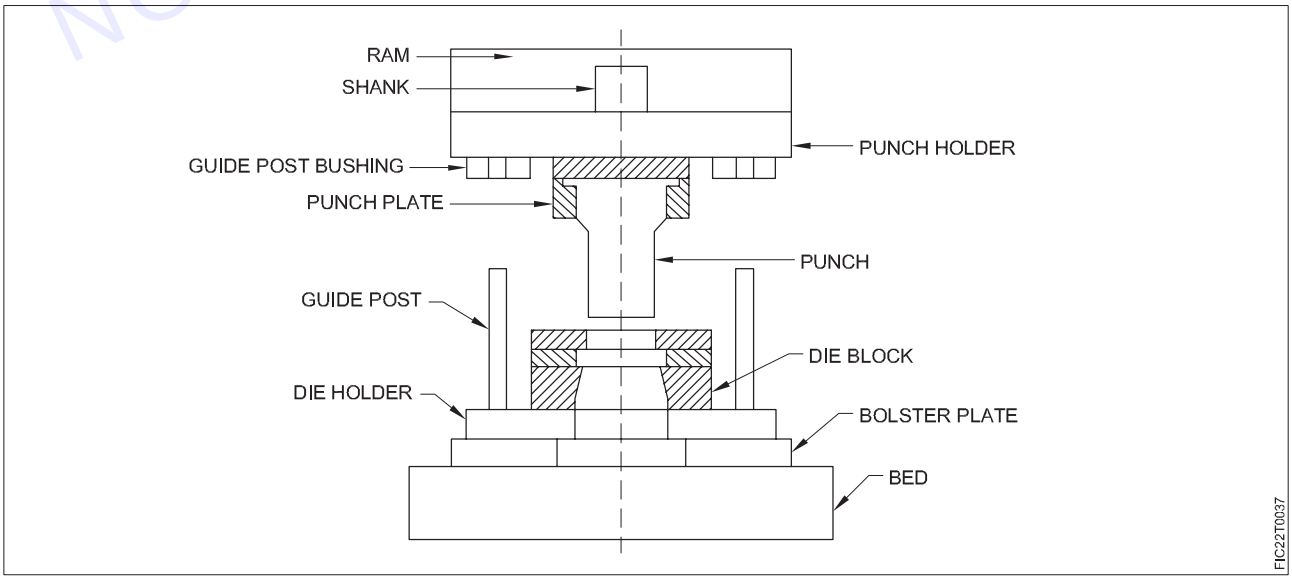
6 **Compound Dies:** Similar to progressive dies but used for simpler parts. They combine multiple operations into a single die, which reduces the need for multiple setups and handling.

7 **Trim Dies:** Used to trim excess material from the edges of a formed part to achieve the final desired shape.

8 **Coining Dies:** These dies are used for precision stamping operations, typically used to produce parts with very tight tolerances or high surface finish requirements.

9 **Bending Dies:** Specifically designed to bend sheet metal at predetermined angles accurately.

10 **Cam Dies:** Employ cams or other mechanical devices to produce non-linear or irregular shapes during the forming process.



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- **Operation Performed Using Press Tool:**

Press tools, also known as stamping dies, are essential in the manufacturing process for shaping and cutting sheet metal into desired forms. They are used in various industries, including automotive, aerospace, electronics, and appliance manufacturing. Here's an overview of the basic operations involved in using a press tool:

1 **Blanking:** This operation involves cutting out a flat shape from a metal sheet. A blanking die consists of a punch and a die that work together to cut the desired shape from the sheet material.

2 **Piercing:** Piercing is the process of creating holes in sheet metal. It is similar to blanking but involves cutting out a hole instead of a complete shape. Piercing dies consist of a punch and die with a hole-shaped cavity.

3 **Forming:** Forming operations bend, stretch, or reshape sheet metal into desired contours or shapes. This can include operations such as bending, drawing, embossing, and coining. Forming dies are designed with contours that shape the metal into the desired form when pressure is applied.

4 **Coining:** Coining is a precise forming operation used to create precise features or patterns on the surface of the metal. It involves applying high pressure to the metal between specially designed coining dies to produce the desired shape or pattern.

5 **Extruding:** Extrusion is a process used to create long, continuous shapes by forcing metal through a shaped opening in a die. It is commonly used in the production of components with complex cross-sections, such as rails, tubes, and rods.

6 **Trimming:** Trimming removes excess material from the edges of formed parts to achieve the final desired shape. Trimming dies are used to cut off excess material after forming operations, ensuring the part meets dimensional and geometric requirements.

7 **Drawing:** Drawing involves forming a flat sheet metal blank into a three-dimensional shape, such as a cup or shell. It is achieved by pulling the metal blank through a die cavity using a punch, gradually shaping it into the desired form.

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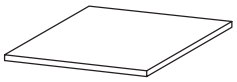
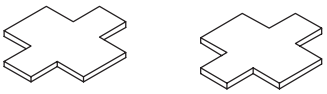
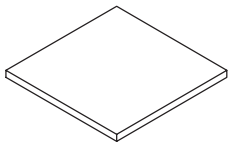
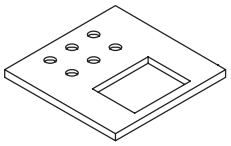
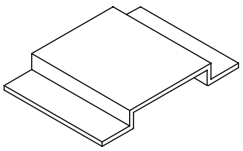
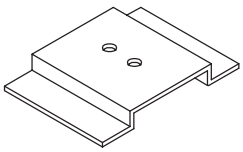
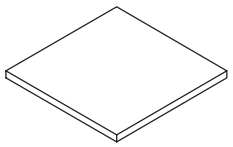
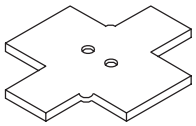
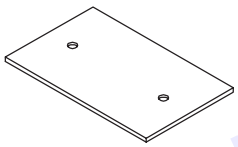
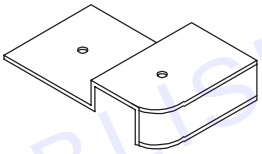
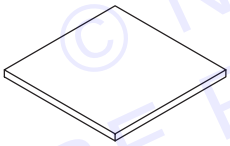
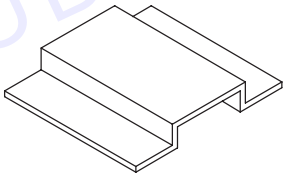
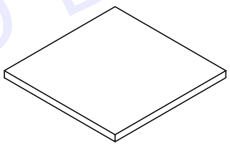
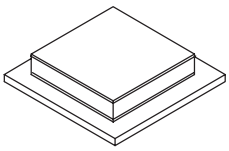
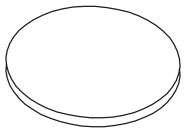
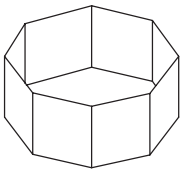
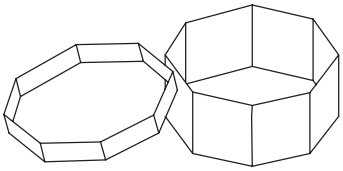
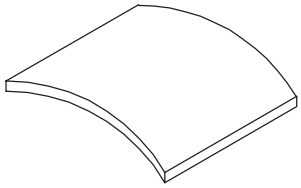
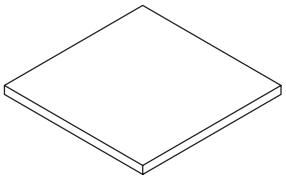
BLANKING		
PUNCHING		
PIERCING		
CORNER CUTTING		
FORMING		
BENDING		
DRAWING		
COINING		
TRIMMING		
STRAIGHTENING		

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LESSON 22 : Introduction to broaching machine

Objectives

At the end of this lesson you shall be able to

- define the broaching machine and its types
- state the process of broaching
- state the different categorized of broaching machine on their design and functionality
- state the safety precaution while operating broaching machine.

- **Introduction of broaching machine:** Broaching is a machining process that uses a toothed tool called a Broach, to remove material.

There are two types of broaching machine: -

1 Linear machine

2 Rotary machine

1 Linear machine:

A linear rotating broaching machine, also known as a rotary broaching machine or wobble broaching machine, is a type of broaching machine that combines linear and rotational motion to perform the broaching operation.

In this type of machine, the broach tool is held stationary while the workpiece is rotated and advanced linearly against the broach. The broach tool has a slightly offset axis compared to the workpiece rotation axis, causing it to wobble as it cuts, hence the term “wobble broaching.”

This method is commonly used for producing hexagonal or other polygonal shapes on the end of cylindrical workpieces, such as bolts or shafts, with high precision and efficiency. It’s often preferred for its ability to create complex shapes with minimal setup time and tool wear.

2 Rotary machine:

A rotary broaching machine, also known as a rotary or rotary table broaching machine, is a type of broaching machine that utilizes rotary motion to perform the broaching operation. In this machine, the broach tool is mounted on a spindle or tool holder that rotates at high speed while being pressed into the workpiece.

The workpiece is typically held stationary or may rotate at a slower speed. As the broach tool rotates, it cuts into the workpiece, producing the desired shape or profile. Rotary broaching is commonly used for creating internal or external features such as splines, keyways, hexagons, squares, or other polygonal shapes.

Rotary broaching machines are valued for their ability to produce precise and accurate features quickly, making them popular in manufacturing applications where high precision and efficiency are required.

Process: -

The broaching process involves using a broach tool—a long, multi-toothed cutting tool—to remove material in a controlled manner. Here’s an overview of the broaching process:

1 Setup: The workpiece is securely clamped into the broaching machine or fixture. Proper alignment and positioning are crucial for accurate cutting.

2 **Selection of Broach Tool:** The appropriate broach tool is selected based on the desired shape or profile to be machined. Broaches come in various types, including keyway broaches, spline broaches, and surface broaches.

3 **Insertion of Broach Tool:** The broach tool is inserted into the broaching machine’s spindle or holder. In some cases, the workpiece may be moved against the stationary broach, while in others, the broach rotates against the stationary workpiece.

4 **Engagement:** The broach tool engages with the workpiece, starting the cutting process. The teeth of the broach progressively remove material with each pass.

5 **Cutting Stages:** The broaching process typically involves multiple cutting stages or passes. Each pass removes a predetermined amount of material until the final desired shape or depth is achieved.

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6 **Coolant and Lubrication:** Coolant or lubricant may be applied during the broaching process to reduce friction, dissipate heat, and improve surface finish.

7 **Completion:** Once all cutting stages are completed, the broach tool is retracted, and the workpiece is removed from the broaching machine. Depending on the application, additional finishing operations such as deburring or surface grinding may be required.

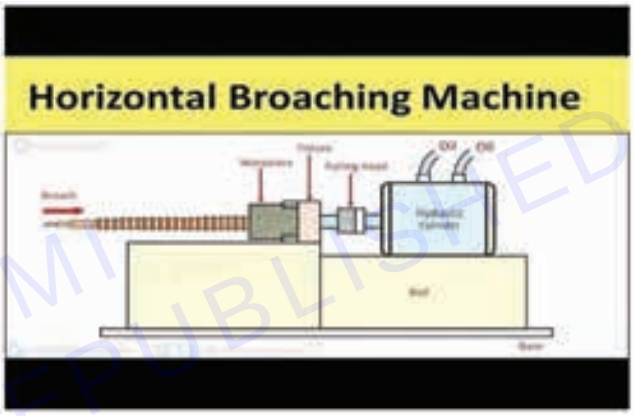
8 **Quality Inspection:** The machined workpiece is inspected to ensure it meets the required specifications and tolerances.

Broaching machines can be categorized into several types based on their design and functionality.

Here are the main types:

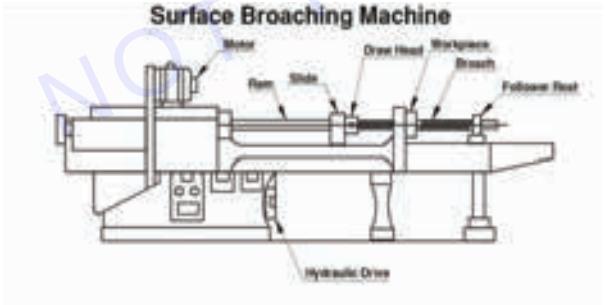
1 **Vertical Broaching Machine:** In this type, the broach tool is mounted vertically, and the workpiece is held stationary. The broach is lowered or raised to performs the cutting operation.

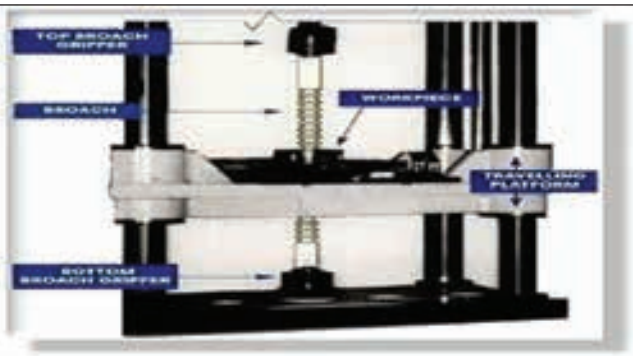
2 **Horizontal Broaching Machine:** The broach tool is mounted horizontally in this type of machine. The work-piece is typically held in a fixture that moves linearly while the broach remain stationary.



3 **Surface Broaching Machine:** Designed for cutting across the surface of a workpiece to create flat or contoured surfaces.

1 **Internal Broaching Machine:** Used for cutting inside surfaces of a workpiece, such as keyways or splines within a hole.





2 **Continuous Chain Broaching Machine:** Utilizes a continuous chain with cutting teeth to remove material continuously along the workpiece.

3 **Pot Broaching Machine:** Designed for high-volume production, these machines use multiple broaches mounted on a rotating turret for sequential cutting operations.

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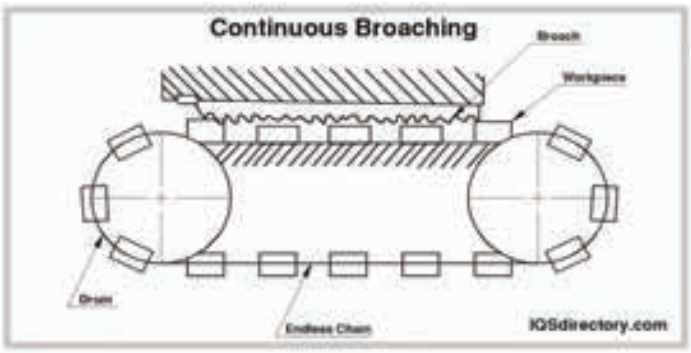

Certainly! Broaches can be categorized into different types based on their design and intended use:

1 Internal Broaches:

Used for cutting internal features such as keyways, splines, or holes within a workpiece.

2 External Broaches:

Designed for cutting external features like flats, keyways, or splines on the outer surface of a workpiece.

3 Keyway Broaches:

Specifically designed for cutting keyways, which are slots in shafts or hubs to accommodate keys for transmitting torque.

4 Surface Broaches:

Used for cutting flat or contoured surfaces on workpieces, often used in surface finishing applications.

5 Specialty Broaches:

This category includes broaches designed for specialized applications, such as cutting gears, serrations, polygons, or other custom profiles.

These categories cover the main types of broaches commonly used in machining processes. Each type serves specific purposes and is designed to produce precise features on work pieces efficiently.

Safety precautions are essential when operating a broaching machine to prevent accidents and injuries. Here are some common safety measures:

1 **Training:** Ensure that operators are properly trained in the safe operation of broaching machines and familiar with the machine's controls, procedures, and potential hazards.

2 **Protective Equipment:** Operators should wear appropriate personal protective equipment (PPE) such as safety glasses, gloves, and hearing protection to safeguard against flying chips, noise, and other hazards.

3 **Machine Guards:** Make sure all machine guards are in place and properly secured before operating the machine. Guards help prevent access to moving parts and cutting tools during operation.

4 **Tool Inspection:** Regularly inspect broach tools for damage, wear, or defects. Damaged or worn tools should be replaced promptly to maintain cutting performance and prevent accidents.

5 **Workpiece Clamping:** Ensure that workpieces are securely clamped in place to prevent movement or displacement during the cutting process. Loose workpieces can lead to tool breakage or ejection.

6 **Clear Workspace:** Keep the work area clean and free of clutter to prevent tripping hazards and ensure safe movement around the machine.

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7 **Emergency Stop:** Familiarize operators with the location and operation of the emergency stop button or switch. This allows for immediate shutdown of the machine in case of an emergency.

8 **Coolant Handling:** If coolant is used during the broaching process, ensure safe handling and proper ventilation to minimize exposure to fumes and splashing.

9 **Maintenance:** Perform regular maintenance and inspection of the broaching machine according to the manufacturer's guidelines to ensure optimal performance and safety.

10 **Lockout/Tagout:** Implement lockout/tagout procedures when servicing or performing maintenance on the machine to prevent accidental startup or energization.

By following these safety precautions, operators can minimize risks and ensure a safe working environment when operating broaching machines.

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LESSON 23 : Lapping and Honing, their application

Objectives

At the end of this lesson you shall be able to

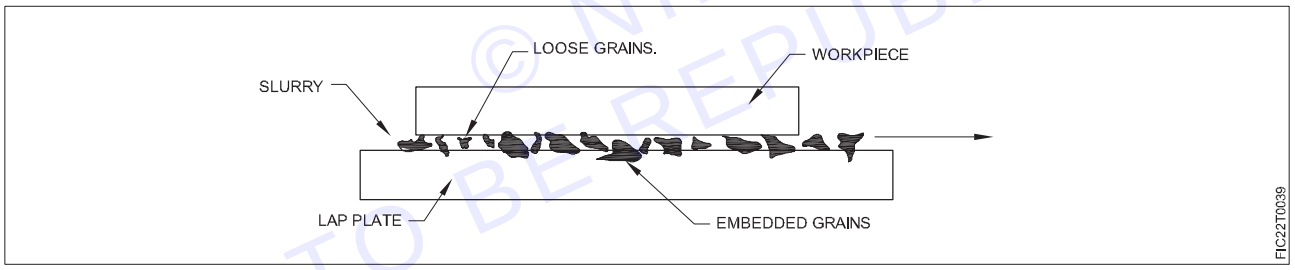
- define the lapping and honing
- state the process of lapping
- state the process of honing
- state the application of lapping and honing.

- **Introduction To Lapping and Honing:**

Lapping and honing are two precision machining processes used in engineering and manufacturing to achieve specific surface characteristics and dimensional accuracy. While they share similarities in their objectives, they are distinct methods with unique applications.

1 Lapping:

- Lapping is a precision machining process used to produce flat surfaces or extremely fine surface finishes.
- It involves rubbing two surfaces together with an abrasive slurry or compound between them.
- The abrasive particles remove material from the workpiece surface, resulting in flatness and fine finishes.
- Lapping is commonly used in industries such as aerospace, automotive, and optics for applications requiring high precision and surface quality.



Lapping involves the cutting and shearing action of loose abrasive particles and the fine grinding of abrasive particles embedded in the lap plate.

2 Honing:

- Honing is a precision machining process used to improve the geometry, surface finish, and dimension of cylindrical bores or holes.
- It employs a specialized tool called a hone, consisting of abrasive stones attached to a rotating spindle.
- The hone is inserted into the cylindrical bore, and the abrasive stones remove material, achieving specific surface finishes and dimensional accuracy.
- Honing is widely utilized in industries such as automotive, aerospace, hydraulic systems, and firearms manufacturing for applications requiring precise tolerances and smooth surface finishes.]
- Process of lapping and honing:

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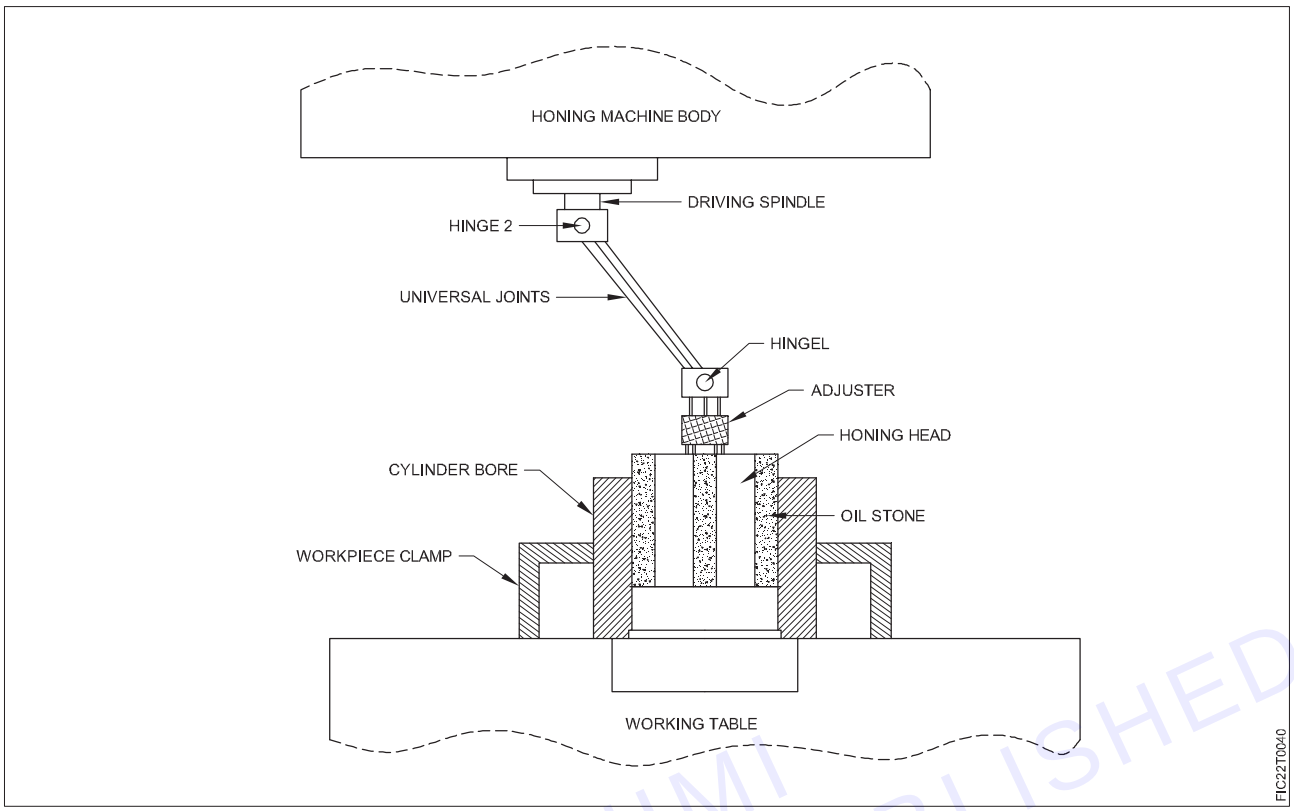

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3 Process of Lapping:

- **Preparation:** The workpiece and the lapping plate are cleaned thoroughly to remove any contaminants. The lapping plate, typically made of cast iron or other materials, is mounted on a flat surface.
- **Application of Abrasive Slurry:** An abrasive slurry or compound, consisting of abrasive particles suspended in a liquid, is applied to the lapping plate.
- **Workpiece Mounting:** The workpiece, which may be a flat component or a part with a concave or convex surface, is placed on the lapping plate.
- **Lapping Action:** The workpiece is moved back and forth, rotated, or oscillated against the lapping plate with a controlled pressure. The abrasive particles in the slurry abrade the workpiece surface, removing material and refining the surface finish.
- **Inspection:** Periodic checks are performed to monitor the progress andensure the desired surface quality and dimensions are achieved.
- **Cleaning and Final Inspection:** Once lapping is completed, the workpiece and lapping plate are cleaned thoroughly to remove any remaining abrasive particles. The workpiece is then inspected for surface finish, flatness, and dimensional accuracy.

4 **Process of Honing:**

- **Setup:** The workpiece, typically a cylindrical bore or hole, is securely mounted on a honing machine or fixture. The honing tool, consisting of abrasive stones attached to a rotating spindle, is inserted into the bore.
- **Application of Honing Oil:** Honing oil or coolant is applied to the workpiece and honing stones to lubricate the process, cool the workpiece, and flush away debris.
- **Honing Action:** The spindle rotates and reciprocates within the bore, causing the abrasive stones to remove material from the bore's surface. The honing process corrects geometry errors, such as out-of-roundness or taper, and produces a specific surface finish.

- **Controlled Material Removal:** Operators adjust parameters such as spindle speed, stroke length, and abrasive grit size to control material removal rates and achieve the desired surface finish and dimensional accuracy.
- **Final Inspection:** After honing, the workpiece is inspected for dimensional accuracy, surface finish, and other quality parameters. Any necessary adjustments or additional honing passes may be performed to meet specifications.
- **Cleaning and Finishing:** The workpiece is cleaned to remove honing oil and debris. Additional finishing processes, such as deburring or polishing, may be applied as needed to achieve the desired surface quality.

- **Application of lapping and honing:**

The applications of lapping and honing span across various industries where precision, fine finishes, and dimensional accuracy are critical. Here are some common applications for each process:

5 **Applications of Lapping:**

- **Optics Manufacturing:** Lapping is extensively used in the fabrication of optical components such as lenses, mirrors, and prisms. It ensures the surfaces are perfectly flat and polished to achieve optimal light transmission and image quality.
- **Semiconductor Industry:** Lapping is employed to create flat and smooth surfaces on semiconductor wafers, ensuring uniformity and precise thickness for subsequent processing steps.
- **Precision Bearings:** Lapping is utilized in the manufacturing of precision bearings to achieve tight tolerances and smooth surfaces, reducing friction and enhancing performance.
- **Aerospace Components:** Lapping is used for critical aerospace components like turbine blades, where precise dimensions and smooth surfaces are essential for efficient operation and reliability.
- **Tool and Die Making:** Lapping is applied in tool and die making to produce precision Molds, dies, and inserts with fine surface finishes for manufacturing various products.

6 **Applications of Honing:**

- **Automotive Engine Cylinders:** Honing is commonly used to finish internal combustion engine cylinders, ensuring precise bore dimensions and surface finishes for optimal piston ring sealing and engine performance.
- **Hydraulic Cylinders:** Honing is employed in the production of hydraulic cylinders to achieve accurate bore dimensions and smooth surface finishes, minimizing friction and leakage for efficient hydraulic operation.
- **Firearm Barrels:** Honing is utilized in firearm manufacturing to finish the bore of gun barrels, ensuring uniformity, precise dimensions, and optimal rifling for accuracy and performance.
- **Pneumatic Components:** Honing is used in the production of pneumatic cylinders and valves to achieve precise bore dimensions and smooth surface finishes, ensuring reliable pneumatic system operation.
- **Machine Tool Spindles:** Honing is applied to machine tool spindles to improve the bore's roundness, straightness, and surface finish, reducing vibration and enhancing machining accuracy.

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LESSON 24 : Introduction and necessity of surface finishing

Objectives

At the end of this lesson you shall be able to

- introduction to surface finishing process
- state the different types of surface finishing process
- state the advantages and uses of surface finishing
- state the difference between surface and waviness, examples.

Introduction:

When components are made either by machining or by hand, the movement of the cutting tool leaves some lines or pits on the surface of the work. This is called surface texture. These are actually irregularities caused by the uniform or uneven spacing of the production method. Due to which the shape of the pattern is formed on the work piece.

Types of Surface Finishing Process

Surface finishing processes encompass a variety of methods tailored to enhance the texture, appearance, and performance of materials and components. These techniques fall into two main categories:

Electropolishing: This method removes ions from the surface, which is ideal for achieving smooth and flawless finishes on metals like stainless steel, aluminium, and copper.

Painting: Techniques like spray painting and powder coating enhance aesthetics and corrosion resistance, widely applied in automotive manufacturing.

Sanding or Sand Blasting: Manual surface finishing involving abrasion to remove imperfections from materials like aluminium, carbon steel, and stainless steel.

Electroplating: Electroplating uses electric current to deposit metals from a solution, offering benefits like increased durability and corrosion resistance for metals such as zinc, copper, and gold.

Vacuum Plating: Utilising high vacuum environments, this method includes processes like sputtering and ion plating for precision applications like titanium nitride surface treatments.

Thermal Spraying: This process involves heating and accelerating materials to mechanically attach them to surfaces, often used for structural elements and thermal barrier coatings.

Chemical Treatment: Chemical reactions create thin oxide or sulphide layers used for colouring, corrosion prevention, and priming surfaces for paint applications.

Powder Coating: Electrostatically applied dry powder adheres to surfaces and is melted, offering durable finishes for a wide range of items.

Hot Dipping: Components are dipped into molten solutions to create metallic coatings, primarily for corrosion protection, as seen in applications like guardrails.

Advantages of Surface Finishing Process

The various advantages of Surface Finishing:

- Enhanced appearance.
- Improved corrosion resistance.
- Increased durability.
- Reduced friction.
- Better electrical conductivity.
- Tighter tolerances.
- Stress relief.

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- Improved adhesion for coatings.
- Reduced surface roughness.
- Enhanced biocompatibility.

Uses of Surface Finishing Process

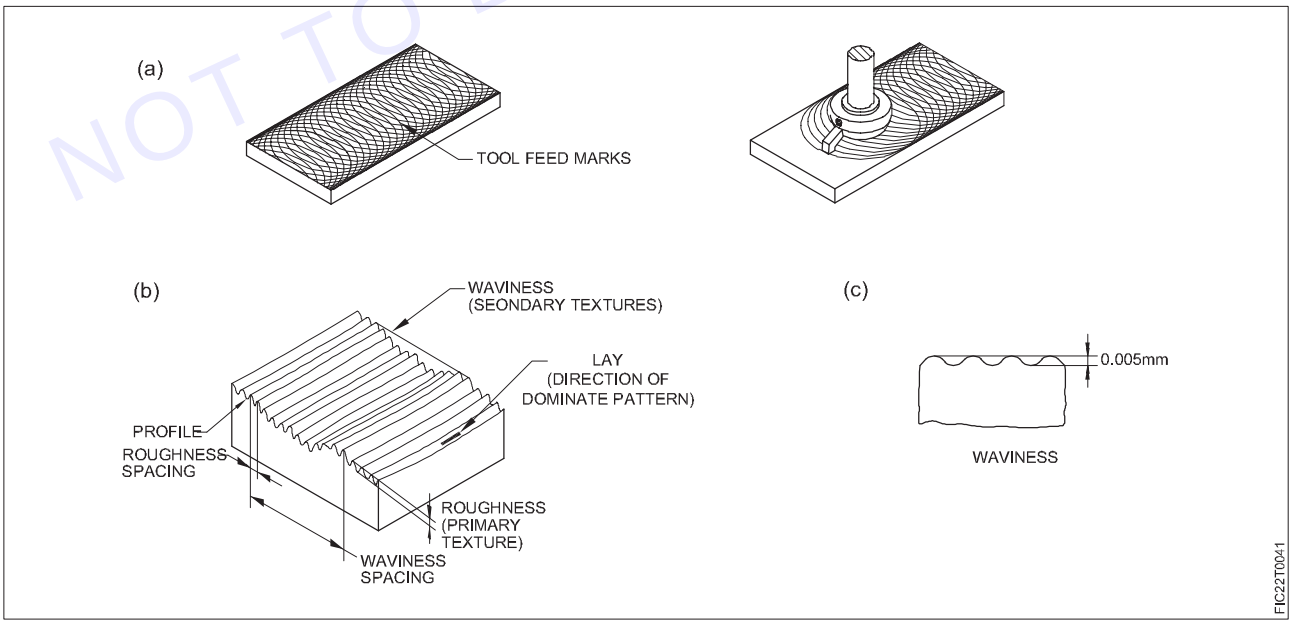
The various uses of the Surface Finishing Process are:

- Enhancing the aesthetic appearance of products.
- Improving corrosion resistance for longevity.
- Enhancing electrical conductivity in electronic components.
- Reducing friction and wear for smoother operation.
- Meeting specific tolerances for precise fits.
- Preparing surfaces for coatings or adhesives.
- Providing stress relief to reduce material fatigue.
- Creating biocompatible surfaces for medical devices.
- Preparing surfaces for bonding in aerospace and automotive applications.
- Restoring antique or worn items to their original condition.

Difference between surface and wavines:

1 Surface Roughness:

- Surface Roughness refers to the fine irregularities or deviations from the ideal surface texture of a material. It includes small-scale variations in surface height that result from the manufacturing process or environmental factors.
- Surface roughness is typically quantified by parameters such as Ra (average roughness), Rz (average maximum height), Rq (root mean square roughness), Rt (total roughness), and others. These parameters provide numerical values that describe the amplitude and frequency of surface irregularities.



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2 Waviness:

- Waviness refers to larger-scale deviations or undulations in the surface texture that occur over longer distances compared to surface roughness. These deviations may be caused by factors such as tool vibration, machine wear, or inherent material properties.
- Waviness is characterized by longer wavelengths and lower amplitudes compared to surface roughness. It represents the overall contour or form of the surface rather than the fine details.
- Waviness is typically quantified by parameters such as Wt (waviness height), Wp (waviness peak height), Wv (waviness valley depth), and others. These parameters describe the amplitude and frequency of the larger-scale undulations in the surface profile.

Example:

In the case of slip gauges the surface texture should be very fine with practically no waviness. Doing this will help the slip gauges stick together while ringing. Some of Didiki's C's help to run for Ijan's Senator Bor ticket. The quality of the serpentine texture is very important for the midden surface.

Ra " values (dimensional therome):

The most common method of quantifying surface texture quality is using Ra values. It is also called center line average (CLA).

The diagram is shown in, in there is a cavity (hollowness) formed below the material and a mean (average) center line cutting the surface profile making it parallel to the above.

After this the curve of the profile is made along the average line. So that the profile below comes down.

After this a new mile file is calculated for the curve obtained by folding the lower half of the original profile.

The distance between the two lines is the 'Ra' value of the surface.

The 'Ra' value is expressed in micrometres (0.000001) or (m). It can also be indicated by a

corresponding surface grade number in the range from N_1 to N_1 12.

When only one value of 'Ra' is specified, it represents the maximum permissible value of surface roughness.

R_a Micrometer μ m	R_a Micro-inch μ in	Roughness grade numbers (new)**	Roughness grade numbers (nold)**
50	2000	N12	
25	1000	N11	
12.5	500	N10	
6.3	250	N9	
3.2	125	N8	
1.6	63	N7	
0.8	32	N6	
0.4	16	N5	
0.2	8	N4	
0.1	4	N3	
0.05	2	N2	
0.025	1	N1	

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LESSON 25 : Introduction to co-ordinate measuring machine and its application

Objectives

At the end of this lesson you shall be able to

- state the CMM and its specification
- state the components of CMM
- state the machine structure and application of CMM
- state the precaution of CMM.

Introduction to Coordinate Measuring Machine (CMM) :

A Coordinate Measuring Machine (CMM) is a sophisticated measuring device used in manufacturing and quality control processes to precisely measure the geometric characteristics of objects. It operates based on Cartesian coordinates and utilizes a probing system to gather data points from the surface of the object being measured. These data points are then used to generate detailed 3D models or to verify the dimensions of the object against the desired specifications.

Components of a CMM:

A Coordinate Measuring Machine (CMM) typically consists of several key components:

1 Frame:

The frame provides the structural support for the entire CMM system. It holds all the other components in place and ensures stability during measurement operations.

2 Bridge or Arm: -

Depending on the type of CMM (bridge, cantilever, horizontal arm, etc.), there will be a component that supports the probe and moves it along the X, Y, and Z axes to reach different points on the object being measured.

3 Probe: -

The probe is the part of the CMM that physically touches the surface of the object and collects data points. Probes can come in various types, including touch-trigger probes, scanning probes, and non-contact probes like laser scanners.

4 Controller: -

The controller is the brain of the CMM system. It receives input from the user interface or measurement program, translates it into motion commands for the machine, and processes the data collected by the probe.

5 Drive System: -

The drive system consists of motors, encoders, and other mechanical components responsible for movingthe probe along the X, Y, and Z axes with precision and accuracy.

6 Software: -

CMM software provides the user interface for programming measurement routines, analyzing collected data, generating reports, and controlling the overall operation of the CMM system.

7 Workpiece Fixture: -

This component holds the object being measured securely in place during the measurement process, ensuring consistent positioning and alignment.

8 Touch Probe Stylus: -

The touch probe stylus is the part of the probe that makes contact with the surface of the object. Stylus configurations can vary depending on the specific measurement requirements, such as size, shape, and material.

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9 Computer System: -

A computer system is typically connected to the CMM to run the measurement software, store measurementdata, and interface with other systems for data analysis and reporting.

10 Enclosure or Housing: -

Some CMMs are housed within an enclosure or cabinet to protect the delicate internal components from environmental factors like dust, temperature fluctuations, and vibrations.

- Machine Structure
- Probing System
- Controller
- Software

Machine Structure: -

CMMs are typically composed of a rigid structure with three or more axes of motion. This structure provides stability and precision during measurements.

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Probing System: -

The probing system is the heart of a CMM. It consists of a probe attached to a moving arm or a scanning head that makes contact with the surface of the object to collect data points. Probes can be mechanical or optical, and they come in various types suitable for different applications.

Controller: -

The controller is responsible for interpreting the measurements obtained by the probing system and converting them into usable data. It manages the motion of the CMM's axes and ensures accuracy and repeatability in measurements.

Software: -

CMMs are equipped with specialized software that allows operators to program measurement routines, analyze collected data, and generate reports. This software often includes powerful algorithms for geometric analysis and statistical evaluation.

- **Application of cmm: -**

1 Quality Control and Inspection: -

CMMs are widely used for quality control purposes in manufacturing industries such as automotive, aerospace, electronics, and medical devices. They ensure that components and products meet specified dimensional tolerances and quality standards.

2 Dimensional Inspection: -

CMMs are used to measure dimensions, angles, distances, and other geometric features of manufactured parts. This includes verifying the accuracy of machined parts, sheet metal components, injection-molded parts, and more.

3 Reverse Engineering: -

CMMs play a crucial role in reverse engineering processes where physical objects are digitized to create CAD models. By capturing the surface geometry of an existing part, CMMs enable the reproduction or modification of parts without the original design data.

4 Tool and Mold Making: -

CMMs are used in the production of molds, dies, and tooling for various manufacturing processes. They help ensure the accuracy and precision of these critical components, which directly impacts the quality of the final products.

5 Prototype Development: -

CMMs are utilized in the development and validation of prototypes by accurately measuring prototype parts and comparing them to the design specifications. This helps identify and rectify any discrepancies early in the product development cycle.

6 Statistical Process Control (SPC): -

CMM data can be integrated into statistical process control systems to monitor and analyze manufacturing processes in real-time. By detecting deviations from the desired tolerances, SPC helps identify process variations and improve overall production efficiency.

7 Assembly Verification: -

CMMs are used to verify the dimensional integrity of assembled components, ensuring proper fit and alignment. This is particularly important in industries where precise assembly is critical, such as automotive and aerospace.

8 Surface Analysis: -

CMMs equipped with scanning probes or laser scanners can perform surface analysis to assess surface roughness, contour, form, and deviations from nominal shapes. This information is valuable for optimizing surface finish and ensuring functional performance.

9 Batch Inspection: -

CMMs can be programmed to perform batch inspection of multiple parts, automating the measurement process and improving throughput in manufacturing operations.

10 Tool Calibration: -

CMMs are used for the calibration of various measurement instruments and gauges, ensuring their accuracy and reliability in quality control processes.

Coordinate Measuring Machines (CMMs) find application across various industries due to their versatility and precision in measuring the physical geometrical characteristics of objects. Here are some specific applications of CMMs:

1 Automotive Industry: -

CMMs are extensively used in automotive manufacturing for quality control and inspection of components such as engine blocks, cylinder heads, gears, pistons, and body panels. They ensure that parts meet strict dimensional tolerances and specifications.

2 Aerospace Industry: -

CMMs play a critical role in the aerospace sector for inspecting complex components like turbine blades, airfoils, structural components, and composite materials. They help verify the accuracy of parts used in aircraft and spacecraft assemblies.

3 Medical Device Manufacturing: -

CMMs are used in the production of medical devices such as implants, prosthetics, surgical instruments, and precision components. They ensure the dimensional accuracy and quality of these critical healthcare products.

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4 Electronics Industry: -

CMMs are employed in the electronics industry for inspecting printed circuit boards (PCBs), semiconductor components, connectors, and other electronic assemblies. They help verify the precise placement of components and ensure compliance with design specifications.

5 Tool and Die Making:

CMMs are essential tools in the manufacturing of molds, dies, and tooling for various industries. They verify the accuracy of tool geometries and dimensions, ensuring high-quality production of stamped, molded, or machined parts.

6 Energy Sector: -

CMMs are used in the energy sector for inspecting components used in power generation, including turbines, generators, valves, and piping systems. They help maintain the reliability and safety of critical infrastructure components.

7 Consumer Goods Manufacturing: -

CMMs are employed in the production of consumer goods such as appliances, furniture, and consumer electronics. They ensure the dimensional accuracy of parts and assemblies, enhancing product quality and reliability.

8 Metal working and Machining Industries: -

CMMs are used in metalworking and machining industries for inspecting machined parts, tooling, fixtures, and weldments. They help optimize machining processes and ensure the quality of finished products.

9 Plastics and Injection Molding: -

CMMs are utilized in the plastics industry for inspecting injection-molded parts, molds, and tooling. They help verify the dimensional accuracy of molded components and ensure conformance to design specifications.

10 Research and Development: -

CMMs are used in research and development laboratories for prototyping, reverse engineering, and analyzing the dimensional characteristics of new materials and components.

- **Precaution of cmm: -**

When using a Coordinate Measuring Machine (CMM), several precautions should be taken to ensure accurate measurements and safe operation:

1 Operator Training: -

Ensure that operators are properly trained in the operation of the CMM, including software use, probe handling, and safety procedures.

2 Environmental Conditions: -

Maintain stable environmental conditions, including temperature, humidity, and cleanliness, to prevent measurement inaccuracies caused by thermal expansion, condensation, or contamination.

3 Regular Calibration: -

Schedule regular calibration and maintenance of the CMM to ensure its accuracy and reliability. Follow manufacturer recommendations for calibration intervals and procedures.

4 Proper Probe Selection: -

Select the appropriate probe and stylus configuration for the specific measurement task and material being inspected. Improper probe selection can lead to inaccurate measurements or damage to the part.

5 Fixture Setup: -

Properly secure the work piece in the fixture to prevent movement or vibration during measurement. Ensure that the fixture does not obstruct the probe's movement and that it provides stable support for the part.

6 Probe Calibration: -

Calibrate the probe before each measurement session to ensure accurate data collection. Follow the manufacturer's calibration procedures and use certified calibration artifacts when necessary.

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7 Avoid Overloading: -

Do not exceed the maximum weight capacity or measurement range of the CMM. Overloading the machine can cause damage to its components and compromise measurement accuracy.

8 Safe Handling: -

Handle the probe and other components of the CMM with care to prevent damage or injury. Avoid dropping or mishandling the probe, and use appropriate lifting techniques when moving heavy parts or components.

9 Data Backup: -

Regularly backup measurement data and software programs to prevent data loss in case of system failure or malfunction.

10 Emergency Procedures: -

Familiarize operators with emergency shutdown procedures and safety protocols in case of equipment malfunction or emergencies.

By following these precautions, operators can ensure the safe and accurate operation of the Coordinate Measuring Machine while minimizing the risk of errors or accidents.

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MODULE 10

LESSON 26 : Types of material handling equipment, accessories and their application

Objectives

At the end of this lesson you shall be able to

- state the types of material handling equipment
- state the accessories used with material handling equipment
- state the application of material handling machine

- **Types of material handling equipment:**

There are various types of material handling equipment used in different industries and applications. Some common types include:

1 **Forklifts:** Used for lifting and transporting heavy loads, forklifts are versatile machines commonly found in warehouses, manufacturing facilities, and construction sites.

2 **Conveyors:** These are used to transport materials or products from one location to another within a facility. They can be belt conveyors, roller conveyors, or overhead conveyors, among others.

3 **Cranes:** Cranes are used for lifting and moving heavy or oversized objects vertically and horizontally. They come in various types, including overhead cranes, gantry cranes, and jib cranes.

4 **Pallet jacks:** Also known as pallet trucks or pump trucks, pallet jacks are used for lifting and moving pallets within a warehouse or distribution center.

5 **Automated guided vehicles (AGVs):** AGVs are autonomous vehicles equipped with sensors and navigation systems that allow them to transport materials or products without human intervention. They are commonly used in manufacturing and distribution facilities.

6 **Stackers:** Stackers are used for stacking and retrieving loads from high shelves or racks. They can be manual, semi-automatic, or fully automated depending on the application.

7 **Hoists:** Hoists are used for lifting and lowering heavy loads vertically. They can be electric, pneumatic, or hydraulic and are often used in conjunction with cranes or overhead lifting systems.

8 **Lift tables:** Lift tables are hydraulic platforms used for raising or lowering loads to ergonomic working heights. They are commonly used in assembly lines, loading docks, and maintenance facilities.

9 **Trolleys and carts:** Trolleys and carts are used for transporting materials or products manually. They come in various configurations, including platform carts, hand trucks, and towable carts.

10 **Drum handling equipment:** This includes equipment designed specifically for handling drums and barrels, such as drum lifters, drum tillers, and drum dollies.

- **Accessories used with material handling equipment:**

Accessories used with material handling equipment can enhance the functionality, safety, and efficiency of handling various types of materials in industrial and warehouse settings. Some common accessories include:

1 **Forklift Attachments:**

- **Fork extensions:** Extend the length of forklift forks to handle longer loads.
- **Forklift booms:** Attachments used for lifting and positioning bulky or awkwardly shaped loads.
- **Forklift platforms:** Platforms mounted on forklifts for lifting personnel or small items to elevated heights.
- **Drum handling attachments:** Clamps, lifters, and tippers for handling drums and barrels.

2 **Hoist and Crane Accessories:**

- **Slings:** Webbing, chain, or wire rope slings used for lifting various types of loads.

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- **Hooks:** Different types of hooks for securely attaching loads to hoists or cranes.
- **Spreader bars:** Bars with multiple attachment points for lifting large or irregularly shaped loads.

3 **Pallet Accessories:**

- **Pallet inverters:** Equipment used for rotating or flipping palletized loads.
- **Pallet dispensers:** Devices that dispense pallets one at a time for easy loading.
- **Pallet stackers:** Equipment for stacking pallets vertically to maximize storage space.

4 **Conveyor Accessories:**

- **Conveyor belts:** Belts of different materials and designs for specific applications.
- **Conveyor rollers:** Rollers used to support and guide materials along conveyor systems.
- **Conveyor guards:** Safety barriers and covers to prevent contact with moving parts.

5 **Racking and Shelving Accessories:**

- **Wire mesh decking:** Decking material that provides a stable surface for storing items on pallet racks.
- **Rack guards:** Protective barriers to prevent damage to racks from forklift collisions.
- **Rack dividers:** Dividers used to separate and organize items stored on shelves or racks.

6 **Drum Handling Accessories:**

- **Drum dollies:** Wheeled platforms for transporting drums and barrels.
- **Drum funnels:** Funnel attachments for pouring liquids into drums without spills.
- **Drum heaters:** Equipment for heating contents of drums to maintain viscosity or facilitate pouring.

7 **Lifting and Rigging Accessories:**

- **Shackles:** Connectors used to attach slings or chains to loads.
- **Turnbuckles:** Devices for adjusting the tension or length of rigging components.
- **Lifting beams:** Structural beams with multiple attachment points for lifting and positioning loads.

8 **Safety Accessories:**

- **Safety barriers:** Barriers and guards to prevent accidents and protect personnel and equipment.
- **Personal protective equipment (PPE):** Helmets, gloves, safety glasses, and other gear to protect workers during material handling tasks.

- **Applications of material handling equipment:**

Material handling equipment finds applications across various industries and settings where the movement, storage, and transportation of materials are essential. Some common applications include:

1 **Warehousing and Distribution Centers:**

- Pallet racking systems and forklifts are used for storing and retrieving palletized goods efficiently.
- Conveyor systems facilitate the movement of goods from receiving areas to storage locations and then to shipping docks.
- Automated guided vehicles (AGVs) transport goods within warehouses, reducing the need for manual labor.

2 **Manufacturing Facilities:**

- Overhead cranes and hoists are used for lifting and positioning heavy machinery, equipment, and raw materials.
- Conveyor belts and rollers transport materials between manufacturing processes, such as assembly lines and workstations.
- Robotic arms and manipulators handle parts and components during production processes, increasing efficiency and precision.

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3. **Construction Sites:**
   - Excavators, loaders, and dump trucks are used for moving earth, aggregates, and construction materials on construction sites.
   - Tower cranes and mobile cranes lift and position heavy materials and equipment, such as steel beams and precast concrete panels.
   - Material hoists and elevators transport workers and materials vertically on multi-story construction projects.

4 **Retail and E-commerce Fulfilment Centers:**
   - Automated sorting systems and conveyors sort and route packages for delivery to customers.
   - Order picking systems and automated guided vehicles (AGVs) retrieve products from storage locations and prepare them for shipping.
   - Packaging machinery, such as case sealers and stretch wrappers, prepare packages for shipment.

5 **Agriculture and Food Processing:**
   - Tractors, harvesters, and combines are used for harvesting crops and transporting agricultural products on farms.
   - Conveyor systems and sorting equipment handle fruits, vegetables, grains, and other food products in processing plants.
   - Forklifts and pallet jacks move packaged goods and ingredients within food distribution centers and warehouses.

6 **Automotive and Aerospace Industries:**
   - Robotic arms and automated assembly lines assemble vehicles and aircraft components with precision and efficiency.
   - AGVs transport parts and materials between production processes, reducing manual handling and improving workflow.

Overhead cranes and manipulators lift and position large vehicle components and aircraft fuselages during manufacturing.

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Hydraulic and pneumatic system and its application in modern machines

Objectives : At the end of this lesson you shall be able to

- prepare and fill maintenance log in format
- prepare and fill the history sheet of machinery and equipment in format
- prepare and fill maintenance record in format.

Definition:

A jig is a specialized tool or device used in manufacturing, machining, or assembly processes to assist in holding, guiding, or supporting a workpiece or tool during various operations. Jigs are designed to ensure precision, repeatability, and efficiency in production by facilitating accurate positioning, alignment, and control of the workpiece or tool. They are commonly used in industries such as automotive, aerospace, woodworking, metalworking, and electronics manufacturing to improve productivity, quality, and consistency of manufactured components or products. Jigs can vary widely in complexity and design, ranging from simple fixtures to intricate templates tailored to specific machining or assembly tasks.

working of a hydraulic and pneumatic system:

A pneumatic system uses compressed air or gas to transmit and control energy. When the compressed air is released from the storage tank, it flows through a series of pipes to reach the pneumatic components. Air pressure

is then controlled by regulating the flow of air through valves or adjusting the pressure regulator. The components of the pneumatic system convert the energy of the compressed air into mechanical motion. For example, a pneumatic cylinder uses a piston that moves within a cylinder. This is driven by compressed air. In a hydraulic system, mechanical energy is transformed into hydraulic energy. The hydraulic energy is used for energy transport, for energy control or regulation and is then converted back into mechanical energy again. The conversion from mechanical into hydraulic energy takes place using a hydraulic pump; the conversion from hydraulic into mechanical energy takes place through hydraulic cylinders motors.

Application of a hydraulic and pneumatic system in modern machines:

Hydraulic Systems:

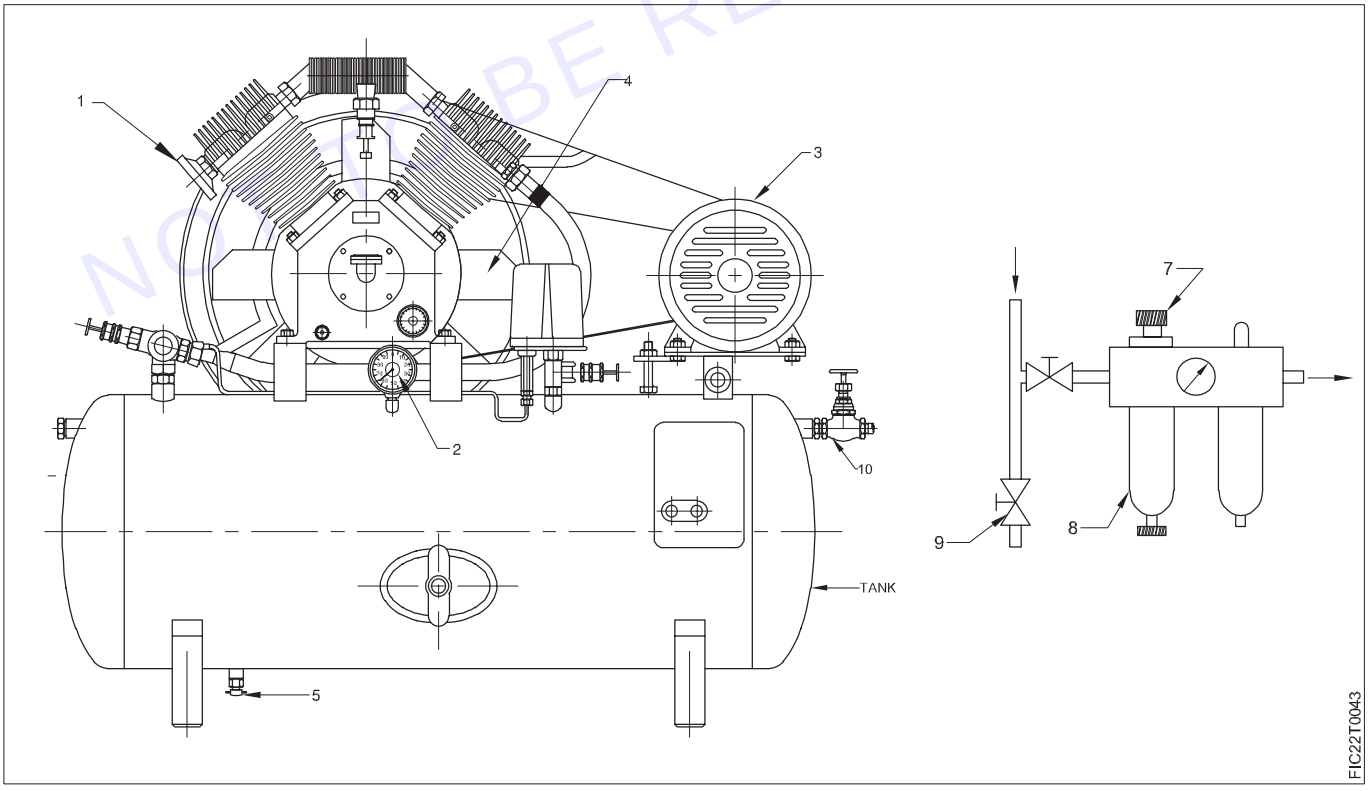
1 **Heavy Machinery:** Hydraulic systems are extensively used in heavy machinery such as excavators, bulldozers, and cranes for tasks such as lifting, digging, and moving heavy loads. The high power density of hydraulic systems allows them to generate significant force with relatively compact components.

2 **Construction Equipment:** Hydraulic systems are integral to construction equipment like hydraulic presses, pile drivers, and hydraulic breakers. These systems provide the force necessary for various construction tasks, including compacting soil, driving piles, and breaking concrete.

3 **Aircraft:** Hydraulic systems play a crucial role in aircraft for controlling flight surfaces such as flaps, ailerons, and landing gear. They provide precise and reliable control of these surfaces, ensuring safe and efficient operation of the aircraft.

4 **Automotive Industry:** Hydraulic systems are utilized in vehicles for power steering, braking, and suspension systems. Hydraulic power steering systems assist drivers in steering vehicles with minimal effort, while hydraulic brakes provide reliable stopping power. Additionally, hydraulic suspension systems offer adjustable ride comfort and handling characteristics.

5. **Machine Tools:** Hydraulic systems are used in machine tools such as presses, shears, and stamping machines for metal forming and cutting operations. These systems provide high force and precise control, allowing for efficient production of metal components.



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Hydraulics is an essential technology in many machines and systems. Here's a look at some key features that make hydraulics so widely used:

1 **Powerful Force:** Hydraulics use liquid, typically oil, to transmit power. This allows for the generation of significant force, making it ideal for lifting heavy loads and operating high-power machinery.

2 **Precision Control:** Hydraulic systems offer precise control of movement and speed. This precision is crucial in applications like manufacturing and construction, where exact movements are necessary.

3 **High Pressure Capability:** Hydraulic systems operate under high pressure, which translates into the ability to do more work with smaller components. This makes them efficient and space-saving.

4 **Wide Range of Applications:** From the brakes in your car to heavy construction equipment, hydraulics are used in a variety of settings due to their versatility and reliability.

5 **Energy Efficiency:** While hydraulic systems require energy to operate, they are designed to maximize the conversion of this energy into useful work, making them efficient in terms of energy use.

6 **Durability and Longevity:** Hydraulic systems are known for their durability. With proper maintenance, they can operate effectively for a long time, making them a cost-effective solution in many industrial applications.

Use of Hydraulics

1 Hydraulics is like the hidden muscle in many machines, playing a crucial role in everything from cars to construction sites. In our cars, for instance, hydraulics is the secret behind the powerful braking system. With just a small press on the brake pedal, hydraulics uses fluid pressure to activate the brakes, bringing the car to a halt. Over at construction sites, those massive machines like excavators and bulldozers rely on hydraulics to dig up earth and lift heavy materials, giving them the strength to handle hefty tasks with ease.

2 In the manufacturing industry, hydraulics is key to the smooth operation of machinery. It allows for precise movements and handling, essential in producing high-quality products. Even in the realm of entertainment, such as amusement parks, hydraulics plays a part. It's what makes those thrilling rides with sudden drops and smooth movements possible, combining excitement with safety.

3 The importance of hydraulics extends up into the skies too, with aircraft relying on it for controlling wings and operating landing gears, ensuring safe flights and landings.

4 Moreover, hydraulics isn't just limited to these large-scale applications. It's also present in everyday tools like jacks and hydraulic presses, commonly used for lifting heavy objects effortlessly, such as during a car tire change. This widespread use of hydraulics showcases its versatility and indispensability, making tough tasks simpler and keeping various systems operating smoothly and safely.

Pneumatic Systems:

1 **Manufacturing and Assembly:** Pneumatic systems are widely used in manufacturing and assembly lines for tasks such as material handling, sorting, and assembly. Pneumatic actuators and grippers provide fast and precise movement of components, enhancing production efficiency.

2 **Packaging Machinery:** Pneumatic systems are employed in packaging machinery for tasks such as sealing, labelling, and filling. Pneumatic actuators and cylinders are used to control the movement of packaging materials and products, ensuring accurate and reliable packaging processes.

3 **Automation and Robotics:** Pneumatic systems are integral to automation and robotics applications, providing actuation for robotic arms, grippers, and end effectors. Pneumatic actuators offer fast response times and precise control, making them suitable for a wide range of robotic applications in manufacturing and logistics.

4 **Medical Devices:** Pneumatic systems are used in various medical devices and equipment, including ventilators, anaesthesia machines, and surgical tools. Pneumatic actuators and controls provide precise movement and pressure regulation, essential for patient care and surgical procedures.

5 **Air Brakes:** Pneumatic systems are commonly used in commercial vehicles, trains, and buses for air brake systems. Pneumatic brakes offer reliable and responsive braking performance, particularly in heavy-duty applications where hydraulic systems may be impractical.

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Pneumatic is an essential technology in many machines and systems. Here's a look at some key features that make Pneumatic so widely used:

1 **Uses Air Power:** The main thing about pneumatics is that it uses compressed air. Air is everywhere, so it's easy to get and safe to use. When air is squeezed into a small space, it gets a lot of energy that can be used to power tools and machines.

2 **Safe and Clean:** Since it's just air, pneumatics is really safe. There's no risk of fires like with systems that use oil. Also, if there's a leak, it's just air escaping, which is much cleaner and less harmful to the environment.

3 **Fast and Responsive:** Pneumatic systems react quickly. When you control them, they start and stop in an instant. This is great for machines that need to move fast or stop right away.

4 **Easy to Maintain:** Pneumatic systems are simpler than other types, like hydraulics. This means they're usually easier and cheaper to fix and take care of.

5 **Versatile:** Pneumatics is used in a lot of different ways. From powering tools like drills and hammers in construction to operating machinery in factories and even helping dentists with their tools.

6 **Energy Efficient:** These systems don't use a lot of electricity, which makes them energy-efficient. They're good for tasks that need a strong force but don't use too much power.

Advantage of Hydraulics and Pneumatics

Understanding the advantages of hydraulics and pneumatics is key to knowing why they are chosen for different tasks in various industries. Let's break down the benefits of each system in a straightforward manner, drawing insights from industry leaders.

Advantages of Hydraulics:

- **High Power and Force:** Hydraulics systems are capable of handling heavier loads and producing more force compared to pneumatics, making them ideal for industrial and construction applications.
- **Precise Control:** They offer fine control over speed and position, which is crucial in applications requiring meticulous movement, like in manufacturing machinery.
- **Efficiency:** Hydraulic systems are efficient in converting energy into motion or force, especially in applications requiring a strong push or pull.
- **Durability:** These systems are known for their robustness and longevity, especially in harsh working environments.

Advantages of Pneumatics:

- **Rapid Movement:** Pneumatics is known for its ability to provide quick and repetitive movements, which is essential in assembly lines and automation processes.
- **Safety:** Using air reduces the risk of fire and is generally safer in environments where sparks or high temperatures could be a hazard.
- **Simplicity and Reliability:** Pneumatic systems are simpler in design and easier to maintain, making them reliable for various applications.
- **Cost-Effectiveness:** Generally, pneumatic systems are more economical to install and operate than hydraulic systems, especially in less heavy-duty environments.

By leveraging these advantages, both hydraulics and pneumatics play crucial roles in modern machinery and technology. Hydraulics, with its high power and precision, is indispensable in heavy lifting and high-force tasks. Pneumatics, being fast, safe, and cost-effective, is ideal for applications requiring speed and efficiency.

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LESSON 27 : Introduction, classification, Type and uses of Bearings

Objectives

At the end of this lesson you shall be able to

- introduction to bearing
- state the parts of bearing
- state the types of bearing and uses

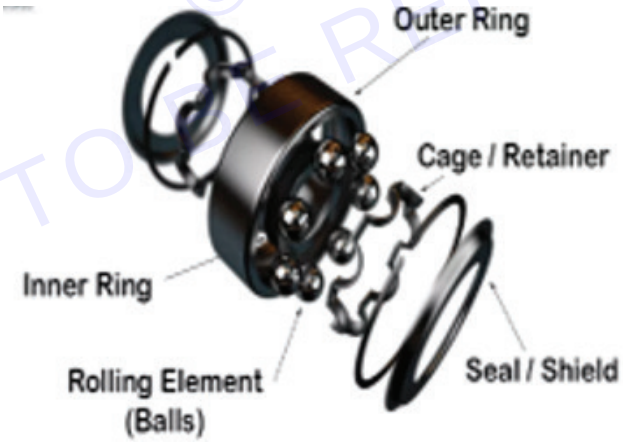
Introduction

Bearings are designed to facilitate smooth and efficient motion by minimizing friction and wear between two surfaces in relative motion. They support radial, axial, or combined loads and enable rotational or linear movement in machines and mechanical systems. Bearings typically consist of an inner and outer ring, rolling elements (such as balls or rollers), a cage or separator to keep the rolling elements spaced apart, and sometimes seals or shields to protect against contamination.

Parts of Bearings:

1 **Inner Ring:** The Inner Ring is the smaller of the two bearing rings. It has a groove on its outer diameter to form a raceway for the balls. The surface of outside diameter path is finished to extremely tight tolerances and is honed to be a very smooth surface. The inner ring is mounted on the shaft and it is the rotating element.

2 **Outer Ring:** The Outer Ring is the larger of the two bearing rings. On outer ring, there is a groove on its inside diameter to form a pathway for the balls. It also has the same high precision finish of the inner ring. The outer ring is usually held stationery.



3 **Rolling Element:** (Balls, Cylindrical Rollers, Spherical Rollers,

Tapered Rollers, Needle Rollers):

The rolling elements separate the inner ring and outer ring and permit the bearing to rotate with minimal friction. The dimension of the rolling elements is made slightly smaller than the track on the inner and outer rings. Rolling element dimensions are controlled to very high accuracy. Surface finish and size variations are important attributes. These attributes are controlled to a micro inch level.

4 **Cage (Retainer):**

The purpose of the cage in bearings is to separate the rolling elements, maintaining a constant spacing between the inner and outer rings, to accurately guide the rolling elements in the path during rotation and to prevent the rolling elements from falling out.

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Types of Bearing:

- Plan bearing -Rubbing surfaces, usually with lubricant; some bearings use pumped lubrication and behave similarly to fluid bearings.
- Roller bearing -Ball or rollers contact both rotating and stationary surfaces which rotate rather than rub.
- Magnetic bearing -Faces of bearing are kept separate by magnets (electromagnets or eddy currents).
- Composite bearing- Plain bearing shape with PTFE liner on the interface between bearing and shaft with a laminated metal backing. PTFE acts as a lubricant.

Uses of Bearing:

1 **Automotive Industry:** Bearings are extensively used in vehicles for various applications, including wheel hubs, transmissions, engines, steering systems, and suspension components. They support rotating shafts, axles, and gears, allowing for smooth and reliable operation of automotive systems.

2 **Industrial Machinery:** Bearings are essential components in industrial machinery and equipment, such as pumps, compressors, motors, turbines, and conveyors. They support rotating shafts, spindles, and other moving parts, enabling efficient power transmission, motion control, and material handling in manufacturing and processing operations.

3 **Aerospace and Aviation:** Bearings are critical in aerospace and aviation applications, where they are used in aircraft engines, landing gear systems, flight control surfaces, and auxiliary systems. They withstand high speeds, temperatures, and loads encountered in flight operations while maintaining precision and reliability.

4 **Construction and Mining:** Bearings are employed in heavy equipment and machinery used in construction, mining, and earthmoving applications. They support rotating components, such asexcavator buckets, crane booms, and conveyor belts, allowing for efficient material handling, digging, and lifting operations in rugged and demanding environments.

5 **Railway and Transportation:** Bearings are used extensively in railway and transportation systems for applications such as wheelsets, axle boxes, couplers, and suspension systems. They support the weight of rolling stock, reduce friction between moving parts, and withstand the dynamic forces and vibrations encountered during train operation.

6 **Marine and Offshore:** Bearings play a crucial role in marine and offshore applications, where they are used in ship propulsion systems, steering mechanisms, deck machinery, and offshore drilling equipment. They withstand harsh marine environments, high loads, and corrosive conditions while ensuring smooth and reliable operation.

7 **Wind Energy:** Bearings are integral components in wind turbines, where they support the rotor shaft, gearbox, and generator. They enable efficient power generation by allowing the rotor blades to rotate smoothly, even under high wind speeds and loads, while minimizing friction and wear.

8 **Medical Devices:** Bearings are used in medical devices and equipment, such as surgical instruments, imaging systems, and laboratory equipment. They provide precise motion control, low friction, and quiet operation in critical healthcare applications, ensuring accuracy, reliability, and patient safety.

9 **Consumer Products:** Bearings are found in various consumer products, including household appliances, power tools, bicycles, and sports equipment. They enable smooth and reliable operation of rotating components, such as motors, gears, wheels, and shafts, enhancing product performance and user experience.

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MODULE 11

LESSON 28 : Introduction to CAD

Objectives

At the end of this lesson you shall be able to

- define the CAD and types of CAD
- state the 2D CAD purpose, feature, application and examples
- state the 3D CAD purpose, feature, application and examples
- state the precautions while using CAD.

- **Definition**

CAD stands for Computer-Aided Design. It refers to the use of computer software to create, modify, analyze, and optimize designs for various products and systems. CAD software allows designers, engineers, architects, and other professionals to digitally draft and model 2D and 3D representations of objects, components, buildings, or mechanical structures. CAD tools provide a wide range of features and functionalities, including precise measurements, geometric modeling, simulation, rendering, and documentation, which streamline the design process and facilitate collaboration among stakeholders.

- **Types of cad**

1 2D CAD

2 3D CAD

2D CAD (Computer-Aided Design)

Software is used to create two-dimensional digital representations of objects, components, or architectural plans. Here's some detailed information about 2D CAD:

1 Purpose

2D CAD software is primarily used for drafting and detailing. It allows designers and engineers to create accurate and detailed technical drawings, schematics, floor plans, and other 2D representations of objects or structures.

2. Features

- **Drawing Tools**

2D CAD software provides a variety of drawing tools such as lines, arcs, circles, polygons, and splines to create geometric shapes and lines.

- **Editing Tools**

It includes tools for modifying and editing objects, such as trimming, extending, filleting, chamfering, and scaling.

- **Dimensioning**

Dimensioning tools allow users to add accurate measurements and annotations to drawings, including linear dimensions, angles, radius, diameter, and text labels.

- **Layer Management**

CAD software typically supports layering functionality, allowing users to organize and manage different elements of the drawing separately for better organization and control.

- **Snap and Grid**

Snap and grid features assist users in aligning and positioning objects accurately within the drawing space.

- **File Compatibility**

2D CAD software supports various file formats for importing and exporting drawings, facilitating compatibility with other CAD software and collaboration with colleagues and clients.

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- **Printing and Plotting**

It enables users to create high-quality prints or plots of their drawings, including options for scaling, page setup, and printing parameters.

3. Applications

- **Engineering Drawings**

2D CAD is extensively used in mechanical, civil, electrical, and architectural engineering for creating technical drawings and plans.

- **Architectural Drafting**

Architects use 2D CAD software to produce floor plans, elevations, sections, and construction details for buildings and structures.

- **Product Design**

It is used in product design and manufacturing industries to create detailed drawings of components, assemblies, and manufacturing specifications.

- **Documentation**

2D CAD software is also used for documentation purposes, such as creating schematics, wiring diagrams, and parts catalogs.

4 Examples of 2D CAD Software

- Auto cad lt
- Draftsight
- Turbo cad 2d
- Librecad
- Corelcad (2d version)

Overall, 2D CAD software is a powerful tool for creating precise and detailed technical drawings, facilitating the design and documentation process across various industries.

3D CAD (Computer-Aided Design)

software is used to create three-dimensional digital models of objects, components, or architectural structures. Here's detailed information about 3D CAD:

1 Purpose

3D CAD software is used for designing, modeling, visualizing, and analyzing complex three-dimensional objects or systems. It enables engineers, designers, architects, and manufacturers to create detailed and accurate 3D representations of products, buildings, machinery, and more.

2 Features

- **Modeling Tools**

3D CAD software provides a wide range of modeling tools for creating complex shapes and geometries, including extrusion, revolve, loft, sweep, fillet, chamfer, and boolean operations.

- **Assembly Design**

It allows users to assemble multiple components together to create complex assemblies, with tools for mating, aligning, and simulating motion between parts.

- **Parametric Design**

Parametric modeling enables users to create models with dimensions and parameters that can be easily modified and updated, ensuring design flexibility and adaptability.

- **Surface Modeling**

Advanced 3D CAD software offers surface modeling capabilities for creating organic shapes, curved surfaces, and freeform designs.

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- **Rendering**

Rendering tools allow users to apply realistic materials, textures, lighting, and environments to their 3D models to create high-quality visualizations and presentations.

- **Simulation and Analysis**

Some 3D CAD software includes simulation and analysis tools for testing and validating designs for structural integrity, fluid flow, thermal performance, and other engineering parameters.

- **File Compatibility**

3D CAD software supports various file formats for importing and exporting models, including industry-standard formats like STEP, IGES, STL, and OBJ.

- **Collaboration**

Collaboration features enable multiple users to work on the same project simultaneously, with tools for version control, markup, and commenting.

3 Applications

- Product Design and Development

3D CAD is widely used in product design and development across industries such as automotive, aerospace, consumer electronics, and industrial machinery.

- **Architectural Design**

Architects use 3D CAD software to create detailed models of buildings, interiors, and landscapes, facilitating visualization and communication with clients and stakeholders.

- **Manufacturing**

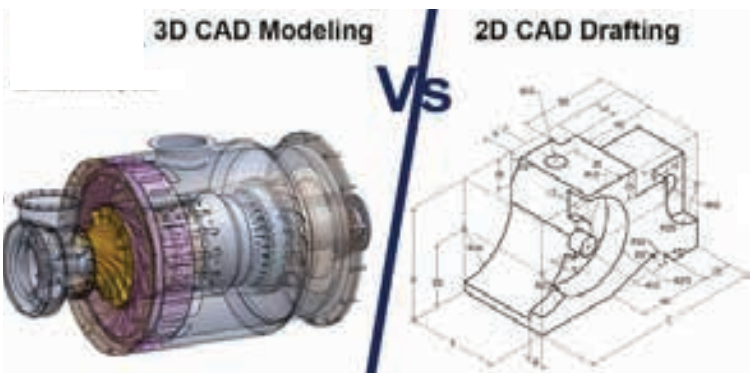
3D CAD models are used in manufacturing processes for CNC machining, 3D printing, injection molding, and other production methods to create prototypes and production parts.

- **Animation and Visualization**

3D CAD models can be used to create animations, walkthroughs, and virtual reality experiences for marketing, training, and simulation purposes.

4 Examples of 3D CAD Software

- AutoCAD
- Solid Works
- Autodesk Inventor
- CATIA
- Siemens NX
- PTC Creo
- Blender (open-source)



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Overall, 3D CAD software is a powerful tool for creating, analyzing, and visualizing three-dimensional models, driving innovation and efficiency in various industries.

Precaution: -

When using 2D and 3D CAD software, ensure to regularly save your work to prevent data loss. Additionally, be cautious when handling complex models to avoid unintentional modifications or deletions. It's also wise to keep backups of your files in case of software glitches or hardware failures. Lastly, stay updated on software updates and best practices to maintain efficiency and security.

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