TURNER

NSQF LEVEL - 5

1st Semester

TRADE THEORY

SECTOR: Production & Manufacturing

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, an autonomous body under the Directorate General of Training (DGT), Ministry of Skill Development & Entrepreneurship is entrusted with developing producing and disseminating Instructional Media Packages (IMPs) required for ITIs and other related institutions.

The institute has now come up with instructional material to suit the revised curriculum for **Turner Trade Theory 1st Semester in Production & Manufacturing Sector .** The NSQF Level - 5 Trade theory will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ASHEESH SHARMA
Joint Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Theory)** for the trade of **Turner** under the Production & Manufacturing

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

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE THEORY

The manual of trade theory consists of theorectical information for the First Semester couse of the Turner Trade. The contents are sequenced accoring to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade Theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercies to be completed by the trainees during the First Semester course of the Turner trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered.

The manual is divided into three modules. The distribution of time for the practical in the three modules are given below.

Module 1	Occupational safety	25 Hrs
Module 2	Basic Fitting	150 Hrs
Module 3	Turning	375 Hrs
	Total	550 Hrs

The skill training in the computer lab is planned through a series of practical exercises centred around some practical project. However, there are few instance where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average traninee. However the development team accept that there if a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

CONTENTS

Guidance to new corners about ITI and system Organisation of the industrial training institute

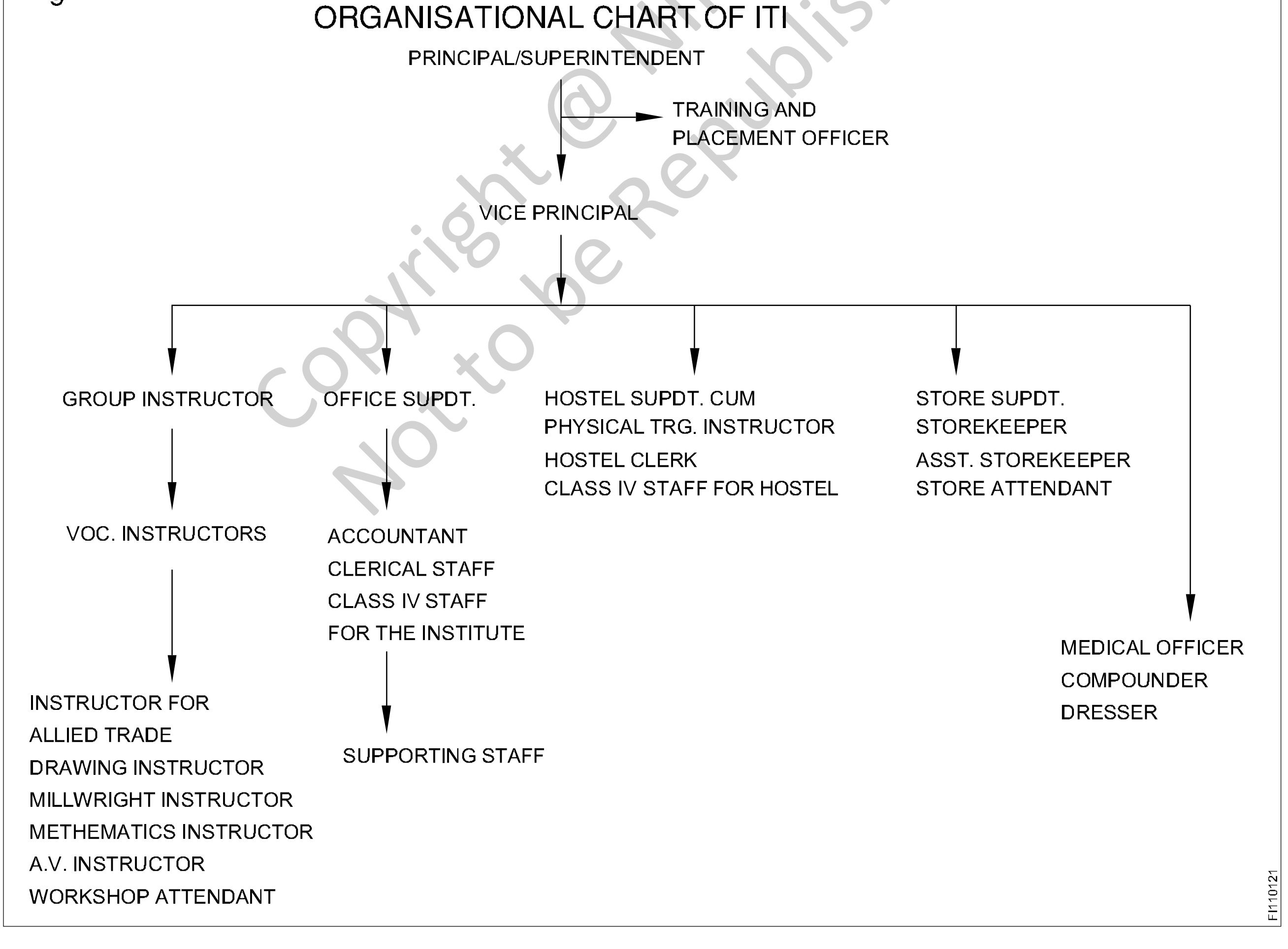
Objectives: At the end of this lesson you shall be able to
- **identify the staff structure of the institute**
- **identify the available trades in the institute and their functions.**

The industrial training institute throughout India follow the same syllabus pattern a given by the National Council for Vocational Training (NCVT) Board. In India there are Govt. ITIs and Private ITIs. Based on the Govt. of India, Ministry of Labour's Annual report of 2011-2012. The Govt. ITIs in each state work under the Directorate of Employment and Training which is a department under the Labour Ministry in most of the states. Some of the ITIs are under the Central Government and are attached to the Advanced Training Institute which are named as Model Training Institutes.

The head of the industrial training institute is the Principal, under whom there is one Vice-Principal, group instructor and a number of trade instructors as shown in the organisation chart of ITI.

Even though there are 62 trades selected for instructional training and 135 trades identified for apprentice training, according to the requirement of industrial needs, area and finance a few selected trades are established under each ITI. The trainees are advised to make a list of the trades available in their ITI, the type of training and the scope of these trades in getting self or job employment in the rural and urban areas.

Fig 1



Job area after complition of soft skill

Objectives : At the end of this lesson you shall be to
- **state the concept of soft skill**
- **list the importants common soft skill**
- **brief the employability aspect of training**
- **brief the further learning scope.**

Concept

Soft skills - refer to the cluster of personality traits, social graces, facility with language, personal habits, friendliness, and optimism that mark people to varying degrees. The same can also be defined as-ability to interact positively & productively with others. Sometimes called "character skills".

More and more business are considering soft skills as important job criteria. Soft skills are used in personal and professional life. Hard skills/technical skills do not matter without soft skills.

Common Soft Skills

- Strong work ethic
- Positive attitude
- Good communication skills
- Interpersonal skills
- Time management abilities
- Problem-solving skills
- Team work
- Initiative, Motivation
- Self-confidence
- Loyalty
- Ability to accept and learn from criticism
- Flexibility adaptability
- Working well under pressure

Job area completion of training: This highlights the employability aspect on completion of training. The trainee should be aware of various prospects available in present market scenario along with scope for self-employment. For example a trainee with NTC engineering trade may opt for:

Various job available in different industries in India and Abroad.

After successfull completion of ITI training in any one of the engineering trade one can see appointment in engineering workshop/Factories (Public Sector, Private Sector and Government Industries) in India and Abroad as technician/Skilled worker.

Self employment

One can start is own factory/ancillary unit or design products manufacture and became an entreprereur.

Further learning scope

- Apprentice training in designated trade.
- Craft Instructor certificate course.
- Diploma in Engineering.

Personal Protective Equipment (PPE)

Objectives: At the end of this lesson you shall be able to
- **state what is personal protective equipment and its purpose**
- **name the two categories of personal protective equipment**
- **list the most common type of personal protective equipment**
- **list the conditions for selection of personal protective equipment.**

Personal protective equipment (PPE)

Devices, equipments, or clothing used or worn by the employees, as a last resort, to protect against hazards in the workplace. The primary approach in any safety effort is that the hazard to the workmen should be eliminated or the workmen through the use of personal protective controlled by engineering methods rather than protecting the workmen through the use of personal protective equipment (PPE). Engineering methods could include design change, substitution, ventilation, mechanical handling, automation, etc. In situations ventilation, Mechanical handling automation etc in situations where it is not possible to introduce any effective engineering methods for controlling hazards, the workman shall use appropriate types of PPE.

As changing times have modernized the workplace, government and advocacy groups have brought more safety standards to all sorts of work environments. The Factories Act, 1948 and several other labour legislations 1996 have provisions for effective use of appropriate types of PPE. Use of PPE is an important.

Ways to ensure workplace safety and use personal protective equipment (PPE) effectively.

- Workers to get up-to-date safety information from the regulatory agencies that oversees workplace safety in their specific area.
- To use all available text resources that may be in work area and for applicable safety information on how to use PPE best.
- When it comes to the most common types of personal protective equipment, like goggles, gloves or bodysuits, these items are much less effective if they are not worn at all times, or whenever a specific danger exists in a work process. Using PPE consistently will help to avoid some common kinds of industrial accidents.
- Personal protective gear is not always enough to protect workers against workplace dangers. Knowing more about the overall context of your work activity can help to fully protect from anything that might threaten health and safety on the job.
- Inspection of gear thoroughly to make sure that it has the standard of quality and adequately protect the user should be continuously carried out.

Categories of PPE's

Depending upon the nature of hazard, the PPE is broadly divided into the following two categories:

1 **Non-respiratory:** Those used for protection against injury from outside the body, i.e. for protecting the head, eye, face, hand, arm, foot, leg and other body parts

2 **Respiratory:** Those used for protection from harm due to inhalation of contaminated air.

They are to meet the applicable BIS (Bureau of Indian Standards) standards for different types of PPE.

The guidelines on 'Personal Protective Equipment' is issued to facilitate the plant management in maintaining an effective programme with respect to protection of persons against hazards, which cannot be eliminated or controlled by engineering methods.

Fig 1

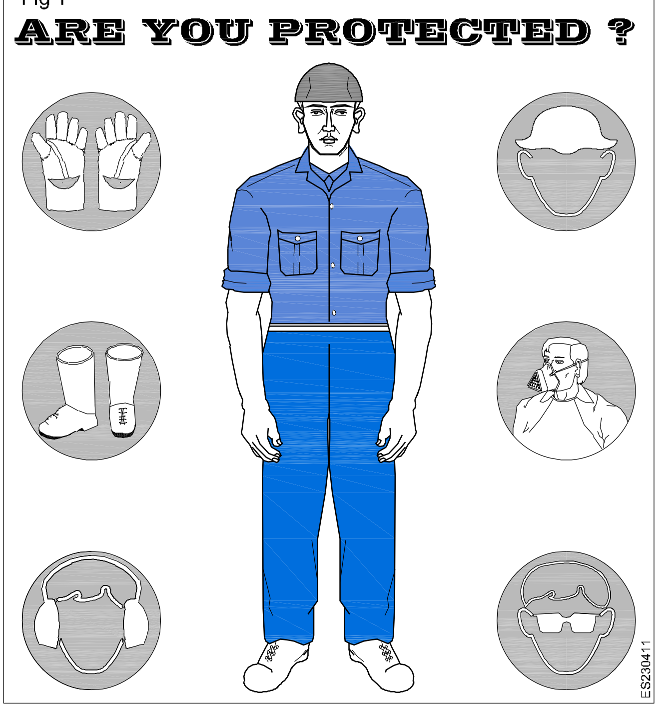
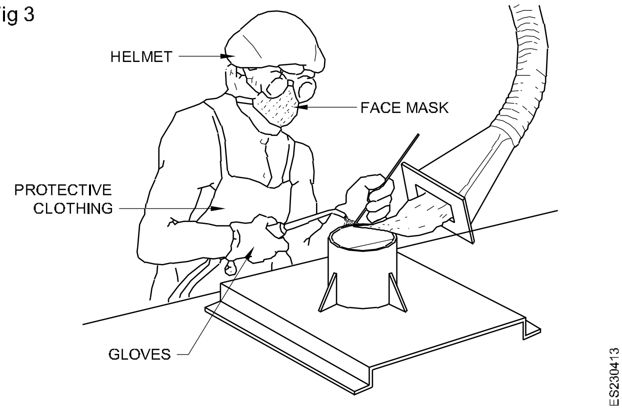
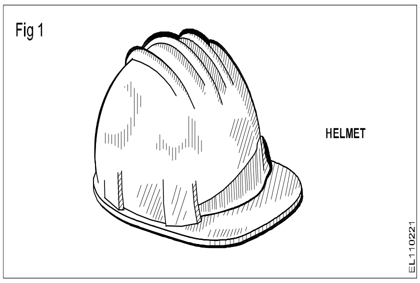
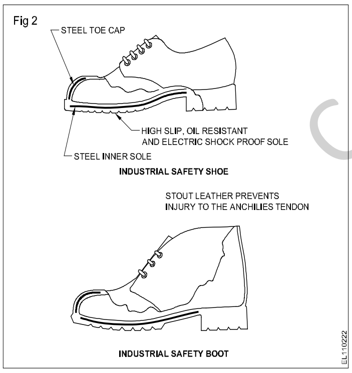
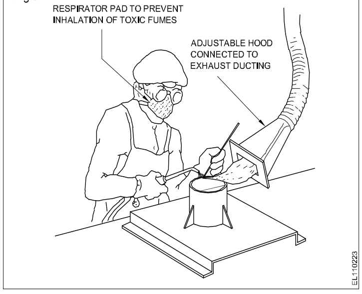


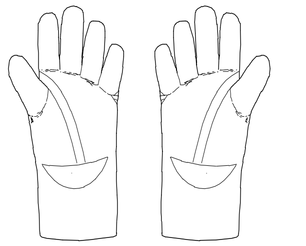
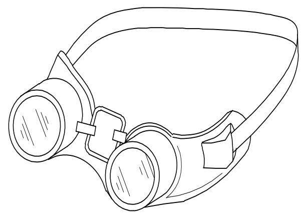
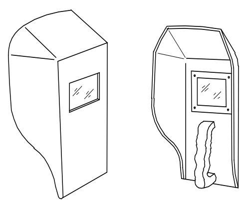
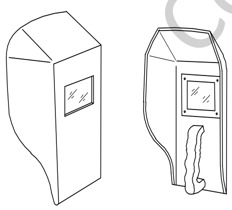
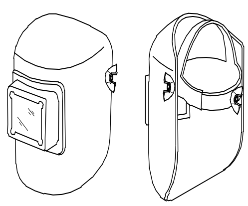
Fig 2

Fig 3



Personal protective equipments and their uses and hazards are as follows

Types of protection	Hazards	PPE to be used
Head Protection (Fig 1) Fig 1 	1. Falling objects 2. Striking against objects 3. Spatter	Helmets
Foot protection (Fig 2) Fig 2 	1. Hot spatter 2. Falling objects 3. Working wet area	Leather leg guards Safety shoes Gum boots
Nose (Fig 3) Fig 3 	1. Dust particles 2. Fumes/ gases/ vapours	Nose mask

Types of protection	Hazards	PPE to be used
Hand protecion (Fig 4) Fig 4  GLOVES	1. Heat burn due to direct contact 2. Blows sparks moderate heat 3. Electric shock	Hand gloves
Eye protection (Fig 5, Fig 6) Fig 5  Fig 6  HAND SCREEN	1. Flying dust particles 2. UV rays, IR rays heat and High amount of visible (UV - ultravoilet IR - Infra Red)	Goggles Face shield radiation Hand shield Head shield
Face Protection (Fig 6, Fig 7) Fig 6  HAND SCREEN Fig 7  WELDING HELMET	1. Spark generated during Welding, grinding 2. Welding spatter striking 3. Face protection from UV rays	Face shield Head shield with or without ear muff Helmets with welders screen for welders

Quality of PPE's

PPE must meet the following criteria with regard to its quality-provide absolute and full protection against possible hazard and PPE's be so designed and manufactured out of materials that it can withstand the hazards against which it is intended to be used.

Selection of PPE's requires certain conditions

- Nature and severity of the hazard
- Type of contaminant, its concentration and location of contaminated area with respect to the source of respirable air
- Expected activity of workman and duration of work, comfort of workman when using PPE
- Operating characteristics and limitations of PPE
- Ease of maintenance and cleaning
- Conformity to Indian/ International standards and availability of test certificate.

Proper use of PPEs

Having selected the proper type of PPE, it is essential that the workman wears it. Often the workman avoids using PPE. The following factors influence the solution to this problem.

- The extent to which the workman understands the necessity of using PPE
- The ease and comfort with which PPE can be worn with least interference in normal work procedures
- The available economic, social and disciplinary sanctions which can be used to influence the attitude of the workman
- The best solution to this problem is to make 'wearing of PPE' mandatory for every employee.
- In other places, education and supervision need to be intensified. When a group of workmen are issued PPE for the first time.

Basic first-aid

Objectives: At the end of this lesson you shall be able to
- **state what is first aid**
- **list the key aims of first aid**
- **explain the ABC of the first aid**
- **brief how to give first-aid for a victim who need 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.
- **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.
- **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 more 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 cause 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 to do it. Hence moving a trauma victim, especially an unconscious one, needs very careful assessment. Removal 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 the 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.

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. But 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.

Declaring death

It is not correct to declare the victim's death at the accident site. It has to be done by qualified medical doctors.

How to report an emergency?

Reporting an emergency is one of those things that seems simple enough, until actually when put to use in emergency situations. A sense of shock prevail at the accident sites. Large crowd gather around only with inquisitive nature, but not to extend helping hands to the victims. This is common in road side injuries. No passer-by would like to get involved to assist the victims. Hence first aid management is often very difficult to attend to the injured persons. The first aiders need to adapt multi-task strategy to control the crowd around, communicate to the rescue team, call ambulance etc., all to be done simultaneously. The mobile phones helps to a greater deal for such emergencies. Few guidelines are given below to approach the problems.

Assess the urgency of the situation. Before you report an emergency, make sure the situation is genuinely urgent. Call for emergency services if you believe that a situation is life-threatening or otherwise extremely disruptive.

- A crime, especially one that is currently in progress. If you're reporting a crime, give a physical description of the person committing the crime.
- A fire - If you're reporting a fire, describe how the fire stated and where exactly it is located. If someone has already been injured or is missing, report that as well.
- A life-threatening medical emergency, explain how the incident occurred and what symptoms the person currently displays.
- A car crash - Location, serious nature of injures, vehicle's details and registration, number of people involved etc.

Call emergency service

The emergency number varies - 100 for Police & 101 Fire, 108 for Ambulance.

Fig 1

FI110311

Look, listen and feel for signs of breathing

Look for the victim's chest to raise and fall, listen for sounds of breathing.

If the victim is not breathing, see the section below

- If the victim is breathing, but unconscious, roll them onto their side, keeping the head and neck aligned with the body. This will help drain the mouth and prevent the tongue or vomit from blocking the airway.

Check the victim's circulation

Look at the victim's colour and check their pulse (the carotid artery is a good option; it is located on either side of the neck, below the jaw bone). If the victim does not have a pulse, start CPR.

Treat bleeding, shock and other problems as needed

After establishing that the victim is breathing and has a pulse, next priority should be to control any bleeding. Particularly in the case of trauma, preventing shock is the priority.

- **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.

Stay with the victim until help arrives

Try to be a calming presence for the victim until assistance can arrive.

Unconsciousness (COMA)

Unconscious also referred as Coma, is a serious life threatening condition, when a person lie totally senseless and do not respond to calls, external stimulus. But the basic heart, breathing, blood circulation may be still intact, or they may also be failing. If unattended it may lead to death.

The condition arises due to interruption of normal brain activity. The causes are too many.

- Shock (Cardiogenic, Neurogenic)
- Head injury (Concussion, Compression)
- Asphyxia (obstruction to air passage)
- Extreme of body temperature (Heat, Cold)
- Cardiac arrest (Heart attack)
- Stroke (Cerbro-vascular accident)
- Blood loss (Haemorrhage)
- Dehydration (Diarrohea & vomiting)
- Diabetes (Low or high sugar)
- Blood pressure (Very low or very high)

- Over dose of alcohol, drugs
- Poisoning (Gas, Pesticides, Bites)
- Epileptic fits (Fits)
- Hysteria (Emotional, Psychological)

The following symptoms may occur after a person has been unconscious:

- Confusion
- Drowsiness
- Headache
- Inability to speak or move parts of his or her body (see stroke symptoms)
- Light headedness
- Loss of bowel or bladder control (incontinence)
- Rapid heartbeat (palpitation)
- Stupor

First aid

- Call EMERGENCY number.
- Check the person's airway, breathing, and pulse frequently. If necessary, begin rescue breathing and CPR.
- If the person is breathing and lying on the back and after ruling out spinal injury, carefully roll the person onto the side, preferably left side. Bend the top leg so both hip and knee are at right angles. Gently tilt the head back to keep the airway open. If breathing or pulse stops at any time, roll the person on to his back and begin CPR.
- If there is a spinal injury, the victims position may have to be carefully assessed. If the person vomits, roll the entire body at one time to the side. Support the neck and back to keep the head and body in the same position while you roll.
- Keep the person warm until medical help arrives.
- If you see a person fainting, try to prevent a fall. Lay the person flat on the floor and raise the level of feet above and support.
- If fainting is likely due to low blood sugar, give the person something sweet to eat or drink when they become conscious.

DO NOT

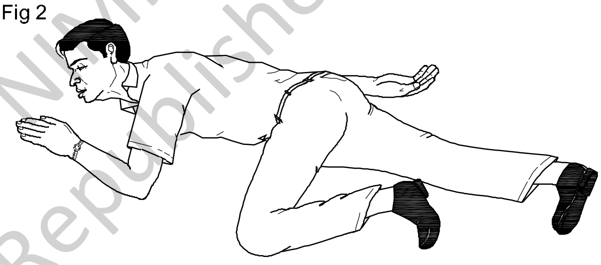
- Do not give an unconscious person any food or drink.
- Do not leave the person alone.
- Do not place a pillow under the head of an unconscious person.
- Do not slap an unconscious person's face or splash water on the face to try to revive him.

Loss of consciousness may threaten life if the person is on his back and the tongue has dropped to the back of the throat, blocking the airway. Make certain that the person is breathing before looking for the cause of unconsciousness. If the injuries permit, place the casualty in the recovery position with the neck extended. Never give anything by mouth to an unconscious casulaty.

How to diagnose an unconscious injured person

- Consider alcohol: look for signs of drinking, like empty bottles or the smell of alcohol.
- Consider epilepsy: are there signs of a violent seizure, such as saliva around the mouth or a generally dishevelled scene?
- Think insulin: might the person be suffering from insulin shock (see 'How to diagnose and treat insulin shock")?
- Think about drugs: was there an overdose? Or might the person have under dosed - that is not taken enough of a prescribed medication?

Fig 2



- Consider trauma: is the person physically injured?
- Look for signs of infection: redness and/ or red streaks around a wound.
- Look around for signs of Poison: an empty bottle of pills or a snakebite wound.
- Consider the possibility of psychological trauma: might the person have a psychological disorder of some sort?
- Consider stroke, particularly for elderly people.
- Treat according to what you diagnose.

Shock(Fig 3)

A severe loss of body fluid will lead to a drop in blood pressure. Eventually the blood's circulation will deteriorate and the remaining blood flow will be directed to the vital organs such as the brain. Blood will therefore be directed away from the outer area of the body, so the victim will appear pale and the skin will feel ice cold.

Fig 3

Artificial respiration

Objectives

On completion of this lesson you shall be able to

- **state the importance of respiration**
- **state occasions when artificial respiration becomes a necessity**
- **state the various methods of artificial respiration**
- **list the procedure to be followed in different methods of artificial respiration**
- **state the action to be taken to treat a victim with cardiac arrest**
- **state the important action to be taken when a patient recovers after undergoing artificial respiration.**

RESPIRATION

Respiration is an involuntary function of all living organisms. In human beings respiration involves breathing in and breathing out air. The air taken consists of oxygen which is made use of the lungs to purify the blood. If a person cannot breathe or stops breathing for any reason he will collapse in no time.

Artificial respiration

There are occasions when breathing/respiration becomes difficult or feeble in a person due to sickness, shock or accident. When breathing becomes feeble the person becomes unconscious. At this stage it is possible to improve the respiration by artificial means. This is known as artificial respiration.

In artificial respiration, air containing oxygen is forced into the lungs of the unconscious person so as to maintain the supply of oxygen to the body till the time the victim reaches the hospital/clinic for further treatment.

There are several methods by which artificial respiration can be given. Some of the well known methods are,

– HOLGEN-NELSON method

– SCHAFER'S method

– Mouth-to-mouth method.

Basically all these methods serve the same purpose and are equally good. Therefore the person/volunteer can adopt any one of the above methods in which he is trained and is confident. However, Nelson's method and Schafer's method should be avoided while giving artificial respiration to those patients who are suspected to have injuries in the chest wall and abdomen.

Each of the above said methods has a systematic procedure to be followed. These procedures are given below. A person must practise this procedure thoroughly before giving artificial respiration to a sick person. Any short cuts in the procedure is dangerous and may worsen the condition of the sick person instead of improving it.

NELSON's Method (Arm-lift back-pressure method)

PRECAUTION

Nelson's arm-lift back pressure method must not be used in case of suspected injuries to the chest wall or abdomen of the victim.

Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.

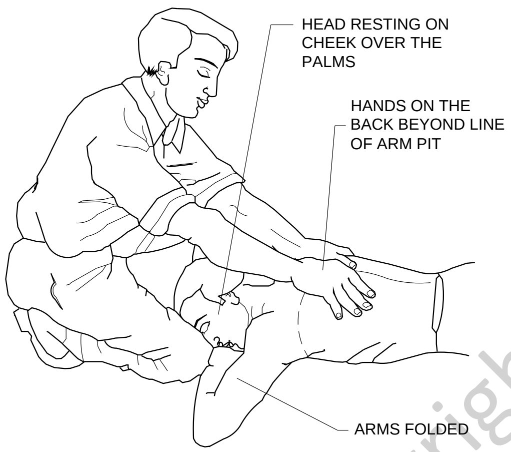
1 Loosen the clothing of the victim as tight clothing interferes with the victim's breathing.

2 Remove any foreign materials or false teeth from the victim's mouth, and keep the mouth open.

NOTE: Do not delay artificial respiration for loosening clothes or even if the mouth is closed tightly.

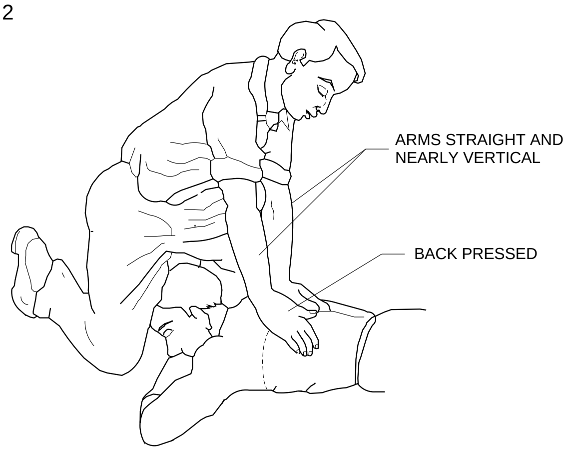
3 As shown in Fig 1, place the victim face down with his arms folded, palms one over the other and head resting on his cheek over the palms. Kneel on one or both knees at the victim's hand. Place your hands on the victim's back beyond the line of the armpits. Spread your fingers outwards and downwards with the thumbs just touching each other.

Fig 1



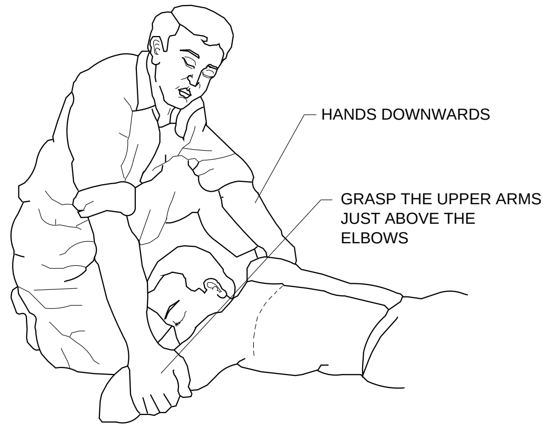
4 As shown in Fig 2, gently rock forward the arms keeping them straight until they are nearly vertical, and thus steadily pressing the victim's back as shown to force the air out of the victim's lungs.

Fig 2



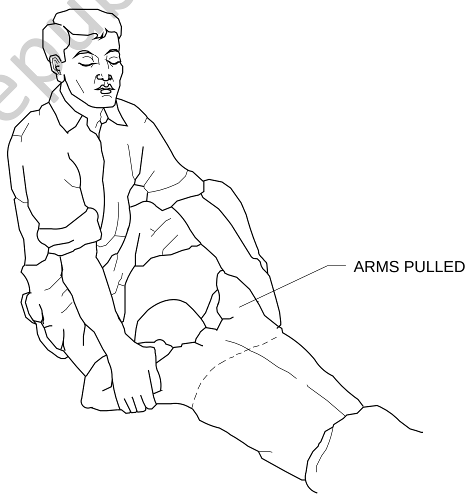
5 As shown in Fig 3, synchronizing the above movement rock backwards sliding your hands downwards along the victim's arms. Grasp his upper arm just above the elbows as shown.

Fig 3



6 Now rock backwards. As you rock backwards, gently raise and pull the victim's arms towards you as shown in Fig 4 until you feel tension in his shoulders. Remain in this position for a few seconds. To complete the cycle, lower the victim's arms and move your hands up to the initial position.

Fig 4



7 Repeat the cycles a few more times by following steps 3 to 6.

SCHAFER'S method

PRECAUTION

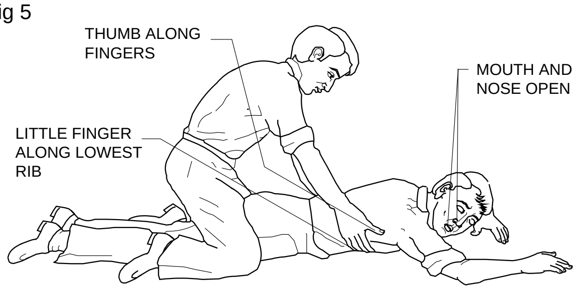
Do not use this method of artificial respiration in case the victim has injuries on his chest or abdomen.

Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.

1 Loosen the clothing of the victim as tight clothing interferes with the victim's breathing.

2 Lay the victim on his abdomen. Extend one arm directly forward, and the other arm bent at the elbow as shown in Fig 5. Keep the face turned sidewalk and resting on the hand or forearm as shown in Fig 5.

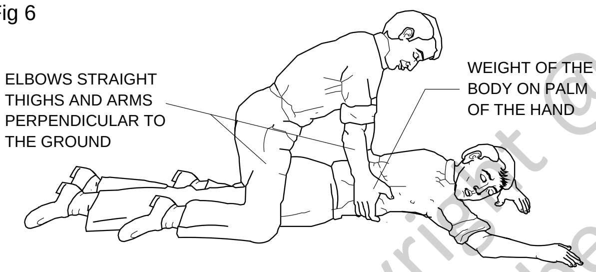
Fig 5



3 Kneel astride the victim as shown in Fig 5 such that his thighs are between your knees. Position your fingers and thumb as shown in Fig 5.

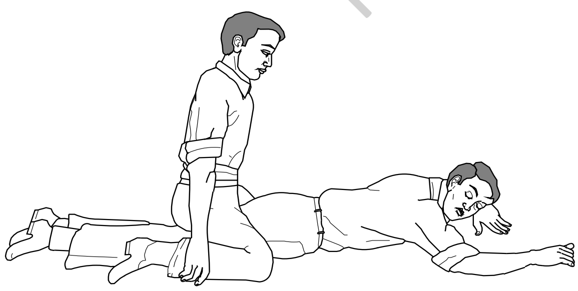
4 With the arms held straight, swing forward slowly so that the weight of your body is gradually applied on the lower ribs of the victim as shown in Fig 6. This weight force the air out of the victim's lungs.

Fig 6



5 Now swing backward immediately removing all pressure on the lower ribs as shown in Fig 7. This allows the lungs to get filled with air.

Fig 7



6 After two to three seconds, swing forward again and repeat the cycle (steps 4 and 5) twelve to fifteen times a minute.

Mouth-to-mouth method of artificial respiration

PRECAUTION

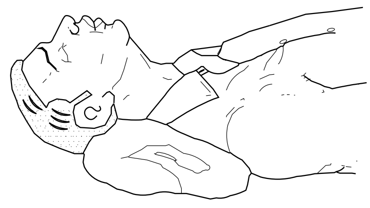
Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.

1 Loosen the clothing of the victim as tight clothing interferes with the victim's breathing.

2 Remove loose dentures or other obstructions from the mouth. Make sure that the victim's nose and mouth are clear.

3 Lay the victim flat on his back. Place a roll of clothing under his shoulders such that his head is thrown well back as shown in Fig 8.

Fig 8

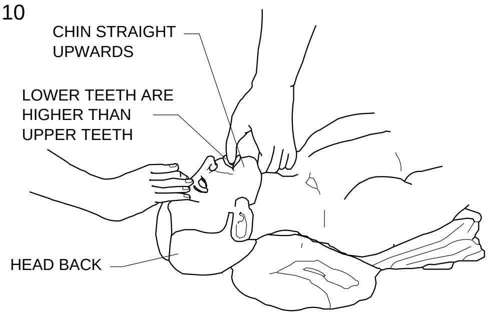


4 Tilt the victim's head back so that the chin points straight upward as shown in Fig 9.

Fig 9

5 Grasp the victim's jaw as shown in Fig 10, and raise it upward until the lower teeth are higher than the upper teeth. Maintain this position throughout the artificial respiration to prevent the tongue from blocking the air passage.

Fig 10



6 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 11 making airtight contact. Hold the victim's nose shut with the thumb and forefinger. Blow into the victim's mouth (gently in the case of infants) until his chest rises. Remove your mouth and release the hold on the victim's nose.

Fig 11

NOTE 1: If you dislike direct contact, place a porous cloth between your mouth and the victim's.

NOTE 2: If air cannot be blown in, check the position of the victim's head and jaw. Check the mouth for obstructions. Then try again blowing air more forcefully. If the chest still does not rise, turn the victim's face down and strike his back sharply to dislodge obstructions.

7 Let the victim exhale. Hear the out rush of air from the victim's mouth and nose.

Sometimes air enters the victim's stomach as evidenced by a swelling stomach. Expel the air by gently pressing the stomach during the exhalation period.

8 Repeat steps 6 and 7, eight to ten times rapidly. Then slow down to 10-12 times a minute. (20 times for infant)

Sometimes it may take hours for the victim to breathe normally. Continue giving artificial respiration till he recovers.

Mouth-to-nose method of artificial respiration

If the victim's mouth will not open, or has a blockage which you cannot clear then the mouth-to-nose method of providing artificial respiration should be followed. In this method use fingers of one hand to keep the victim's lips firmly shut. As shown in Fig 12 seal your lips around the victim's nostrils and blow air gently into his nose and suck back. Check if the victim's chest is rising and falling.

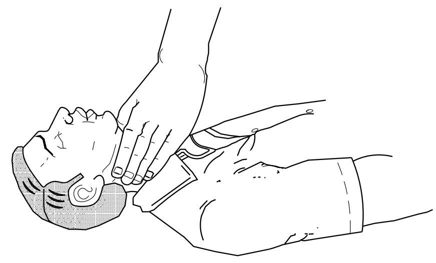
Fig 12

Artificial respiration in case of cardiac arrest

In the case of cardiac arrest where the heart has stopped beating, the following procedure has to followed. One must act immediately as any delay will reduce the chances of the patient's recovery.

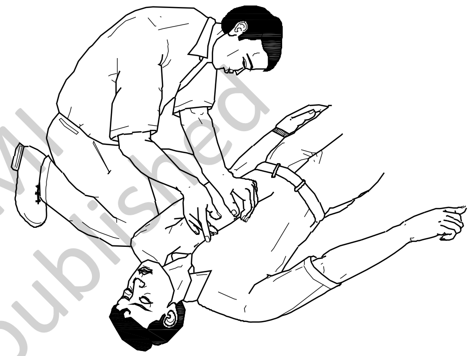
1 As shown in Fig 13, check if the carotid pulse in the neck can be felt. If the pulse is found feeble, go head with the following steps.

Fig 13



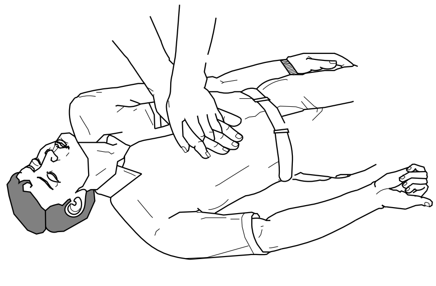
2 Lay the victim on his back on a firm surface. Kneel alongside as shown in Fig 14. Facing the chest, locate the lower part of the breastbone.

Fig 14



3 Place the palm of one hand on the centre of the lower part of the breastbone, keeping your fingers off the ribs. As shown in Fig 15, cover the palm with your other hand and lock your fingers together as shown.

Fig 15



4 Keeping your arms straight as shown in Fig 16, press sharply down on the lower part of the breastbone and release the pressure.

Fig 16

5 Repeat step 6, fifteen times at a rate of approximately one per second.

6 Recheck the carotid pulse as done in step 1, Fig 13.

7 Give two cycles of mouth-to-mouth artificial respiration as shown in Fig 17.

Fig 17

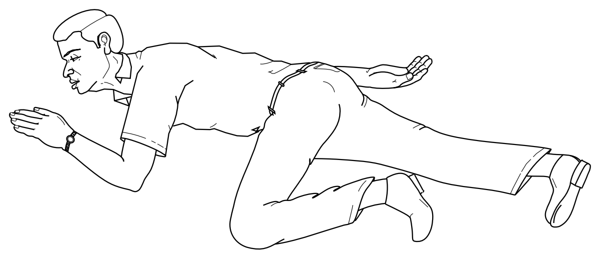
8 Give 10-15 more compressions of heart as done in step 5,7 and 6 follow it up with a further two cycles of mouth-to-mouth artificial respiration.

9 Checking for the carotid pulse. If the pulse is still feeble, repeat step 10 till the pulse improves.

10 As soon as the heartbeat returns, stop the compressions immediately and continue with mouth-to-mouth artificial respiration until natural breathing is fully restored.

11 Place the victim in the recovery position as shown in Fig 18. Keep him warm and get medical help quickly.

Fig 18



IMPORTANT POINTS TO NOTE AFTER GIVING ARTIFICIAL RESPIRATION TO VICTIMS

1 Even if the victim's breathing and heartbeat have recovered, do not delay in calling a doctor for a check up and treatment.

2 After the victim has recovered, keep the victim warm with a blanket, wrapped up with hot water bags. Stimulate circulation by stroking the insides of the arms and legs towards the heart.

3 When the victim revives, make him lie down. Do not let him exert himself as this may lead to a detorioration in his condition.

4 Do not give the victim any stimulant such as coffee, tea etc. until he is fully conscious.

Importance of house keeping introduction to '5s'

Objectives: At the end of this lesson you shall be able to
- **list the benefits of a shop floor maintanance**
- **state what is 5S**
- **list the benefits of 5S**

Benefits of a shop floor maintenance

Some of the benefits which may be derived from the utilization of a good Shop Floor Maintenance are as follows:

- Improved Productivity
- Improved operator efficiencies.
- Improved support operations such as replenishment moves and transportation of work in process and finished goods .
- Reduction of scrap
- Better control of your manufacturing process
- More timely information to assist shop floor supervisors in managing their assigned production responsiblities.
- Reduction of down time due to better machine and tool monitoring.
- Better control of Work In Progress inventory, what is is and where it is improved on time schedule performance.

5S Concept

5S is a Japanese methodology for workspace organisation. In Japanese it stands for seiri (SORT), seiton (SET), seiso (SHINE), seiketsu(STANDARDIZE), and shitsuke (SUSTAIN).

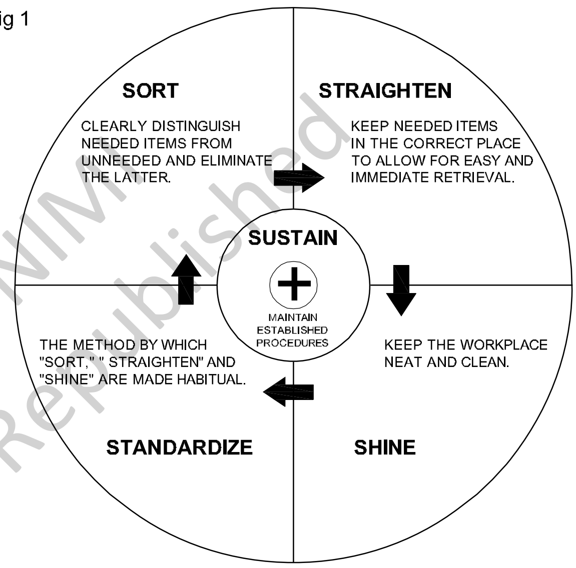
The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order.

5S Wheel

The Benefits of the '5s' system

- Increases in productivity
- Increases in quality
- Reduction in cost

Fig 1



5S WHEEL

Disposal of waste material

Objectives: At the end of this lesson you shall be able to
- **state what is waste material**
- **list the waste materials in a work shop**
- **explain the methods of disposal of waste material.**
- **state advantage of disposal of waste material.**

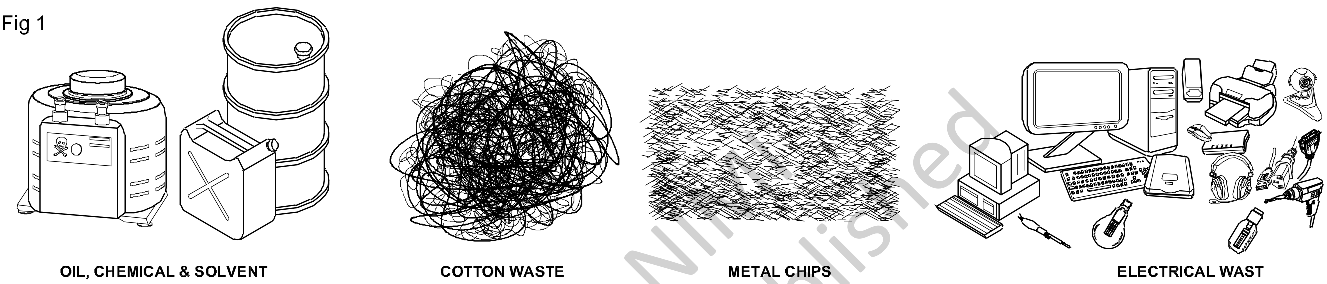
Waste material

Industrial waste is the waste produced by industrial activity, such as that of factories, mills and mines.

List of waste material (Fig 1)

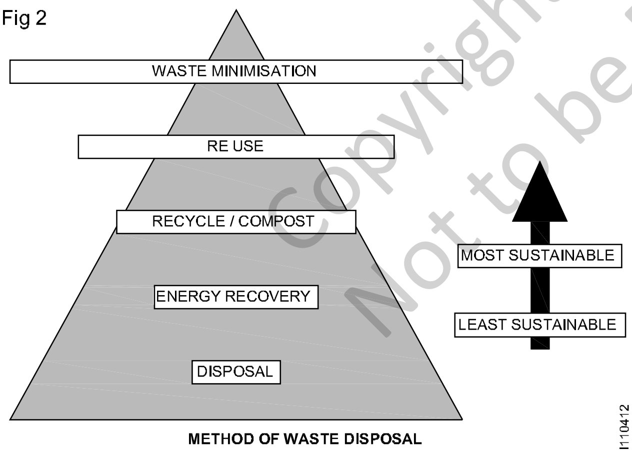
- Cotton waste
- Metal chips of different material.
- Oily waste such as lubricating oil, coolant etc.
- Other waste such as electrical, glass etc.

Fig 1



Methods of waste disposal

Fig 2



Recycling

Recycling is one of the most well known method of managing waste. It is not expensive and can be easily done by you. If you carry out recycling, you will save a lot of energy, resources and thereby reduce pollution.

Composting

This is a natural process that is completely free of any hazardous by-products. This process involves breaking down the materials into organic compounds that can be used as manure.

Landfills

Waste management through the use of landfills involves the use of a large area. This place is dug open and filled with the waste.

Burning the waste material

If you cannot recycle or if there are no proper places for setting up landfills, you can burn the waste matter generated in your household. Controlled burning of waste at high temperatures to produce steam and ash is a preferred waste disposal techinque.

Advantage of waste disposal

- Ensures workshop neat & tidy
- Reduces adverse impact on health
- Improves economic efficiency
- Reduce adverse impact on environment

Colour code for bins for waste segregation

Sl.no.	Waste Material	Color code
1	Paper	Blue
2	Plastic	Yellow
3	Metal	Red
4	Glass	Green
5	Food	Black
6.	Others	Sky blue

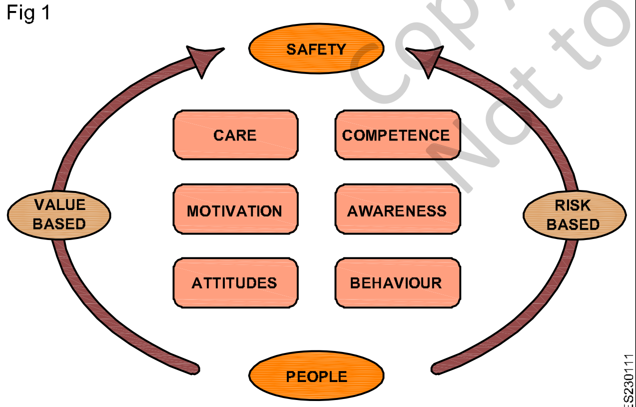
Occupational safety and health

Objectives: At the end of this lesson you shall be able to
- **define occupational safety and health**
- **state the importance of safety and health at workplace**
- **state the role of employer, trade union & employee for health & safety program.**

Occupational Safety and Health (OSH) is an area concerned with protecting the safety, health and welfare of people engaged in co-workers, family members, employees, customers , and many others who might be affected by the workspace environment.

Workspace safety : Owner/Occupier of industries have to comply with legal directions to take care for the safety, health and welfare of their employees. Equally the workers have moral responsibilities to follow all safety norms and healthy on the shop-floor. (Fig 1)

Fig 1



Occupational health : Health at work is also called occupational health. It is concerned with enabling an individual to undertake their day to day work fully knowing the health hazards they are exposed to and preventing them at the workspace.

Good safety and health practices can also reduce employee injury and illness related costs, including medical care, sick leave and disability benefit costs. (Fig 2)

Fig 2

The joint ILO/WHO committee on occupational health (1995) main focus in occupational health is on three different objectives :

(i) The maintenance and promotion of workers' health and working capacity.

(ii) The improvement of working environment and work to become conductive to safety and health.

(iii) Development of work organization and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings.

Employment and working conditions in the formal or informal economy embrace other important determinants, including working hours, salary, workspace policies concerning maternity leave, health promotion and protection provisions etc.

1 **Chemical hazards,** in which the body absorbs toxins.

2 **Ergonomic hazards,** in which the body is strained or injured, often over an extended period, because of the nature (design) of the task, its frequency, or intensity.

3 **Physical hazards,** in which the worker is exposed to harmful elements or physical dangers, such as heat or moving parts.

In the modern context, corporate management increasingly has viewed industrial safety measures as an investment - one that may save money in the long run by way of reducing disability pay, improving productivity and avoiding lawsuits.

Hazards and Avoidance

Objectives: At the end of this lesson you shall be able to
- **explain various occupational hazard**
- **state occupational hygiene**
- **describe occupational disease disorders and its prevention.**

All jobs, primarily provides many economic and other benefits, But equally there are a wide varieties of workplace dangers and hazards, which are risky to the health and safety of people at work.

Basic hazards :

Employers have a responsibility to protect workers against health and safety hazards at work. Workers have the right to know about potential hazards and to refuse work that they believe is dangerous. Workers also have a responsibility to work safely with hazardous materials. Health and Safety hazards exist in every workplace. Some are easily identified and corrected, while others create extremely dangerous situations that could be a threat to your life or long-term health. The best way to protect oneself is to learn to recognize and prevent hazards in the workplaces.

Physical hazards are the most common hazards and are present in most workplace at some point of time. Examples include; live electrical cords, unguarded machinery, exposed moving parts, constant load noise, vibrations, working from ladders, scaffolding or heights, spills, tripping hazards. Physical hazards are a common source of injuries in many industries. Noise and vibration, Electricity, Heat, Ventilation, Illumination, Pressure, Radiation etc.

- **Ventilation** and air circulation have major say on the health and working comfort of the worker. There must be good ventilation, a supply of fresh, clean air drawn from outside is required. It must be uncontaminated and circulated around the workspace. Closed of confined spaces also present a work hazard, which has limited openings for entry and exit and unfavorable natural ventilation, and which is not intended for continuous employee occupancy.

  Spaces of this kind can include storage tanks, ship compartments, sewers, and pipelines. Asphyxiation is another potential work hazard in certain situations. Confined spaces can pose a hazard not just to workers, but also to people who try to rescue them.

- **Noise and Vibration :** Noise and vibration are both fluctuations in the pressure of air (or other media) which affect the human body. Vibrations that are detected by the human ear are classified as sound. We use the term 'noise to indicate unwanted sound. Noise and vibration can harm workers when they occur at high levels, or continue for a long time. (Fig 1)

Fig 1

- **Electricity** poses a danger to many workers. Electrical injuries caused by contact with electric energy can be divided into four types
  - fatal electrocution,
  - electric shock,
  - burns,
  - falls .

Fig 2

  Wires and electrical equipment pose safety threats in the workspace. When employees mishandle electrical equipment and wires, they are taking risks. (Fig 2)

- **Temperature (Heat Stress) :** A reasonable working temperature, for strenuous work, local heating or cooling where a comfortable temperature is to be maintained which is safe and does not give off dangerous or offensive fumes, Thermal clothing and rest facilities where necessary (for example, for 'hot work' or work in cold storage areas). Sufficient space in workrooms etc. are under the legislation for implementation by the owner of the factories.

- **Illumination (lighting) :** Good lighting is essential for productivity Natural light is preferred where possible. Glare and flickering should be avoided.

HEAT EXHAUSTION/HEAT STROKE & TREATMENT

- NORMAL BODY CORE TEMPERATURE MINUS 37 °C
- HEAT EXHAUSTION SIMILAR SUGGESTION MINUS 38°C - 40°C
- HEAT STROKE 41°C AND HIGHER

SIGNS AND SYMPTOMS

HEAT EXHAUSTION	HEAT STROKE
• RESTLESS	• REDUCED LEVEL OF CONCIOUSNESS
• WEAK	• IRRITABLE
• DIZZY	• MUSCULAR PAIN
• RAPID PULSE	• RAPID PULSE
• LOW BLOOD PRESSURE	• HIGH BLOOD PRESSURE
• NAUSEA	• NAUSEA
• VOMITTING	• VOMITTING
• MENTAL STATUS - NORMAL	• MENTAL STATUS - CONFUSED
• BEHAVIOR - NORMAL	• BEHAVIOUR - ERRATIC
	• HOT, DAY, RED SKIN
	• DEATH

TREATMENT

• LAY PERSON DOWN & ELEVATE LEGS	• MOVE PERSON TO COOL VENTILATED AREA
• ENSURE NORMAL BREATHING	• CHECK FOR BREATHING, PULSE & CIRCULATION
• IF THIRSTY GIVE WATER TO DRINK	• IF POSSIBLE COVER THE PERSON WITH ICE PACKS OR COLD WATER TO REDUCE THE BODY TEMPERATURE
• REPORT INCIDENT TO SUPERVISOR	• GIVE WATER TO DRINK
	• MONITOR VITAL SIGNS
	• GET PERSON TO HOSPITAL
	• REPORT INCIDENT TO SUPERVISOR

Chemical hazards are present when you are exposed to any chemical preparation (solid, liquid or gas) in the workplace. Examples include: cleaning products and solvents, vapours and fumes, carbon monoxide or other gases, gasoline or other flammable materials. Chemicals hazards are the major causes of concern. Many chemicals are used not on generic names but on brands. The chemicals have biological effects on the human body if digested, inhaled or if direct skin contact with the chemicals, injuries occurs.

Accidents involving chemical spills, exposure and inhalation can lead to burns, blindness, rashes and other ailments. Most of them cause acute poisoning when taken orally, eye-skin irritation, Respiratory injuries etc. Long term effects of chemicals on blood, nerve, bones, kidneys, livers etc., may lead to serious diseases/disorders. The only way is to understand their chemical nature and handle them very carefully.

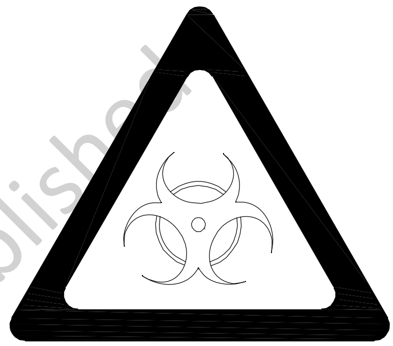
CHEMICAL POISONING

Poison : An agent or substances which may cause structural damage or functional disorders when introduced into the body by :

- **Ingestion**
- **Inhalation**
- **Absorption or**
- **Injection**

Biological hazards (Fig 3) come for working with people, animals or infectious plant material. Examples include; blood or other bodily fluids, bacteria and viruses, insect bites, animal and bird droppings. Biological hazards are due agent like bacteria, virus, fungi, mold, blood-borne pathogens etc., are main agents to cause various illness. (Fig 4)

Fig 3



BIOLOGICAL HAZARD

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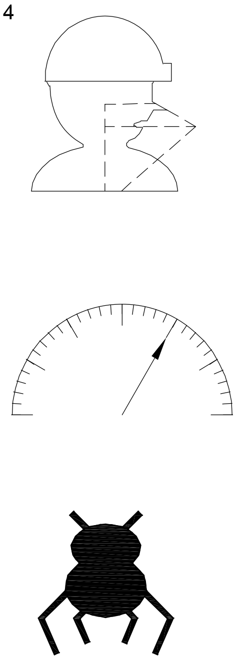
Fig 4



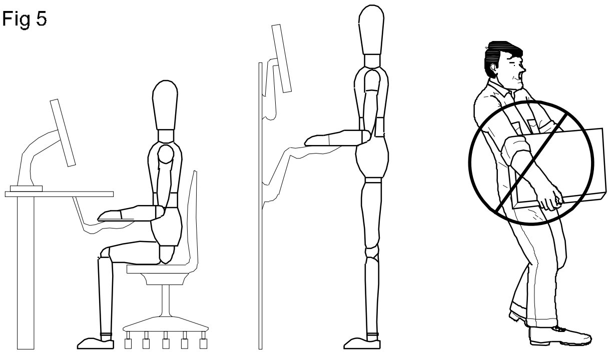
BIOLOGICAL HAZARD

ES230214

Ergonomic hazards (Fig 5)

Ergonomic hazards occur when the type of work you do, your body position and/or your working conditions put a strain on your body. They are difficult to identify because you don't immediately recognize the harm they are doing to your health. Examples include : poor lighting, improperly adjusted workstations and chairs, frequent lifting, repetitive or awkward movements. Musculo Skeletal Disorders (MSDs) affect the muscles, nerves and tendons. Work related MSDs are one of the leading causes injury and illness.

Fig 5



ERGONOMIC HAZARDS

ES230214

Workers in many different industries and occupations can be exposed to risk factors at work, such as lifting heavy items, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures and performing the same or similar tasks repetitively. Exposure to these known risk factors for MSDs increases a worker's risk of injury.

Mechanical hazards are factor arise out of varieties of machines in industries including manufacturing, mining, construction and agriculture. They are dangerous to the worker when operated without training and experience. Operating machines can be risky business, especially large, dangerous machines. When employees don't know how to properly use machinery or equipment, they risk such injuries as broken bones, amputated limbs and crushed fingers. Many machines involve moving parts, sharp edges, hot surfaces and other hazards with the potential to crush, burn, cut, shear, stab or otherwise strike or wound workers if used unsafely.

Various safety measures exists to minimize these hazards, lockout-tagout procedures for machine maintenance and roll over protection systems for vehicles. Machines are also often involved indirectly in worker deaths and injuries, such as in cases in which a worker slips and falls, possibly upon a sharp or pointed object. Safeguarding machinery decreases accidents and keeps employees who use the machine safer.

Falls (Fig 6) are a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance. Slips and falls to be the leading cause of workplace injuries and fatalities. From slippery surfaces to un-railed staircases, the possibility of slipping, tripping

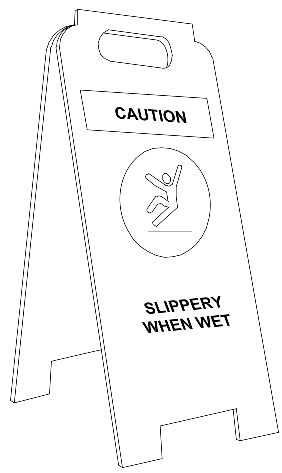
Fig 6

ES230215

or falling on the job is a workplace safety hazard. Broken bones, fractures, sprained wrists and twisted ankles constitute some of the physical injuries caused by falling accidents.

Falls in the workplace is effectively prevented by putting caution signs around slippery surfaces (Fig 7), having rails on every staircase and making sure that wires on the floor are covered to avoid tripping. They are perhaps unavoidable in certain industries, such as construction and mining, but over time people have developed safety methods and procedures to manage the risks of physical danger in the workplace. Employment of children may pose special problems.

Fig 7



CAUTION BOARD

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Psychosocial hazards : psychosocial hazards are related to the way work is designed, organized and managed, as well as the economic and social contexts of work and are associated with psychiatric, psychological and/or physical injury or illness. Linked to psychosocial risks are issues such as occupational stress and workplace violence which are becoming a major challenge to occupational health and safety.

Workplace inspections prevent hazards

Regular workplace inspections are another important factor in preventing injuries and illnesses. By critically examining all aspects of the workplace, inspections identify and record hazards that must be addressed and corrected.

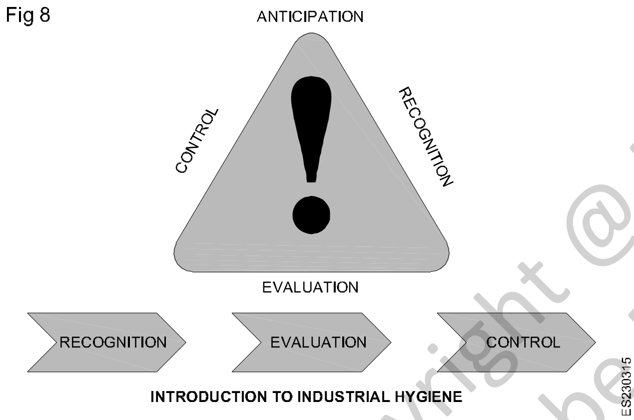
A workplace inspection should include

- Listening to the concerns of workers and supervisors.
- Gaining further understanding of jobs and tasks.
- Identifying existing and potential hazards.
- Determining underlying causes of hazards.
- Monitoring hazard controls (Personal protective equipment, engineering controls, policies, procedures)
- Recommending corrective action.

Occupational hygiene

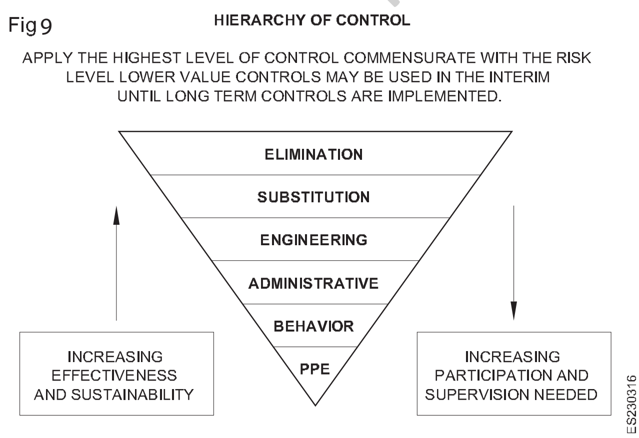
Occupational hygiene (Industrial hygiene) (Fig 8) is the discipline of anticipating, recognizing, evaluating and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large.

Fig 8



Occupational hygiene uses science and engineering to prevent ill health caused by the environment in which people work. It helps employers and employees to understand the risks and improve working conditions and working practices. (Fig 9)

Fig 9



Occupational disease/Disorders & its prevention

Occupational disease, illness incurred because of the conditions or environment of employment. Unlike with accidents, some time usually elapses between exposure to the cause and development of symptoms. In some instances, symptoms may not become evident for many years and hence the relationship between work and disease is ignored.

Among the environmental causes of occupational disease are subjection to extremes of temperature leading to heatstroke, air contaminants of dust, gas, fumes causing diseases of the respiratory tract, skin, or muscles and joints or changes in atmospheric pressure causing decompression sickness, excessive noise causing hearing loss, exposure to infrared or ultraviolet radiation or to radioactive substances. The widespread use of X rays, radium and materials essential to the production of nuclear power has led to an special awareness of the dangers of radiation sickness. Hence careful checking of equipment and the proper protection of all personnel are now mandatory.

In addition there are industries in which metal dusts, chemical substances, and unusual exposure to infective substances constitute occupational hazards. The most common of the dust and fiber inspired disorders are the lung diseases caused by silica, beryllium, bauxite and iron ore to which miners, granite workers and many others are exposed causing pneumoconiosis and those caused by asbestos is cancer - mesothelioma, Fumes, Smoke and Toxic liquids from a great number of chemicals are other occupational dangers. Carbon monoxide, Carbon tetrachloride, Chlorine, Creosote, Cyanides, Dinitrobenzene, Mercury, Lead Phosphorus and nitrous chloride are but a few of the substances that on entering through the skin, respiratory tract or digestive tract cause serious and often fatal illness.

Occupational hazards also are presented by infective sources. Persons who come into contact with infected animals in a living or deceased state are in danger of acquiring such diseases as anthrax. Doctors, Nurses and other hospital personnel are prime targets for the tuberculosis bacillus and for many other infectious organisms.

Basic provisions for OSH

Objectives: At the end of this lesson you shall be able to
- **state the basic provisions of safely, health, welfare under legislation of India.**

India has legislation on occupational health and safety for over 50 years. A safe and health work environment is the basic right of every worker. The constitutional provision for occupational safety and health under the Article 24 - No child below the age of fourteen years shall be employed to work in any factory or mine or engaged in other hazardous employment.

Article 39 (e & f) - The state shall in particular direct its policy towards securing.

e. That the health and strength of workers, men and women, and the tender age of children are not abused and that citizens are not forced by economic necessity to enter vocations unsuited to their age and strength.

f. That children are given opportunities and facilities to develop in healthy manner and in conditions of freedom and dignity and that childhood and youth are protected against exploitation and against moral and material abandonment.

Article 42 - The state shall make provision for securing just and human conditions of work and maternity relief.

National policy

Safety and health occupies a very significant position in India's constitution which prohibits employment of children under 14 in factories, mines and in hazardous occupations. Policy aims to protect the health and strength of all workers. It prevents employment in occupations unsuitable for the age and strength of the workers. It is the policy of the state to make provisions for securing just and humane conditions of work. The constitution provides a broad framework under which policies and programmes for occupational health and safety could be established.

National Legislation

Legislation provides an essential foundation for safety. To be meaningful and effective legislation should be reviewed and updated regularly as scientific knowledge develops.

The most important legislation cover occupational safety, health and welfare are :

- The Factories Act 1948. amended 1954, 1970, 1976, 1987.
- The Mines Act, 1952.
- The dock workers (safety, health and welfare) Act, 1986.
- The plantation labour Act, 1951.
- The Explosives Act, 1984.
- The Petroleum Act, 1934.
- The Insecticide Act, 1968.
- The Indian Boilers Act, 1923.
- The Indian Electricity Act, 1910.
- The Dangerous Machines (Regulations) Act, 1983.
- The Indian Atomic Energy Act, 1962.
- The Radiological Protection Rules, 1971.
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.

Occupational safety

At the end of this lesson you shall be able to
- **state the importance of safety**
- **list out the safety precautions to be observed in a machine shop**
- **list out the personal safety precautions to be observed**
- **list out the safety precautions to be observed while working on the machines.**

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 damage. To achieve this, it is essential that every person should follow safety procedures.(Fig 1)

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

General safety
Personal safety
Machine safety

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 authorised 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 spilt 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.

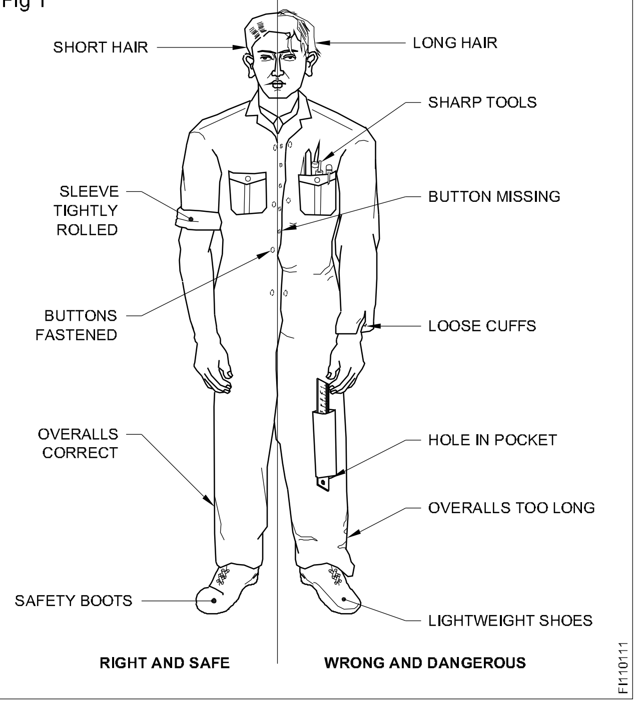
Personal safety

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 and goggles.
Cut the hair short.
Don't wear a ring, watch or chain.
Never lean on the machine.
Don't clean your 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 authorised electrician only.
Concentrate on your work.
Have a calm attitude.
Do things in a methodical way.
Don't engage yourself in conversation with others while concentrating on your job.
Don't distract the attention of others.
Don't try to stop a running machine with hands.

Fig 1

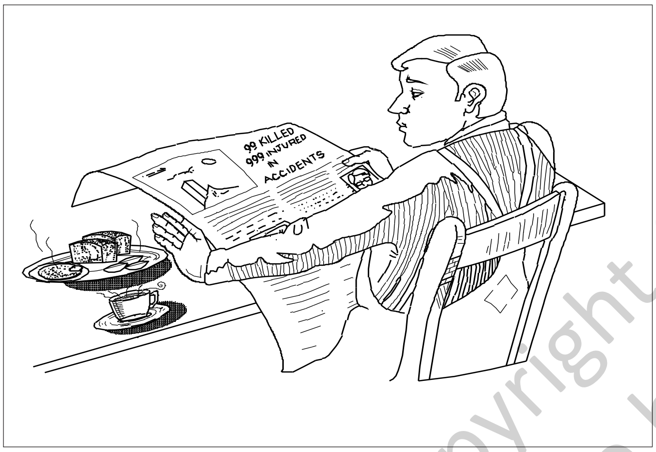


Occupational Safety

At the end of this lesson you shall be able to
- **state what an accident is**
- **state the causes for accidents in general terms**
- **state what is safety attitude**
- **identify the four basic categories of safety signs**.

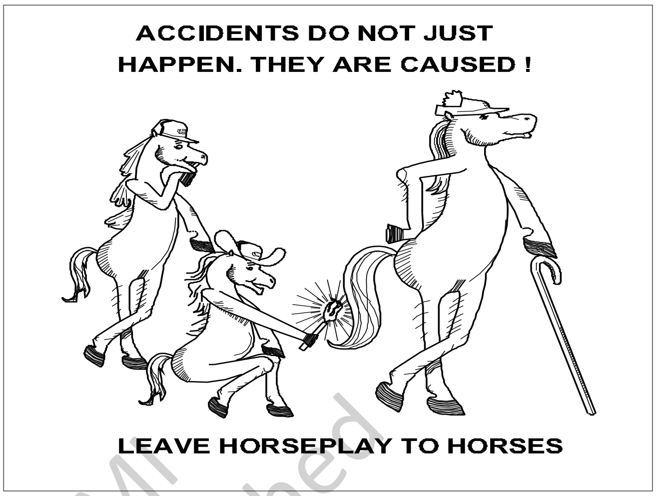
What is an accident?

Nobody deliberately has an accident; accidents occur due to causes which are not foreseen. Sometimes nothing can be done to prevent them from happening. For example, a part of a machine fails when nobody has any reason to think there is anything wrong with it, or the driver of a vehicle collapses at the wheel. Most accidents however occur as a result of human error of ignorance or neglect, forgetfulness or recklessness. These accidents can be prevented. If people had acted differently at some point, the event which we call an 'accident' would not have occurred.



Lots of accidents still happen every year killing a lot of people. Although most people are alarmed and horrified by this state of affairs, accidents continue to happen, costing the industry millions of rupees every year. Older workers who have come to terms with the dangers, young workers who may be reckless, employers who turn a blind eye to the possibility of things going wrong - because they want to get the job done, all these factors contribute to this senseless waste. Fortunately there are many who do not take this view. They have a different attitude to safety - and 'attitude' is an all-important factor in the chain of events which leads to someone causing, being involved in or becoming the victim of an 'accident'.

Causes for accidents



Normally accidents do not just happen. They are caused.

Causes for accidents are many. Some of the important causes are listed below.

Unawareness of danger
Disregard for safety
Negligence
Lack of understanding of proper safety procedures
Untidy condition of work place
Inadequate light and ventilation
Improper use of tools
Unsafe conditions

Safety attitudes

People's attitudes govern what they do or fail to do. In most cases where someone is working with unsafe equipment or in an unsafe situation, somebody has allowed that state of affairs to come about by something they have done or failed to do.

Most accidents don't just happen; they are caused by people who (for example) damage equipment or see it is faulty but don't report it, or leave tools and equipment lying about for other people to trip over. Anybody who sees a hazard and does nothing about it is contributing to the possibility of an accident. A worker doesn't necessarily need to do anything to help bring about an accident; just going mindlessly about his work may be enough to ensure a workmate being crippled for life. He didn't do it - but by proper and timely thinking and acting, he could have prevented it.

RESPONSIBILITIES

Safety doesn't just happen - it has to be organised and achieved like the work-process of which it forms a part. The law states that both an employer and his employees have a responsibility in this behalf.

Employer's responsibililties

The effort a firm puts into planning and organising work, into training people, into engaging skilled and competent workers, maintaining plant and equipment, and checking, inspecting and keeping records - all of this contributes to the safety in the workplace.

The employer will be responsible for the equipment provided, the working conditions, what the employees are asked to do, and the training given.

Employee's responsibilities

You will be responsible for the way you use the equipment, how you do your job, the use you make of your training, and your general attitude to safety.

A great deal is done by employers and other people to make your working life safer; but always remember you are responsible for your own actions and the effect they have on others. You must not take that responsibility lightly.

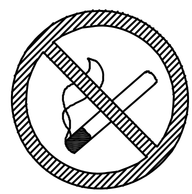
Rules and procedures at work

What you must do, by law, is often included in the various rules and procedures laid down by your employer. They may be written down, but more often they not, are just the way a firm does things - you will learn these from other workers as you do your job. They may govern the issue and use of tools, protective clothing and equipment, reporting procedures, emergency drills, access to restricted areas, and many other matters. Such rules are essential; they contribute to the efficiency and safety of the job.

Safety signs fall into four separate categories. These can be recognised 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.

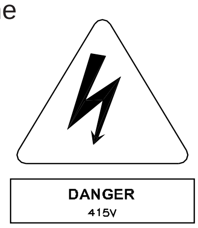


SHAPE Circular.
COLOUR Red border and cross-ba
Black symbol on
white background.
MEANING Shows it must not be done
Example No smoking

Prohibition signs

Mandatory signs

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



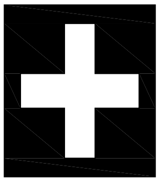
SHAPE Triangular.
COLOUR Yellow background with black border and symbol

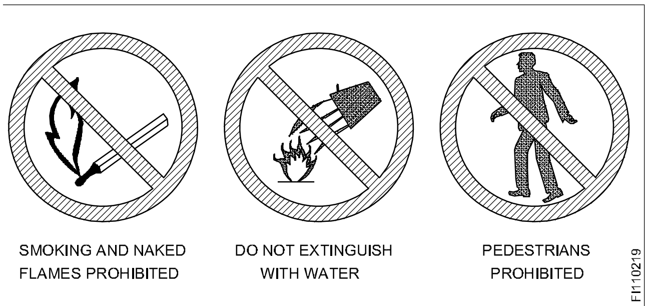
MEANING Warns of hazard or dang
Example Caution, risk of electric shock.

Warning signs

Information signs

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





Questions about your safety

Do you know the general safety rules that cover your place of work?

Are you familiar with the safety laws that govern your particular job?

Do you know how to do your work without causing danger to yourself, your workmates and the general public?

Are the plant, machinery and tools that you use really safe? Do you know how to use them safely and keep them in a safe condition?

Do you wear all the right protective clothing, and have you been provided with all the necessary safety equipment?

Have you been given all the necessary safety information about the materials used?

Have you been given training and instruction to enable you to do your job safely?

Do you know who is responsible for safety at your place of work?

Do you know who are the appointed 'Safety Representatives'?

Electrical Safety

Objectives: On completion of this lesson you shall be able to
- **State prevention of electrical accidents**
- **State the meaning of electric shock**
- **State the severity of shock based on the voltage level**
- **Rescue a person who is in contact with a live wire**
- **Treat a person for electric shock/injury**
- **State the response to emergency during power failure.**

Prevention of electrical accidents

1 Have only licensed electricians should install, repair and dismantle job site wiring.

2 Always plug in to a ground fault circuit interupter protection.

3 Check each extension cord before use.

4 Do a through check for electrical wiring before cutting through any wall, floor or ceiling.

5 Inspect power tools on a regular basis.

6 Check insulated tools for damage before each use

7 Never modify electrical plugs.

8 Keep extension cords in a safe place where they won't be stepped on or driven over.

9 Ensure that all electrical components stay dry.

10 Use the right extension cord for the job.

Electric shock

If a person happens to come in contact with an electrical live wire and if he has not insulated himself, then electric current flows through his body. Since the human body cannot withstand current flow more than a few tens of milliamps, the human body suffers a phenomenon generally known as **electric shock.** Electric shock may turn out to be hazardous to some of the parts of the human body and some times even to the life of the person.

The severity of an electric shock depends on:

- the level of current passing through the body
- how long does the current keep passing through the body.

Therefore, the higher the current or longer the time, the shock may result in a causality.

In addition to the above factors, other factors which influences the severity of shock are:

- age of the person receiving a shock
- surrounding weather condition
- condition of the floor (wet or dry)
- voltage level of electricity
- insulating property of the footwear or wet footwear, and so on.

Effects of electric shock

The effect of electric shock at very low voltage levels (less than 40 V) may only be an unpleasant tingling sensation. But this shock itself may be sufficient to cause someone to lose his balance and fall, resulting in casualty.

At higher voltage levels the muscles may contract and the person will be unable to break off from the contact by himself. He may lose consciousness. The muscles of the heart may contract spasmodically (fibrillation). This may even turn out to be fatal.

At an excessive level of voltage, the person receiving a shock may be thrown off his feet and will experience severe pain and possibly burns at the point of contact. This in most cases is fatal.

Electric shock can also cause burning of the skin at the point of contact.

Action to be taken in case of an electric shock

If the victim of an electric shock is in contact with the supply, break the contact the victim is making with the electricity by any one or more of the following.

- Switch off the electric power,insulate yourself and pull away the person from the electrical contact

OR

Remove the mains electric plug. Avoid direct contact with the victim. Wrap your hands using dry cloth or paper, if rubber gloves are not available.

OR

Remove the electric contact made by wrenching the cable/equipment/point free from contact using whatever is at hand to insulate yourself such as a wooden bar, rope, a scarf, the victim's coat-tails, any dry article of clothing, a belt, rolled up newspaper, non-metallic hose, PVC tubing, baked paper, tube etc. and break the contact by pushing or pulling the person or the cable/equipment/point free

OR

Stand on some insulating material such as dry wood, rubber or plastic, or whatever is at hand to insulate yourself and break the contact by pushing or pulling the person or the cable/equipment/point free.

If you are uninsulated, do not touch the victim with your bare hands. Otherwise you also will get a shock and become a victim.

If the victim is aloft(working on a pole or at raised place), take suitable measures to prevent him from falling or atleast ensure that his fall is safe.

Treatment to be given for the victim of electric shock

Electric burns on the victim may not look big/large. But it may be deep rooted. Cover the burnt area with a clean, sterile dressing. Get a doctor's help to treat him as quickly as possible.

If the victim is unconscious after an electric shock, but is breathing, carry out the following first aid:

- loosen the clothing at the neck, chest and waist
- place the victim in the recovery position as shown in Fig 1.
- Keep a constant check on the breathing and pulse rate. If you find them feeble, immediately give artificial respiration and press the lower rib to improve the heartbeat.
- Keep the casualty warm and comfortable.
- Send for a doctor immediately.

The severity of an electric shock will depend on the level current which passes through the body and the length of time of contact. Do not delay, act at once. Make sure that the electric current has been disconnected.

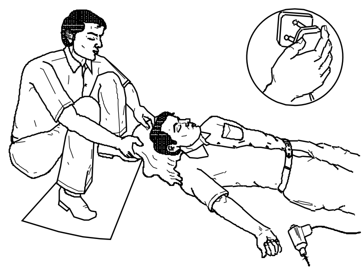
If the casually is still in contact with the supply - break the contact either by switching off the power, removing the plug or wrenching the cable free. If not, stand on some insulating material such as dry wood, rubber or plastic, or using whatever is at hand to insulate yourself and break the contact by pushing or pulling the person free. (Figs 1 & 2)

Fig 1

If you remain un-insulated, do not touch the victim with your bare hands until the circuit is made dead or he is moved away from the equipment.

If the victim is aloft, measures must be taken to prevent him from falling or atleast make him fall safe.

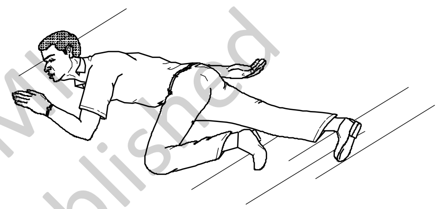
Fig 2



Electric burns on the victim may not cover a big area but may be deep seated. All you can do is to cover the area with a clean, sterile dressing and treat for shock. Get expert help as quickly as possible.

If the casualty is unconscious but is breathing, loosen the clothing about the neck, chest and waist and place the casualty in the recovery position. (Fig 3)

Fig 3



Keep a constant check on the breathing and pulse rate.

keep the casualty warm and comfortable. (Fig 4)

Fig 4

Send for help.

Do not give an unconscious person anything through the mouth.

Do not leave an unconscious person unattended.

A person having received electric shock may also have burn injuries. DO NOT waste time by applying first aid to the burns until breathing has been restored and the patient can breathe normally unaided.

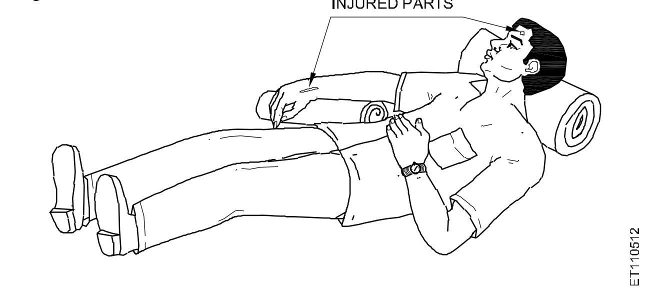
Treatment to be given in case of burns, severe bleeding

Burns caused due to electrical shock are very painful. If a large area of the body is burnt, clean the wound using clear water, or with clean paper, or a clean shirt. This treatment relieves the victim of pain. Do not give any other treatment on your own. Send for a doctor for further treatment.

A wound which is bleeding profusely, especially in the wrist, hand or fingers must be considered serious and must receive a doctor's attention. As an immediate first aid measure, carry out the following;

- make the patient lie down and rest
- if possible, raise the injured part above the level of the body as shown in Fig 2.

Fig 2



Squeeze together the sides of the wound as shown in Fig 3. Apply pressure as long as it is necessary to stop the bleeding.

When the bleeding stops temporarily, put a dressing over the wound using sterilized cotton, and cover it with a pad of soft material as shown in Fig 4.

If the wound is in the abdominal area (stab wound), caused by falling on a sharp tool, keep the patient bending over the wound to stop internal bleeding.

Fig 3

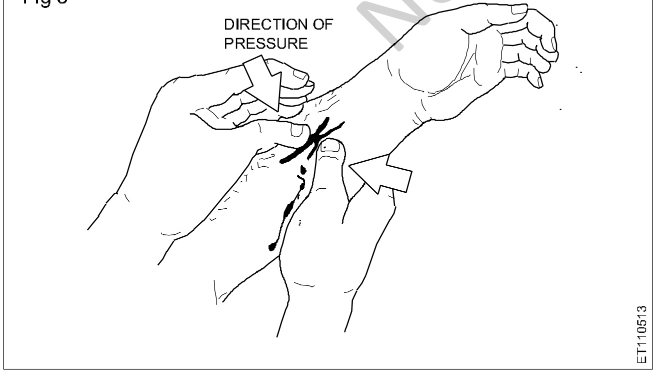
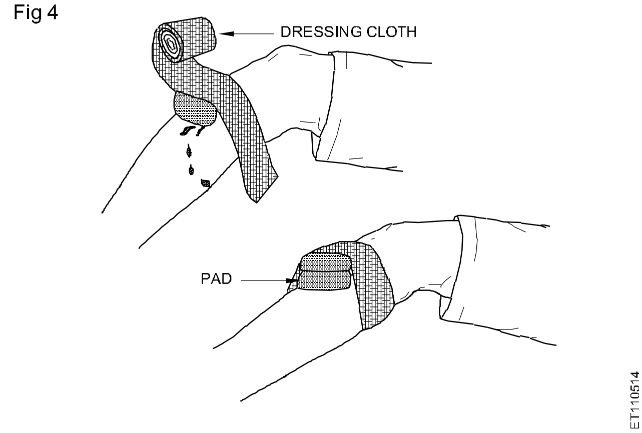


Fig 4



General procedural steps to be adopted for treating a person suffering from an electrical shock

1 Observe the situation. Choose the appropriate method(listed in earlier paragraphs) to release the person from electrical contact.

Do not run to switch off the supply that is far away or start searching for the mains switch.

2 Move the victim gently to the nearest ventilated place.

3 Check the victim's breathing and consciousness. Check if there are injuries in the chest or abdomen. Give artificial respiration/applying pressure on the heart if found necessary (refer to Lesson/Exercise 1.1.01).

Use the most suitable method of giving artificial respiration depending upon the injuries if any on the chest/abdomen.

4 Send for a doctor.

Till the doctor arrives, you stay with the victim and render help as best as you can.

5 Place the victim in the recovery position.

6 Cover the victim with a coat, socks or any such thing to keep the victim warm.

Actions listed above must be taken sys - tematically and briskly. Delay in treating the patient may endanger his life.

Response to emergency during power failure

Power failure may damage sensitive equipments or experiments. However sensitive electronic equipments, instruments and computer should be shut down before a planned outage.

In a power failure, equipment on emergency power will have power supplied to it by theemergency generator.

- Turn off lights and equipment that do not need power
- Check of your cold room is on emergency power if not, move temperature sensitive materials (or) arrange for a dry ice delivery.

- A disruption may damage computers, equipments or instruments with automatic resets or logic functions. Turn these off if it is not essential for continous operation. Back up computers routinely.
- Designate an emergency contact for the Manager or coordinator. Services to contact you for your information in the event of an unexpected shutdown.
- Even when using a surge protector, make sure the electrical load is not too much for the circuit.
- Avoid over loading outlets with too many appliances

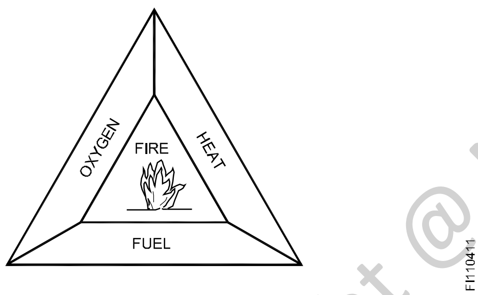
Fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **state the effects of a fire breakout**
- **state the causes for fire in the workshop**
- **state the conditions required for combustion relevant to fire prevention**
- **state the general precautionary measures to be taken for fire prevention.**

Fire is the burning of combustible material. A fire in an unwanted place and on an unwanted occasion and in uncontrollable quantity can cause damage or destroy property and materials. Fires injur people, and sometimes, cause loss of life. Hence, every effort must be made to prevent fire. When a fire outbreak is discovered, it must be controlled and extinguished by immediate correct action.

Is it possible to prevent fire? Yes, by eliminating anyone of the three factors that cause fire. (Fig 1)

Fig 1



The factors that must be present in combination for a fire to continue to burn are as follows.

Fuel Any substance, liquid, solid, or gas will burn if given oxygen and high enough temperature.

Heat Every fuel will begin to burn at a certain temperature. Solids and liquids give off vapour when heated and it is this vapour which ignites. Some liquids give off vapour even at normal room temperature say 15°C, eg. petrol.

Oxygen Usually it exists in sufficient quantity in air to keep a fire burning.

EXTINGUISHING OF FIRES

Isolating or removing any of these factors from the combination will extinguish the fire. There are three basic ways of achieving this.

- Starving the fire of fuel by removing the fuel in the vicinity of fire.
- Smothering - i.e. by isolating the fire from the supply of oxygen by blanketing it with foam, sand etc.
- Cooling - i.e. by using water to lower the temperature.

Preventing fires

The majority of fires begin with small outbreaks which burn unnoticed until they become big fires of uncontrollable magnitude. Most of the fires could be prevented with more care and by following some rules of simple common sense.

Accumulation of combustible refuse (cotton waste soaked with oil, scrap wood, paper, etc.) in odd corners are of fire risk. Refuse should be removed to collection points.

The cause of fire in electrical equipment is misuse or neglect. Loose connections, wrongly rated fuses or cables, overloaded circuits cause over heating which may in turn lead to fire. Damage to insulation between conductors in cables also causes fire.

Clothing and anything else which might catch fire should be kept well away from heaters. Make sure the heater is shut off at the end of a working day.

Highly flammable liquids and petroleum mixtures (Thinner, Adhesive solutions, Solvents, Kerosene, Spirit, LPG Gas etc.) should be stored in a separate place called the flammable material storage area.

Blowlamps and torches must not be left burning when they are not in use.

Classification of fires and recommended extinguishing agents.

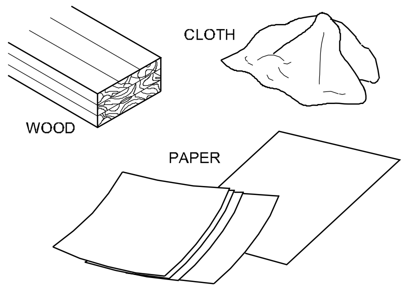
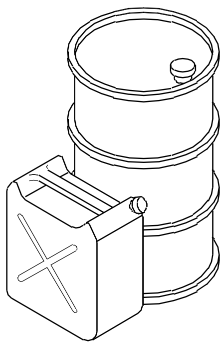
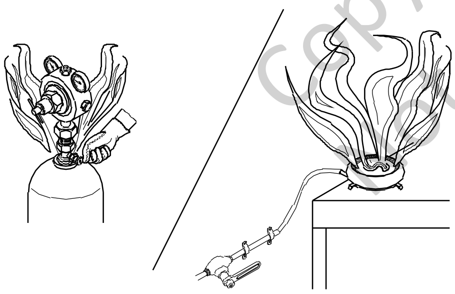
Fires are classified into four types in terms of the nature of fuel.

Different types of fire have to be dealt with different ways and with different extinguishing agents.

An agent is the material or substance used to put out the fire, and is usually (but not always) contained in a fire extinguisher with a mechanism for spraying into the fire.

It is important to know the right type of agent for a particular type of fire; using the wrong one can make things worse.

There is no classification for 'electrical fires' as such, since these are only fires in materials where electricity is present.

Fuel	Extinguishing
CLASS 'A' Fire — Wood, paper, cloth etc. Solid materials. 	Most effective i.e. cooling with water. Jets of water should be sprayed on the base of the fire and then gradually upwards.
CLASS 'B' Fire — Flammable liquids & liquifiable solids 	Should be smothered. The aim is to cover the entire surface of the burning liquid. This has the effect of cutting off the supply of oxygen to the fire. Water should never be used on burning liquids. Foam, dry powder or CO_2 may be used on this type of fire.
CLASS 'C' Fire — Gas and liquified gas 	Extreme caution is necessary in dealing with liquified gases. There is a risk of explosion and sudden spreading of fire in the entire vicinity. If an appliance fed from a cylinder catches fire - shut off the supply of gas. The safest course is to raise an alarm and leave the fire to be dealt with by trained personnel. Dry powder extinguishers are used on this type of fire. Special powders have now been developed which are capable of controlling and/ or extinguishing this type of fire.
CLASS 'D' Fire — Involving metals 	The standard range of fire extinguishing agents is inadequate or dangerous when dealing with metal fires. Fire on electrical equipment. Carbon dioxide, dry powder and vapourising liquid (CTC) extinguishers can be used to deal with fires in electrical equipment. Foam or liquid (e.g. Water) extinguishers must not be used on electrical equipment under any circumstances.

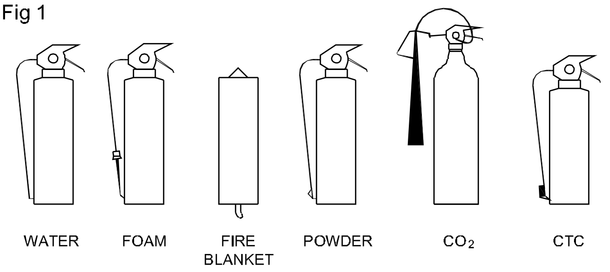
Types of fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **distinguish different types of fire extinguishers**
- **determine the correct type of fire extinguisher to be used based on the class of fire**
- **describe the general procedure to be adopted in the event of a fire.**

A fire extinguisher, flame extinguisher or simply extinguisher is an active fire protection device used to extinguish or control small fires, often in emergency situation. It is not intended for use on an out off control fire.

Many types of fire extinguishers are available with different extinguishing 'agents' to deal with different classes of fires. (Fig 1)

Fig 1

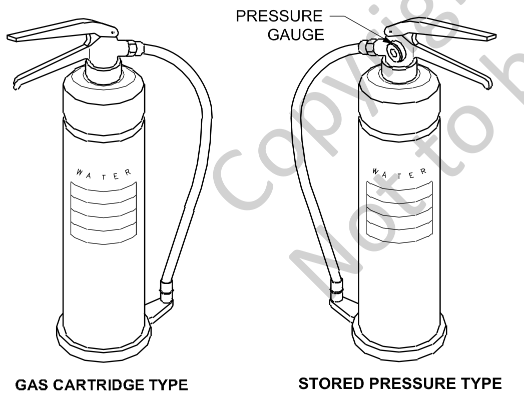


Water-filled extinguishers

There are two methods of operation. (Fig 2)

- Gas cartridge type
- Stored pressure type

Fig 2



With both methods of operation the discharge can be interrupted as required, conserving the contact and preventing unnecessary water damage.

Foam extinguishers (Fig 3)

These may be of stored pressure or gas cartridge types.

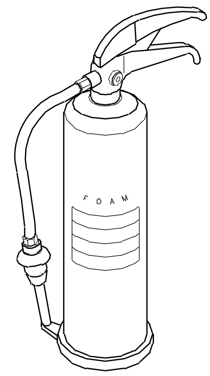
Always check the operating instructions on the extinguisher before use.

Foam extinguishers are most suitable for:

- flammable liquid fires
- running liquid fires

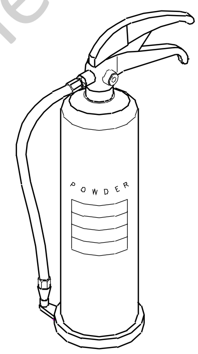
Must not be used where electrical equipment is involved.

Fig 3



Dry powder extinguishers (Fig 4)

Fig 4

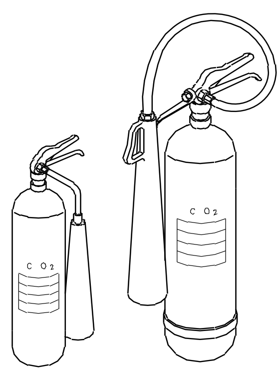


Extinguishers fitted with dry powder may be of the gas cartridge or stored pressure type. Appearance and method of operation is the same as that of the water-filled one. The main distinguishing feature is the fork-shaped nozzle. Powders have been developed to deal with class D fires.

Carbon dioxide (CO_2)

This type is easily distinguished by the distinctively shaped discharge horn. (Fig 5)

Fig 5

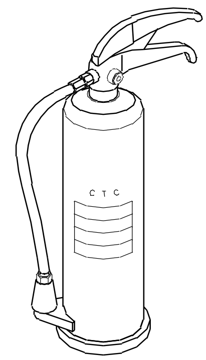


Suitable for class B fires. Best suited where contamination by deposits must be avoided. Not generally effective in open air.

Always check the operating instructions on the container before use. Available with different gadgets of operation such as - plunger, lever, trigger etc.

Halon extinguishers (Fig 6)

Fig 6



Theses extinguishers may be filled with carbon tetrachloride and bromochlorodifluoro methene (BCF). They may be of either gas cartridge or stored pressure type.

They are more effective in extinguishing small fires involving pouring liquids. These extinguishers are particularly suitable and safe to use on electrical equipment as the chemicals are electrically non-conductive.

The fumes given off by these extinguishers are dangerous, especially in confined space.

General procedure to be adopted in the event of a fire to be adopted.

- Raise an alarm.
- Turn off all machinery and power (gas and electricity).
- Close the doors and windows, but do not lock or bolt them. This will limit the oxygen fed to the fire and prevent its spreading.
- Try to deal with the fire if you can do so safely. Do not risk getting trapped.
- Anybody not involved in fighting the fire should leave calmly using the emergency exits and go to the designated assembly point. Failure to do this may mean that some person is unaccounted for and others may have to put themselves to the trouble of searching for him or her at risk to themselves.

Response to emergency during Fire

1. Inform people in the immediate area to evacute .
2. Activate the nearest building fire alarm.
3. Call if safe to do so. Otherwise evacuate the building and call from other side the building.
4. If the fire is small and you have been trained to use a fire extinguisher, you may attempt to extinguish the fire, make sure that you have a safe exit from the fire area and use the buddy system.
5. To use a fire extinguisher, remember the acronym pass
   - Pull the pin
   - Aim the extinguisher at the base of the fire
   - Squeeze the handle
   - Sweep the extinguisher from side to side.
6. Evacutates the building as soon as the alarm sounds and proceed to designated evacuation meeting point.
7. On your way out, warn others near by.
8. Move away from fire and smoke close doors and win dows if time permits.
9. Don't touch and open /close doors if it is hot.
10. If doors are hot, place a wet cloth at the base to keep smoke from entering.
11. Use stairs only. Do not use elevators.
12. Move well away from the building and go to your designated meeting point.
13. Do not reenter the building or work area untill you have been instructed to do by the emergency responders.

Response to emergency during system failure:

Emergency guide outlines procedure and actions for managing major emergencies that may threaten the health and safety of the compus community or disrupt its programs and activities. The guide identified individuals that are responsible for emergency response and critical support services.

A work place emergency is an unforeseen situation that threatens employees or customersdisrupt or shut down operations or causes physical or environmental damage.

The committee's main responsibility is to manage and deal with any emergency or disastrous situation. The committee consists of faciity and admin staff from different departments can form other sub committees or an emergency response team in case of necessities.

Each department should nominate a per or term to act / follow the guidelines framed with respect their areas.

Certain exercises like evacuation, security, safety, fire medical, transportation etc.

The exercise includes:

– Rescuse persons who are in immediate danger.
– Pull the nearest fire alarm.
– Inform security personal.
– Evacuate the building using the nearest exit.
– Account for all staff with service and security respresentative.
– Document the situation, what happened and the out come.

The emergency team's main responsibility is to manage and deal with any critical situations.

Precaution to follow while working fitting job

Objectives: At the end of this lesson you shall be able to
- list precaution to follow while working fitting job.

Fitting is the assembling to gether of parts and removal of metal to secure necessary fit. Following safety measures need to be taken in fitting workshop.

1. Files must have well fitted with handle.
2. See that work pieces is perfectly clamped or fixed in the vice.
3. Never use hammer with loose/mush room splint heads.
4. Select suitable weight of the hammer for the work.
5. Check the hammer head and handle whether any crack is there.
6. Ensure that the face of the hammer is free from oil or grease
7. Use the right tools for the operation performed.
8. Do not use a spanner as a hammer.
9. Do not use a steel rule as a screw driver.
10. Use the coolant at the time of hack shaving and drillling.
11. Keep the work place neat and clean after work.

Precaution to follow while working fitting job

Objectives: At the end of this lesson you shall be able to
- Safe uses of hand tools
- Safe uses of machinary & equipents

Name of the tools	Safety
Hammer	Select correct weight of hammer for particular work, check the handle defects. Do not use ashroomhead hammer. Select the suitable hammer (ball peen/cross/ straight) for the appropriate work.
Scriber	Do not use blunded point. Place a cork on the point when not in use to prevent accidents.
Hacksaw frame	Do not use without handle Tight the hack saw blades with correct tension. While selecting blodes, make sure atleast two teeth of the blades will be in contact with the work at all times.
Cutting plier	To use insulated cutting plier for electrical work.
Screw driver	Select the suitable screw driver to suit screw head.
Vernier Caliper	Do not place with other hand tools. After the work clean and apply film of oil. Check jaws butting and '0' of main scale and vernier scale matching.
Micro meter	Before measuring clean the measuring surface. Do not mix with other tools. Find and note the'Zero' error before use.
Swage block	Do not give heavy blows on the edge or corners of the swage block without poper handle of swages and flatters should be fitted firmly for safe working.
Punch and drift	For retaining the hardness and original shape of punches and drifts, they should be frequenctly cooled in water. Handle must be secured rigidly so that the punches Do not come off while working.

Name of the tools	Safety
Machineries and Equipments	Ensure that electrical connections are made by an authorised electrician only. Concentrate on your work Have a calm attitude. Do things in a methodical way Don’t engage yourself in conversation with others while concentrating on your job. Don’t distract the attention of others. Don’t try to stop a running machine with hands. 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 machine until you know how to operate it properly. Do not adjust the stroke, 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. Before starting the machine, move the ram by hand to ensure that the ram or tool-holder does not strike the workpiece or table. 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. Do not stop the machine before the finish of the cutting stroke.

Identification of tools and equipments

Objectives: At the end of this lesson you shall be able to
- **list the type of identification of tools**
- **state the different types of tools**
- **state how tools are specified.**

1 Hand tools

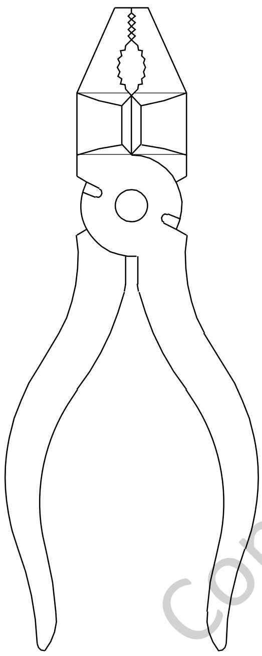
2 Fitting tools

3 Measuring tools

1 Hand tools

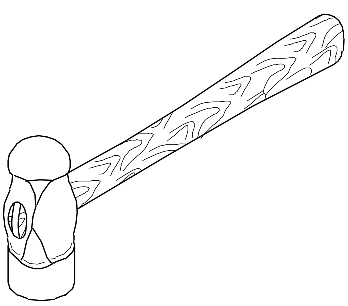
a Cutting plier specified according to their length (150mm). (Fig 1)

Fig 1



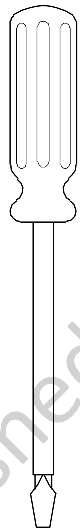
b Hammer specified by their weight and shape of pein. (Fig 2)

Fig 2



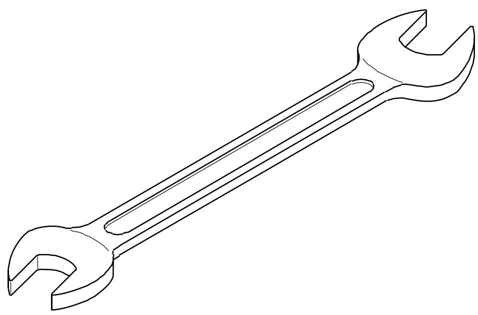
c Screw driver specified according to the
- length of the blade
- width of the tip (Fig 3)

Fig 3



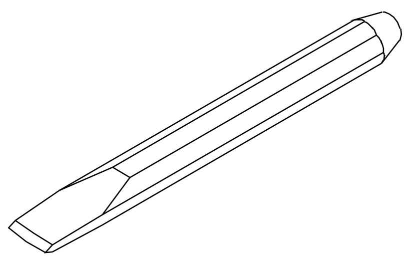
d Spanner specified by across to the flat 12mm to 13mm. (Fig 4)

Fig 4



e Chisel are specified according to their length, width of cutting edge, type, cross section of the body. (Fig 5)

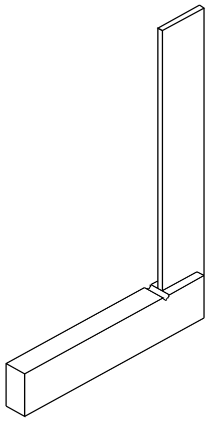
Fig 5



2 Fitting tools

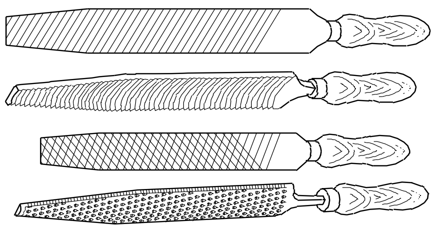
a Try square specified according to the length of the blade. (Fig 6)

Fig 6



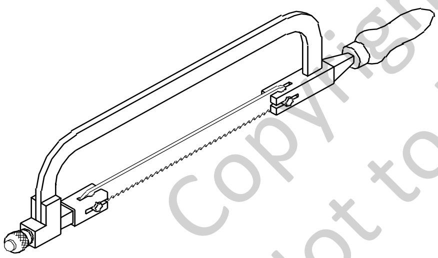
b File specified according to their length, grade, cut and shape. (Fig 7)

Fig 7



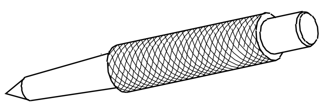
c Hacksaw frame specified by types. (Fig 8)

Fig 8



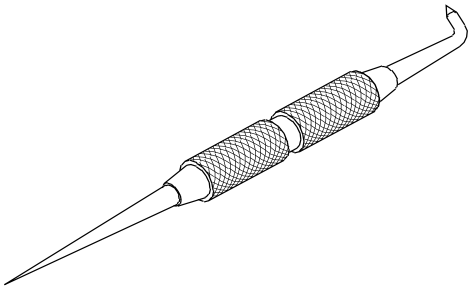
d Punch specified by types. (Fig 9)

Fig 9



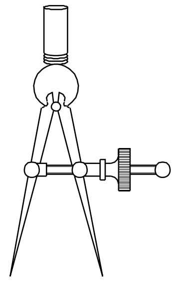
e Scriber specified by different shape and sizes. (Fig 10)

Fig 10



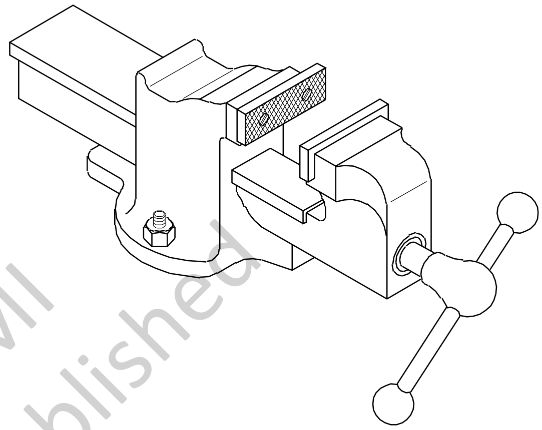
f Divider spring joint specified by its length. (Fig 11)

Fig 11



g Bench vice specified with & jaw. (Fig 12)

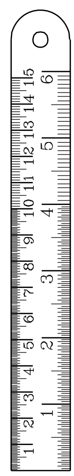
Fig 12



3 Measuring tools

a Steel rule specified by length. (Fig 13)

Fig 13



b Outside caliper spring joint specified by its length. (Fig 14)

c Inside caliper spring joint specified by its length. (Fig 15)

Fig 5

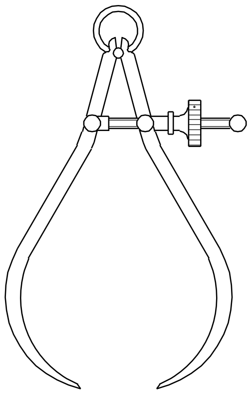
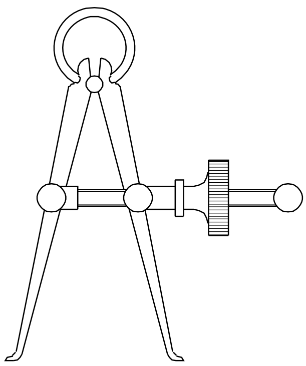


Fig 15



d **Vernier caliper** specified by its length. (Fig 16)

e **Outside micro meter** specified by ranges of 0 to 25mm, 25 to 50 mm etc (Fig 17)

Fig 16

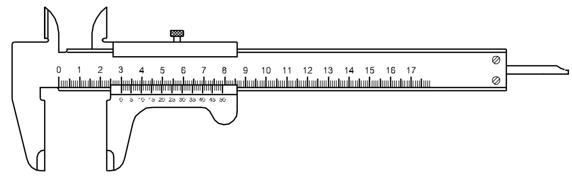
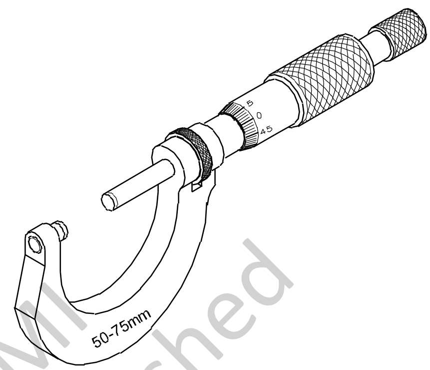


Fig 17



Selection of metals

Objectives: At the end of this lesson you shall be able to
- **state the different methods of identifying ferrous metals and alloys**
- **state how non-ferrous metals and alloys are identified**
- **state the corrosion, scaling, rusting.**

A fitter has to handle different types of metals in his work. A knowledge about how to recognise and differentiate the commonly used metals will help him in many ways.

Ferrous metals and alloys can be identified by

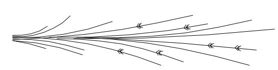
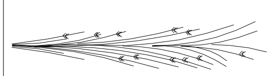
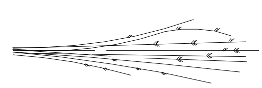
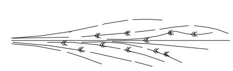
- their appearance (colour, texture etc)
- their weight (light or heavy)
- the sound
- cold hammering
- the spark test (grinding).

Note

The above characteristics of different ferrous metals and alloys are given in Table 1. Apart from the above tests, steel bars are also identified by the code colours painted on them.

Different colours are marked, based on the different composition of materials and grade. Colour charts are available to determine the different metals.

Table 1

Ferrous metals & alloys	Appearance	Density/ weight	Sound (Drop a ø 15 bar 25 cm long, on to the ground)	Cold hamme -ring	Spark test	
Low carbon steel	Smooth scale with blue/ black sheen/ silver grey	7.85 medium	Medium metallic sound	Flattens easily	Stream of yellow white sparks varying in length, slightly 'fiery'.	
Medium carbon steel	Smooth scale black sheen steel	Weight 7.85 medium	Higher note than that of low carbon	Fairly difficult to flattern	Yellow sparks shorter than those of low carbon steel, finer and more feathery.	
High carbon steel	Rougher scale black	Weight 7.85 medium	Good ringing sound	Difficult to flattern	Sparkless bright, starting near grinding wheel and more feathery with secondary branching.	
High speed steel	Roughness scale black with reddish tint	Weight 9 comparitivily to heavy	Lower ringing more like low carbon steel	Very difficult flattern tends crack easily.	Faint red streak ending in fork.	

Most non-ferrous metals and alloys can be identified by their colour. (Table 2)

Table 2

Metal/Alloy	Colour
Copper	Distinctive red colour
Aluminium	Dull white
Lead	Bluish-grey colour
Tin	Silvery white, with a slightly yellowish tinge
Brass (Alloy) (free cutting)	Distinctive yellow colour
Bronze (alloy)	Colour between copper and brass

Rusting

Rusting is the process in which iron turns into iron oxide. It happens when iron comes into contact with water and oxygen. The process is a type of corrosion that occurs easily when natural conditions.

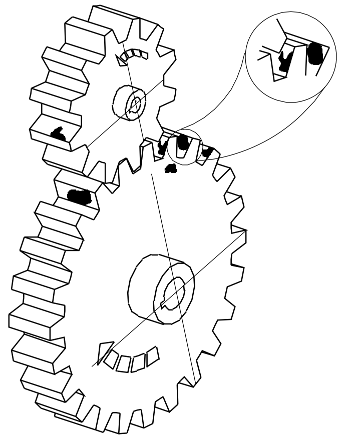
Rusting is the conversion related to iron and iron-based alloys. Non-ferrous metals corrode but do not rust. (Fig 1)

Corrosion

The slow and continuous eating away of metallic components by chemical or electro-chemical action is known as corrosion. Corrosion affects the service conditions and accuracy of the components. It is very essential to understand the causes for corrosion and to know the metals that resist corrosion.

Conversion is the deterioration of materials by chemical interaction with their environments. The term corrosion is some times also applied to the degradation of plastics, concrete and wood, but generally refers to metals. (Fig 2)

Fig 2



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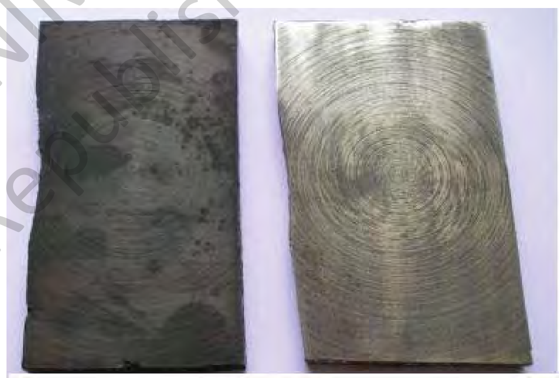
Scaling

Scale is hard mineral coatings and corrosion deposits made up of solids and sediments that collect on or it distribution system.

Scaling which is the deposition of mineral solids on the interior surfaces of water lines and containers. (Fig 3)

Fig 3



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Length measurement

Objectives: At the end of this lesson you shall be able to
- **name the base unit of length measurement as per the international system of units of measurement (SI)**
- **state the multiples of a metre and their values.**

When we measure an object, we are actually comparing it with a known standard of measurement.

The base unit of length as per SI is the metre.

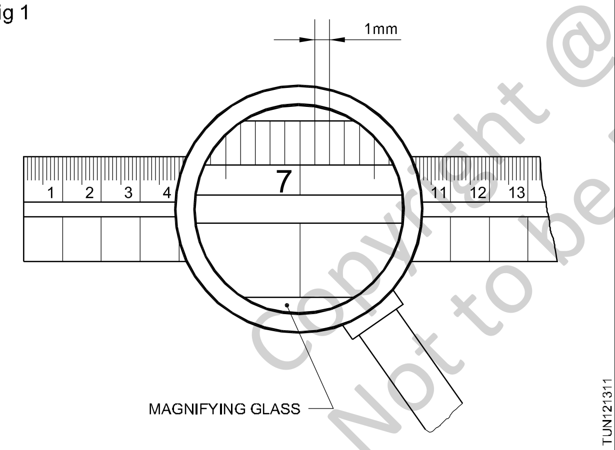
Length - SI units and multiples.

Base unit : The base unit of length as per the systems international is the metre. The table given below lists some multiples of a metre.

1 Metre (m)	= 1000 mm
1 Centimetre (cm)	= 10 mm
1 Millimetre (mm)	= 1000μm
1 Micrometre (μm)	= 0.001 mm

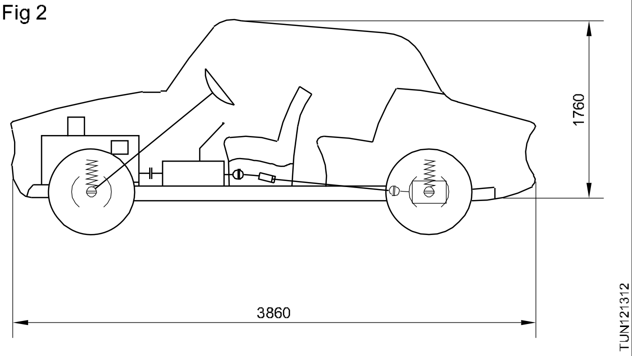
Measurement in engineering practice: Usually, in engineering practice, the preferred unit of length measurement is the millimetre. (Fig 1)

Fig 1



Both large and small dimensions are stated in millimetres. (Fig 2)

Fig 2



The british system of length measurement : An alternative system of length measurement is the british system. In this system, the base unit is the imperial standard yard. Most countries, including great britain itself, have, however, in the last few years, switched over to SI units.

12 Inch = 1 Feet

3 Feet = 1 Yard

Line standards and end standards

Line standards

In the line standard the unit of length is defined as the distance between the centres of engraved lines e.g. steel rule.

End standards

When the length being measured is expressed as the distance between two surfaces, e.g. slip gauges.

Difference between line standards and end standards

The differences between line standards and end standards are given as follows:

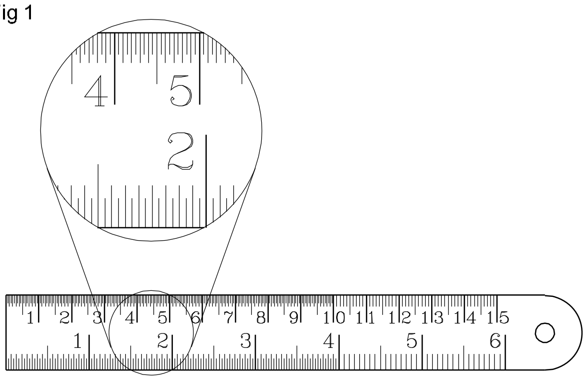
Sl. No	Line standard	End standard
1	Line standards do not provide high accuracy.	End standards more suited to accuracy requirement of high order.
2	They are quick and easy to use over a wide range.	They are time consuming in use, and prove only one dimension at a time.
3	They are not subjected to wear although significiant wear on leading and leads to under-sizing.	They are subjected to wear on their measuring faces.
4	They are subjected to the parallax effect, a source of both positive and negative reading errors.	They are not subjected to parallax effects as their use depends on 'feel'.

Steel rule

Objectives: At the end of this lesson you shall be able to
- **state the purpose of steel rule**
- **state the types of steel rule**
- **state the precautions to be followed while using a steel rule.**

Engineer's steel rule (Fig 1) are used to measure the dimensions of work pieces.

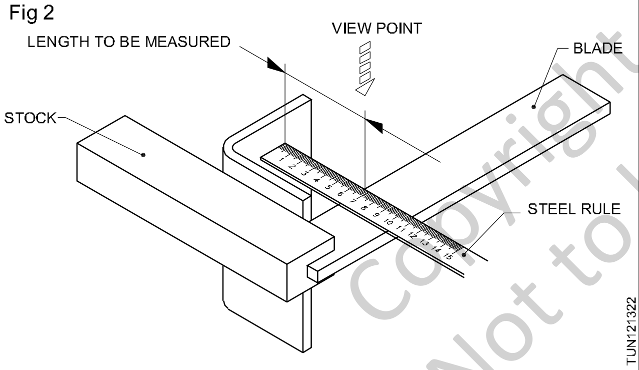
Fig 1



Steel rules are made of spring steel or stainless steel. These rules are available in length 150mm. 300mm and 600mm. the reading accuracy of steel rule is 0.5mm and 1/64 inch.

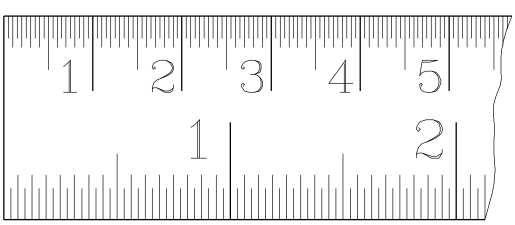
For accurate reading it is necessary to read vertically to avoid errors arising out of parallax. (Fig 2)

Fig 2



Steel rule in english measure, they can also be furnished with metric and english graduation in a complete range of sizes 150, 300, 500 and 1000 mm. (Fig 3)

Fig 3

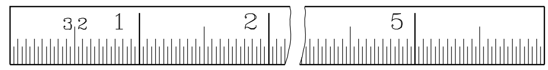


Other types of rule

- Narrow steel rules
- Short steel rules
- Full flexible steel rule with tapered end

Narrow steel rule : Narrow steel rule are used to measure the depth of key-ways and depth of smaller dia, blind holes and other jobs, where the ordinary steel rule cannot reach. Width approximately 5mm thickness 2mm. (Fig 4)

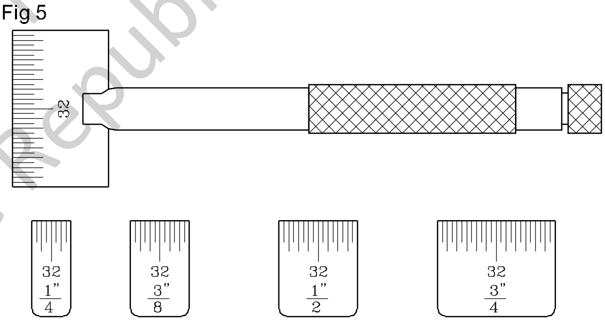
Fig 4



Short steel rule (Fig 5) : This set of five small rules together with a holder is extremely useful for measurements in confined or hard to reach locations which prevent use of ordinary steel rules. It is used suitably for measuring grooves, short shoulder, recesses, key ways etc. in machining operation on shapers, millers and tool and die work.

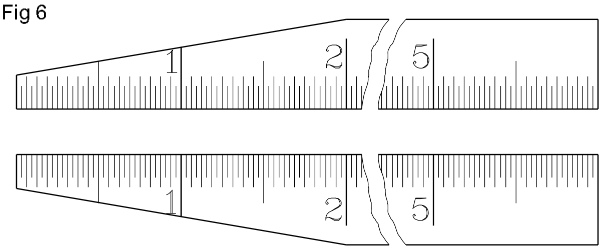
The rules are easily inserted in the slotted end of the holder and are rigidly clamped in place by a slight turn of the knurled nut at the end of the handle. five rule lengths are provided 1/4", 3/8", 1/2", 3/4" and 1" and each rule is graduated in 32[nds] on one side and 64ths on the reverse side.

Fig 5



Steel rule with tapered end : This rule is a favorite with all mechanics since its tapered end permits measuring of inside size of small holes, narrow slots, grooves, recesses etc. This rule has a taper from 1/2 inch width at the 2 inch graduation to 1/8 inch width at the end. (Fig 6)

Fig 6



For maintaining the accuracy of a steel rule, it is important to see to it that its edges and surfaces are protected from damage and rust.

Do not place a steel rule with other cutting tools. Apply a thin layer of oil when not in use.

Hacksaw frame

Objectives: At the end of this lesson you shall be able to
- **name the different types of hacksaw frames**
- **specify hacksaw blades.**

Hacksaw frame: 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.

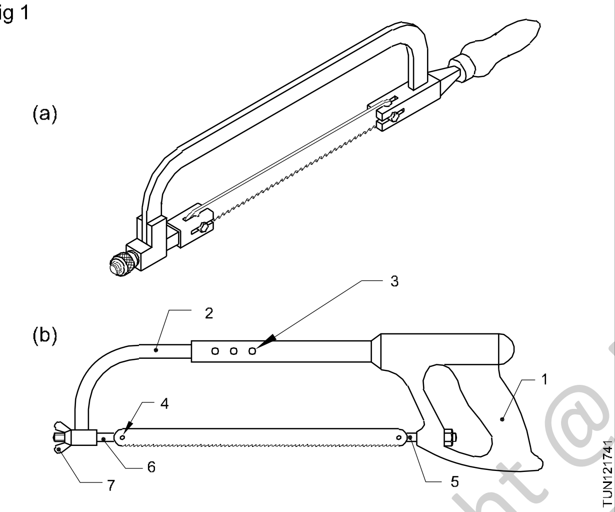
Example

Adjustable hacksaw frame-tuber-250-300 or 8" - 12"

Types of hacksaw frames

Solid frame (Fig 1a) : Only a blade of a particular standard length can be fitted to this frame. e.g. 300mm or 250mm.

Fig 1



Adjustable frame (flat type) : Different standard lengths of blades can be fitted to this frame i.e. 250mm and 300mm.

Adjustable frame (tubular type) (Fig 1b) : This is the most commonly used type. It gives a better grip and control.

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

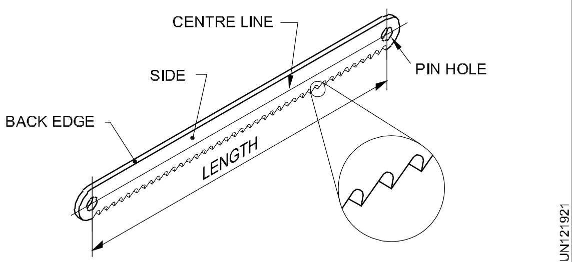
7 Wing - nut

Hacksaw blade

Objectives: At the end of this lesson you shall be able to
- **name the different types of hacksaw blades**
- **specify hacksaw blades.**

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 300 mm. (Fig 1)

Fig 1



Parts of a hacksaw blade (Fig 1)

1 Back edge

2 Side

3 Centre line

4 Pin holes

Type of hacksaw blades

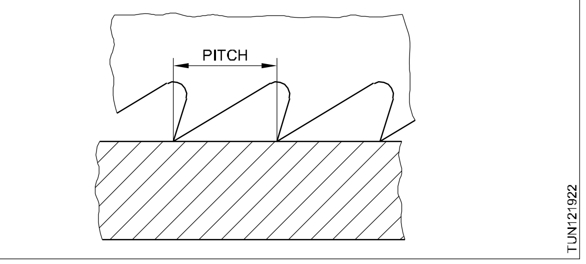
All-hard blade: The full length of the blade between the pins is hardened and it is used for harder metals such as tool steel, die steel and HCS.

Flexible blade: Only the teeth are hardened. Because of their flexibility these blades are useful for cutting along curved lines. Flexible blades should be thinner than all - hard blades.

Pitch of the blade (Fig 2)**:** The distance between adjacent teeth is known as the 'pitch' of the blade. (Fig 2)

Classification	Pitch
Coarse	1.8 mm
Medium	1.4 mm & 1.0 mm
Fine	0.8 mm

Fig 2



Specification: Hacksaw blades are specified by the length, pitch and type of material. (The width and thickness of blade is standardised)

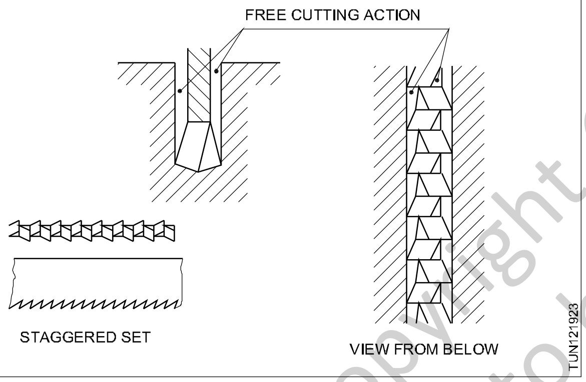
Example

300 x 1.8 mm, pitches LA all-hard blade.

To prevent the hacksaw blade binding when penetrating into the material, and to allow free movement of the blade, the cut is to be broader than the thickness of the hacksaw blade. This is achieved by the setting of the hacksaw teeth. There are two types of hacksaw teeth settings.

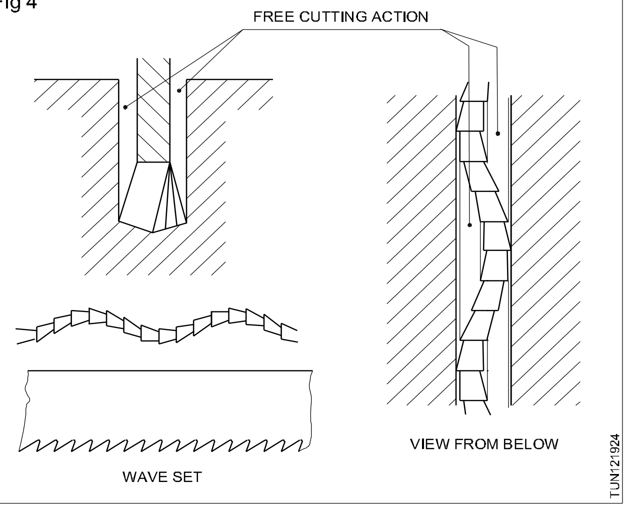
Staggered set (Fig 3)**:** Alternate teeth or groups of teeth are staggered. This arrangement helps for free cutting, and provides for good chip clearance.

Fig 3



Wave set (Fig 4)**:** In this, the teeth of the blade are arranged in a wave-form. The types of sets for different pictures are as follows:

Fig 4

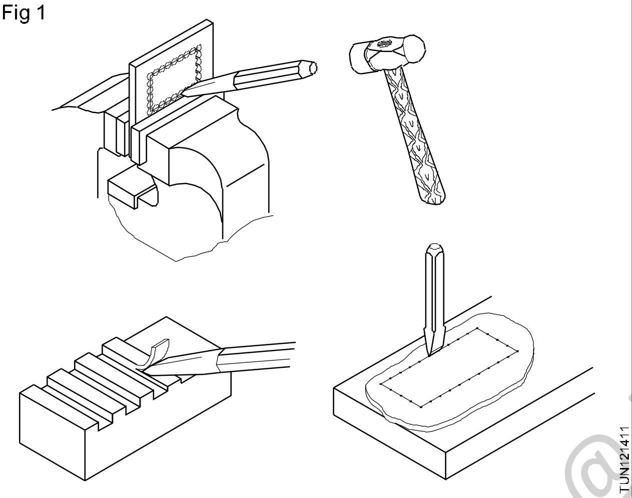


Chisel

Objectives: At the end of this lesson you shall be able to
- **list the uses of a cold chisel**
- **name the parts of a cold chisel**
- **state the different types of chisels**
- **follow the safety measures.**

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig 1)

Fig 1

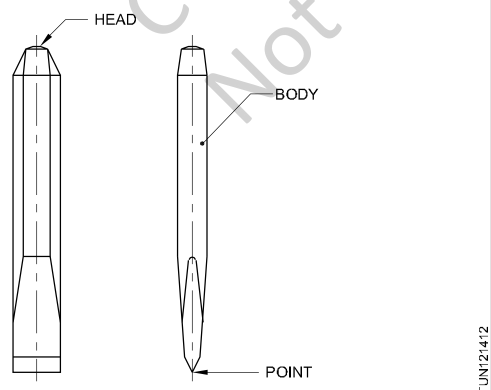


Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

Parts of a chisel (Fig 2) : A chisel has the following parts.

Head, body, point or cutting edge

Fig 2



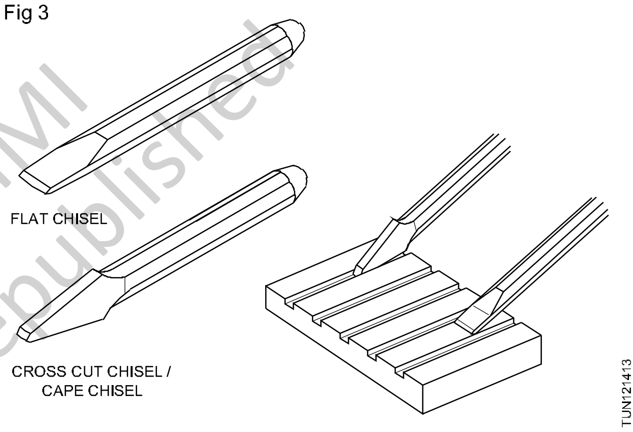
Chisels are made from high carbon steel or chrome-vanadium steel. The cross-section of chisels is usually hexagonal or octagonal. The cutting edge is hardened and tempered.

Common types of chisels : There are five common types of chisels.

- Flat chisel
- Cross-cut chisel
- Half-round nose chisel
- Diamond point chisel
- Web chisel

Flat chisels (Fig 3) : They are used to remove metal from large flat surfaces and chip-off excess metal of welded joints and castings.

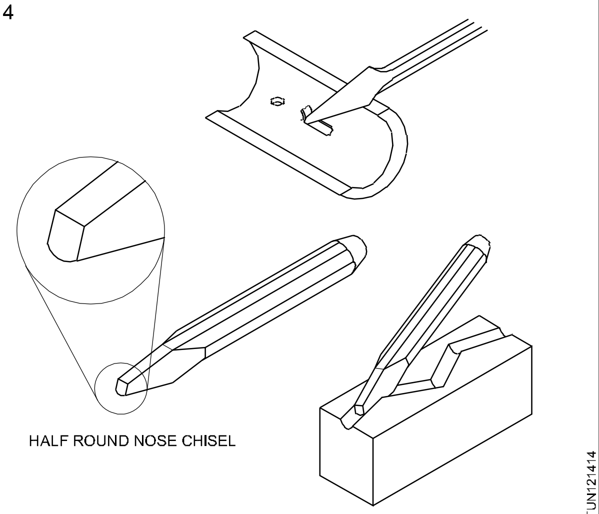
Fig 3



Cross-cut or cape chisels (Fig 3) : These are used for cutting keyways, grooves and slots.

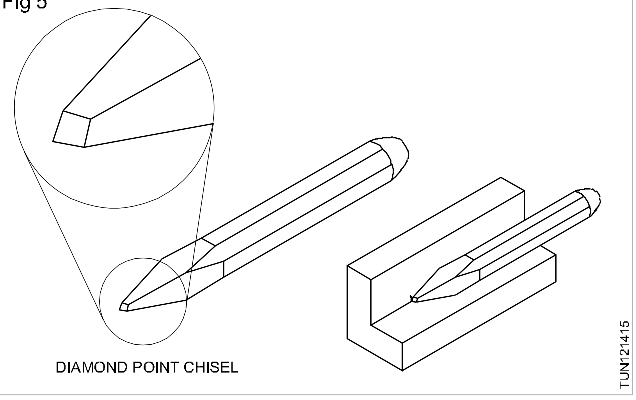
Half-round nose chisels (Fig 4) : They are used for cutting curved grooves (oil grooves).

Fig 4



Diamond point chisels (Fig 5): These are used for squaring materials at the corners, joints.

Fig 5



Web chisels/punching chisels (Fig 6) : These chisels are used for separating metals after chain drilling.

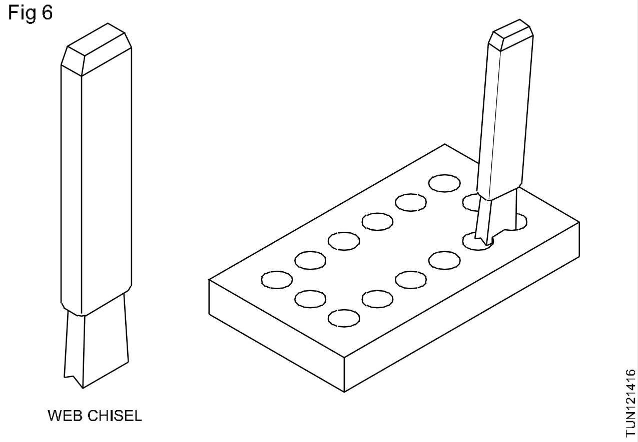
Chisels are specified according to their

- length
- width of the cutting edge
- type
- cross-section of the body

The length of chisels ranges from 100 mm to 200 mm.

The width of the cutting edge varies according to the type of chisels.

Fig 6



Hammer

Objectives: At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **name the parts of an engineer's hammer**
- **name the types of engineer's hammers**
- **specify the engineer's hammer.**

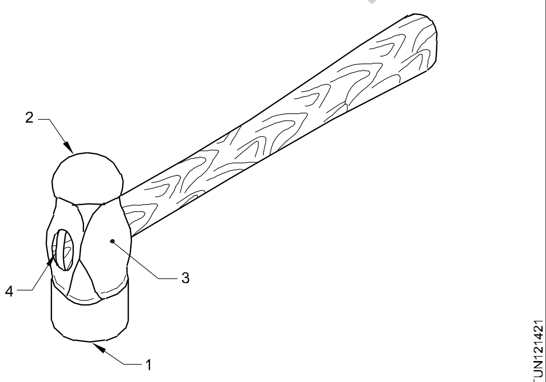
An engineer's hammer is a hand tool used for striking purposes while punching, bending, straightening, chipping, forging and riveting.

Major parts of a hammer : The major parts of a hammer are the head and the handle.

The head is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

The parts of a hammer head (Fig 1) are the face (1), pein (2), cheek (3) and the eyehole (4).

Fig 1

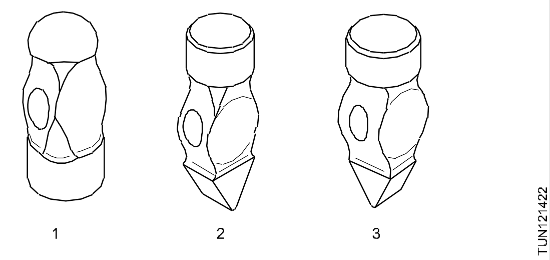


Face: The face is the striking portion. A slight convexity is given to it, to avoid digging of the edge. It is used for striking while chipping, bending, punching etc.

Pein: The pein is the other end of the head. It is used for shaping and forming work like riveting and bending. The pein is of different shapes such as :

- ball pein
- cross-pein
- straight pein (Fig 2)

Fig 2



The face and the pein are case hardened.

Cheek: The cheek is the middle portion of the hammer head. The weight of the hammer is stamped here.

This portion of the hammer-head is left soft.

Eyehole: The eyehole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eyehole. (Figs 3 and 4)

Fig 3

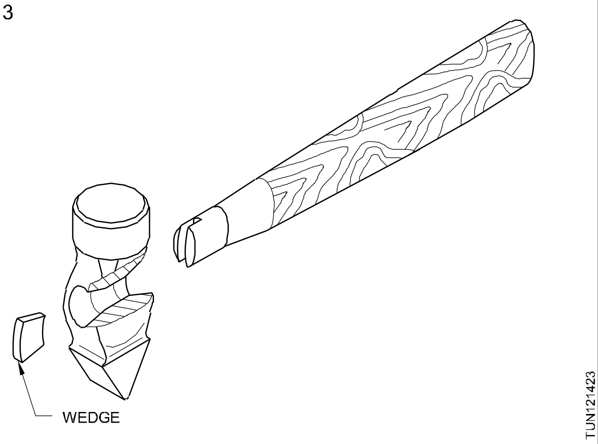
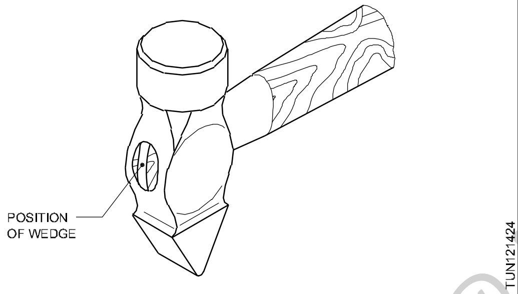
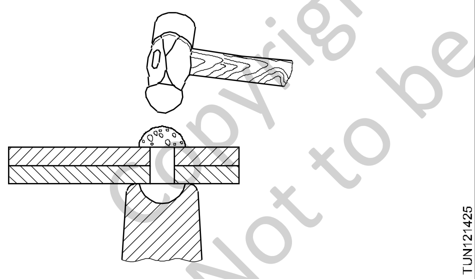


Fig 4



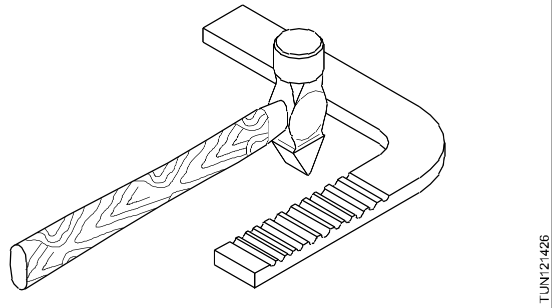
Application of hammer pein : The ball pein is used for riveting. (Fig 5)

Fig 5



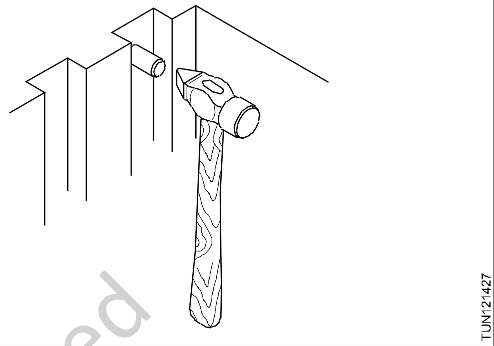
The cross-pein is used for spreading the metal in one direction. (Fig 6)

Fig 6



The straight pein is used at the corners. (Fig 7)

Fig 7



Specification: An engineer's hammers are specified by their weight and the shape of the pein. Their weight varies from 125 gms to 750gms.

The weight of an engineer's hammer used for marking purposes is 250 gms.

The ball pein hammers are used for general work in machine/ fitting shop.

Before using a hammer:

- make sure the handle is properly fitted.
- select a hammer with the correct weight suitable for the job.
- check the hammer head and handle whether any crack is there.
- ensure that the face of the hammer is free from oil or grease.

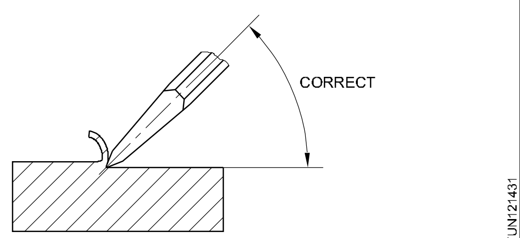
Angles of chisels

Objectives: At the end of this lesson you shall be able to
- **select the point angles of chisels for different materials**
- **state the effect of rake and clearance angles.**

Point angle and materials: The correct point/cutting angle of a 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. (Fig 1)

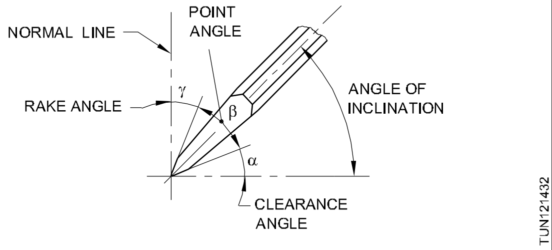
Fig 1



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. (Fig 2)

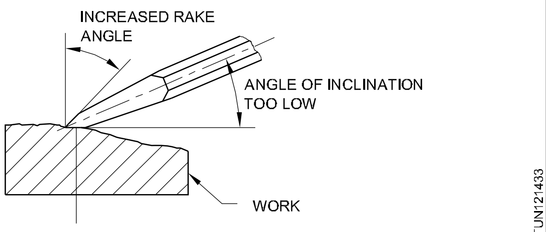
Clearance angle : Clearance angle is the angle between the bottom face of the point and the tangent to the work surface originating at the cutting edge. (Fig 2)

Fig 2



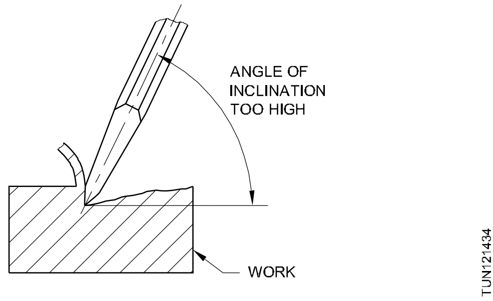
If the clearance angle is too low or zero, the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip. (Fig 3)

Fig 3



If the clearance angle is too great, the rake angle reduces. The cutting edge digs in and the cut will become deeper and deeper. (Fig 4) The correct point angle and angle of inclination for different materials for chipping is given in Table 1.

Fig 4



Crowning : A slight curvature is ground called "Crowning" to the cutting edge of the chisel, to prevent digging or corners, which leads to breakage of chisel point. "Crowning" allows the chisel to move freely along a straight line while chipping.

Table 1

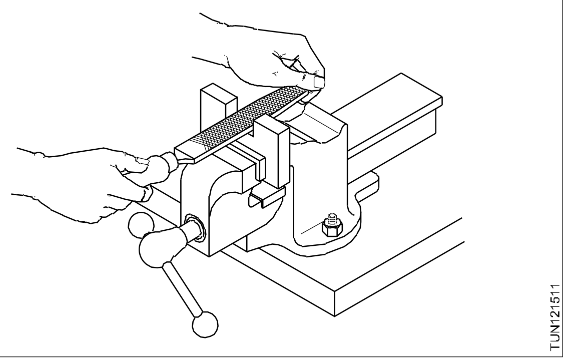
Material to be cut	Point angle	Angle of inclination
High carbon steel	65°	39.5°
Cast iron	60°	37°
Mild steel	55°	34.5°
Brass	50°	32°
Copper	45°	29.5°
Aluminium	30°	22°

Elements of a file

Objectives: At the end of this lesson you shall be able to
- **name the parts of a file**
- **name and state the uses of each grade of file**
- **list and state the uses of different cuts of files**
- **state the specification of a file.**

Filing is a method of removing excess material from a workpiece by using a file. (Fig 1)

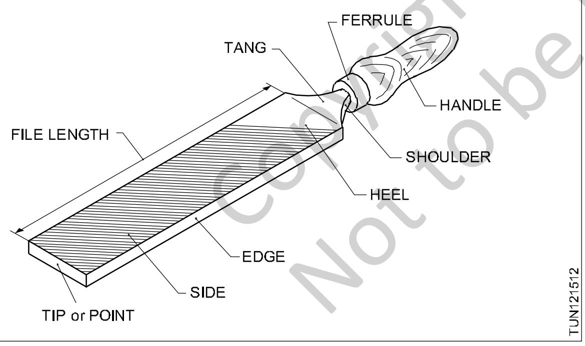
Fig 1



Files are available in many shapes and sizes. They are made of high carbon or high grade cast steel. The teeth portion of the file (body) alone is hardened and tempered.

Parts of a file (Fig 2): The illustration above will help you in learning the parts of a file.

Fig 2



Files are specified according to their (1) length (2) grade (3) cut and (4) shape.

Eg. File flat 300 mm bastard double cut.

The length of a file is the distance from the tip to the heel.

File grades are determined by the spacing of the teeth.

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 (Fig 3A) and fins-burrs on forged components.

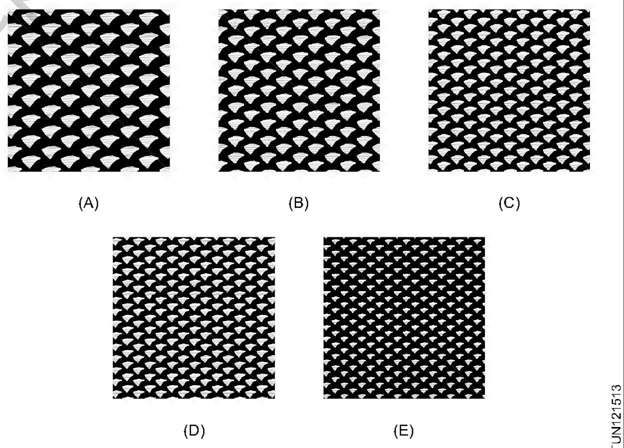
A bastard file is used in cases where a heavy reduction of material is required. (Fig 3B)

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. (Fig 3C)

A smooth file is used to remove small quantities of material and to give a good finish. (Fig 3D)

A dead smooth file is used to bring the material to accurate size with a high degree of finish. (Fig 3E)

Fig 3



Flat file & hand file

Objectives: At the end of this lesson you shall be able to
- **state the features of flat and hand files**
- **state the application of flat and hand files**
- **list different cuts and their uses.**

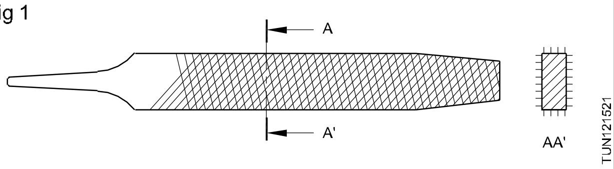
Files are made in different shapes so as to able to file and finish components to different shapes.

The shape of files is usually specified by their cross section.

The files useful for this exercise are flat files and hand files.

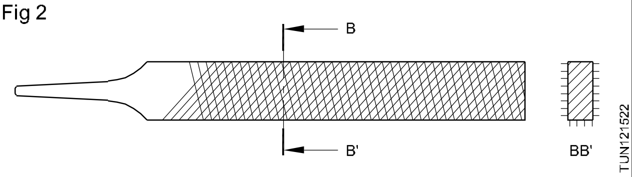
Flat files (Fig 1)**:** These files are of rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut and the edges single cut. These files are used for general purposes work. They are useful for filing and finishing external and internal surfaces.

Fig 1



Hand files (Fig 2)**:** 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 a single cut whereas the other is a safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces already finished.

Fig 2



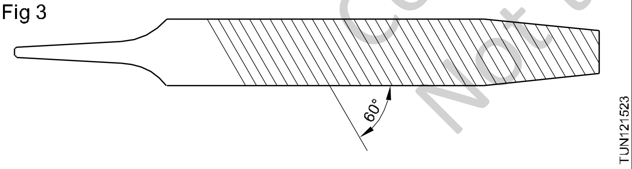
The most used grades of files are bastard, second cut, smooth and dead smooth. These are the grades recommended by the Bureau of Indian Standards. (BIS)

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

The uses of the different cuts of files are as follows.

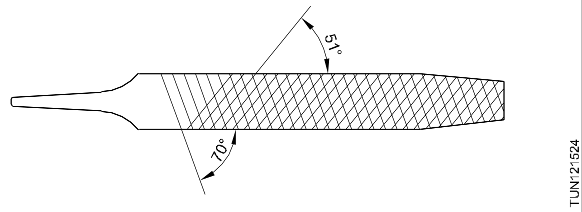
Single cut files are useful for filing soft metals like brass, aluminium, bronze and copper and also used for deburring the job on lathe. (Fig 3)

Fig 3



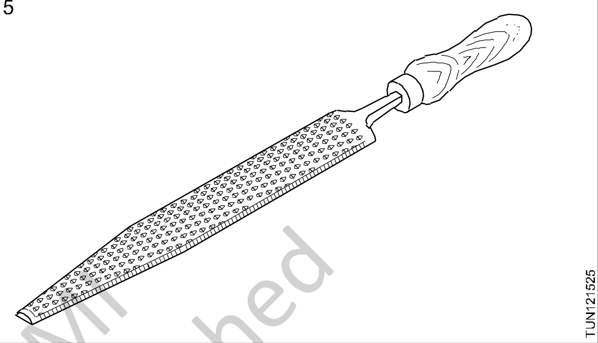
Double cut files remove material faster than the single cut files. (Fig 4)

Fig 4



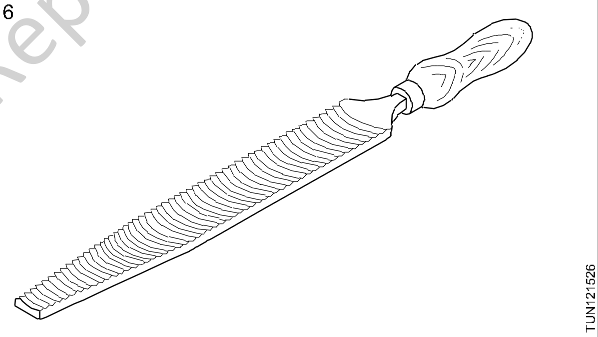
Rasp cut files are useful for filing wood, leather and other soft materials and are available only in half round shape. (Fig 5)

Fig 5



Curved cut files have deeper cutting action and are useful for filing soft materials like aluminium, tin, copper and plastic. (Fig 6)

Fig 6



Bench vice

Objectives: At the end of this lesson you shall be able to
- **name the parts and uses of a bench vice**
- **specify the size of a bench vice**
- **state the uses of vice clamps.**

Vices are used for holding workpieces. They are available in different types. The vice used for bench work is the bench vice or called Engineer's vice.

A bench vice is made of cast iron or cast steel and it is used to hold work for filing, sawing, threading and other hand operations. (Fig 1)

The size of the vice is stated by the width of the jaws.eg. 150mm parallel jaw bench vice.

Parts of a bench vice (Fig 2)

The following are the parts of a vice.

Fixed jaw, movable jaw, hard jaws, spindle, handle, box-nut and spring are the parts of a file.

The box-nut and the spring are the internal parts.

Fig 1

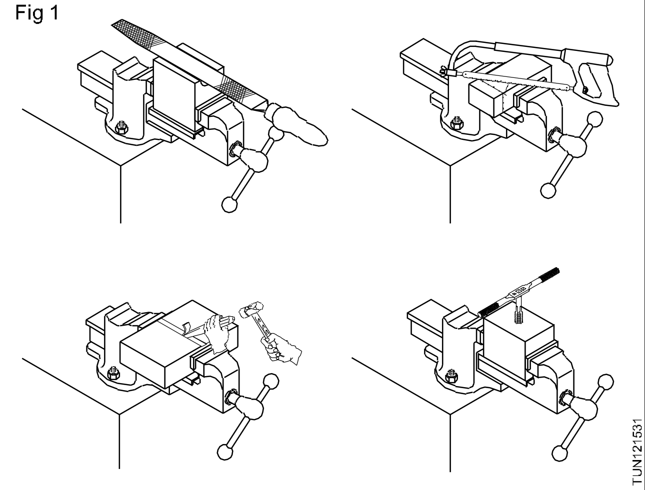
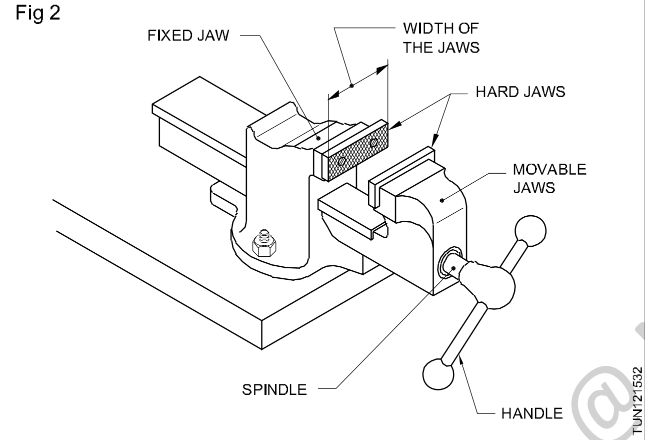


Fig 2

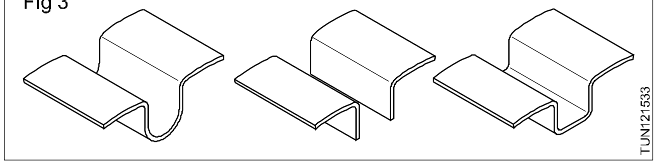


Vice clamps or soft jaws (Fig 3)

To hold a finished work use soft jaws (vice clamps) made of aluminium over the regular jaws. This will protect the work surface from damage.

Do not over-tighten the vice as, the spindle may be damaged.

Fig 3

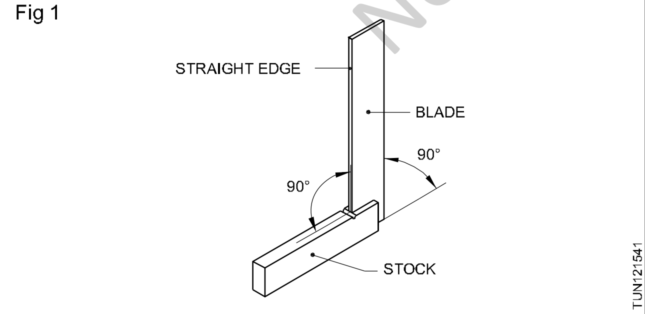


Try square

Objectives: At the end of this lesson you shall be able to
- **name the parts of a try square**
- **state the uses of a try square.**

The try square (Fig 1) is an instrument which is used to check squareness (angles of 90°) of a surface.

Fig 1



The accuracy of measurement by a try square is about 0.002 mm per 10 mm length, which is accurate enough for most workshop purposes. The try square has a blade with parallel surfaces. The blade is fixed to the stock at 90°.

Try squares are made of hardened steel.

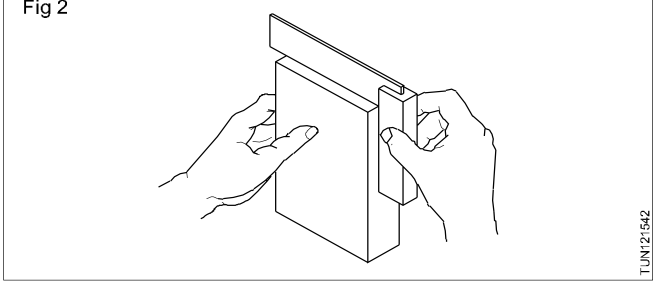
Try squares are specified according to the length of the blade i.e. 100mm, 150mm 200mm.

Uses

The try-square is used to:

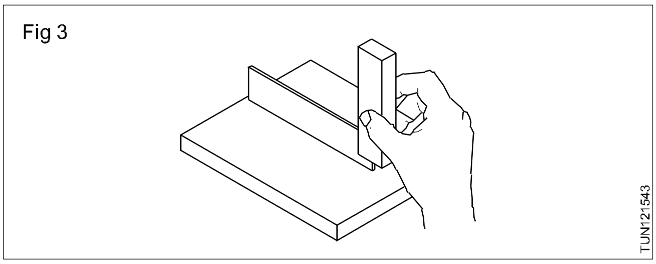
– check the squareness (Fig 2)

Fig 2



– check the flatness (Fig 3)

Fig 3



– mark lines at 90° to the edges of workpieces (Fig 4)

– set workpieces at right angles. (Fig 5)

Fig 4

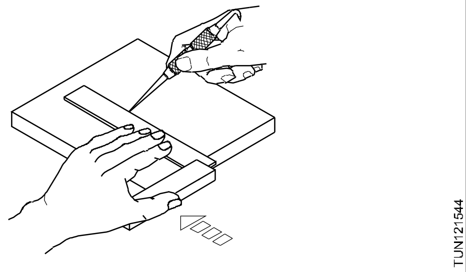
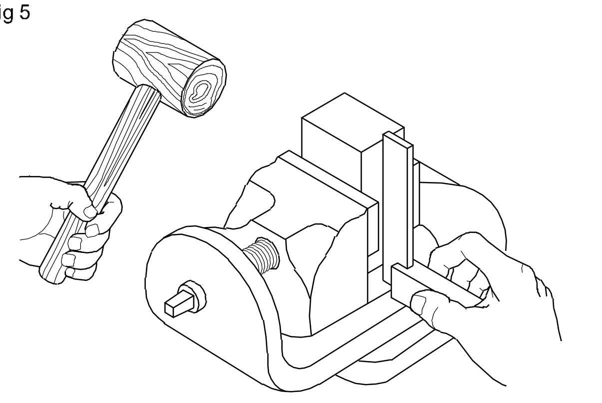


Fig 5



TYPES OF VICES

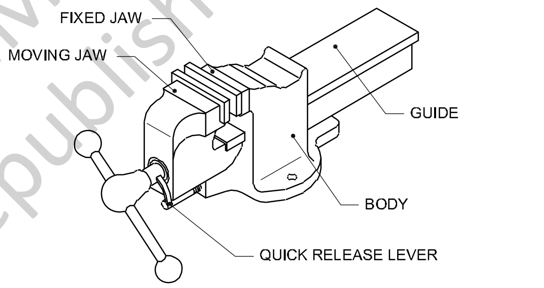
At the end of this lesson you shall be able to
- **state the construction and advantages of a quick releasing vice**
- **state the uses of pipe vice, toolmakers vice, hand vice and pin vice**

There are different types of vices used for holding work-pieces. They are quick releasing vice, pipe vice, hand vice, pin vice and toolmaker's vice.

Quick releasing vice (Fig 1)

A quick releasing vice is similar to an ordinary bench vice but the opening of the movable jaw is done by using a trigger (lever). If the trigger at the front of the movable jaw is pressed, the nut disengages the screw and the movable jaw can be set in any desired place quickly.

Fig 1

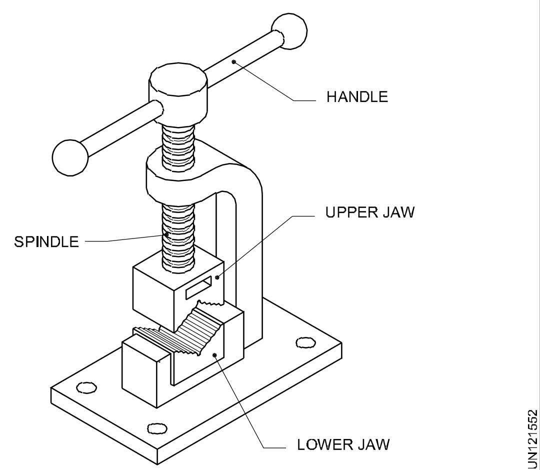


Pipe Vice (Fig 2)

A pipe vice is used for holding round sections of metal, tubes and pipes. In this vice, the screw is vertical and movable. The jaw works vertically.

The pipe vice grips the work at four points on its surface. The parts of a pipe vice are shown in Figure 2.

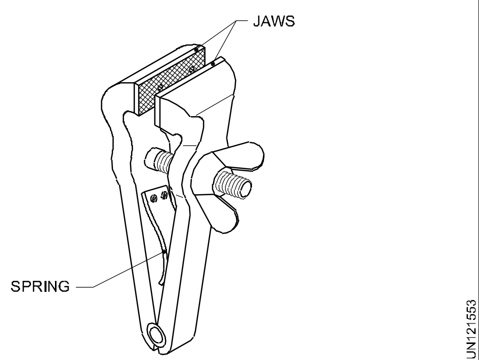
Fig 2



Hand Vice (Fig 3)

Hand vice are used for gripping screws, rivets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. A hand vice is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 to 44mm. The jaws can be opened and closed using the wing nut on the screw that is fastened to one leg, and passes through the other.

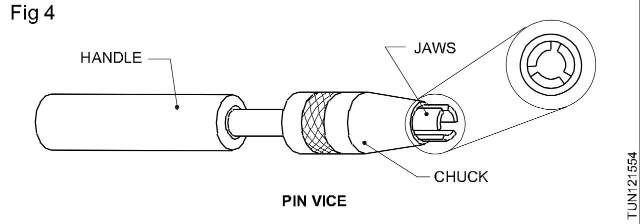
Fig 3



Pin Vice (Fig 4)

The pin vice is used for holding small diameter jobs. It consists of a handle and a small collect chuck at one end. The chuck carries a set of jaws which are operated by turning the handle.

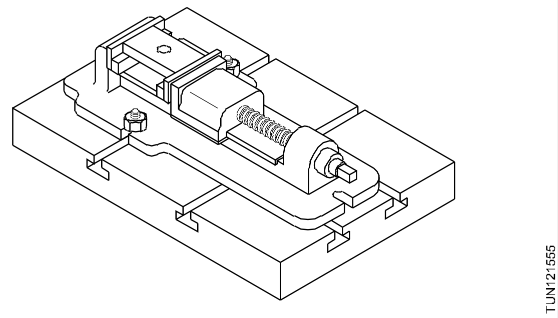
Fig 4



Toolmarker's Vice (Fig 5)

The toolmarker's vice is used for holding small work which requires filing or drilling and for marking of small jobs on the surface plate. This vice is made of mild steel. Toolmarker's vice is accurately machined

Fig 5

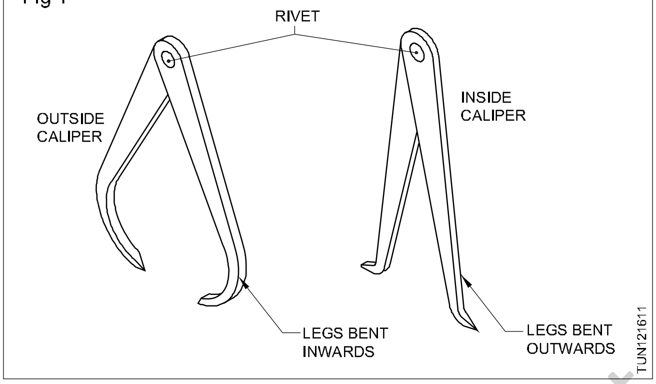


Calipers

Objectives: At the end of this lesson you shall be able to
- **name the parts of the calipers**
- **mention the capacities of the calipers**
- **differentiate between the various types of calipers and their applications.**

The most common devices used for measuring the outside and inside diameter of an object are the outside calipers and inside calipers. these devices cannot read the sizes themselves but measurements taken by them can be read by transfering the sizes on to a steel rule or other precision measuring instruments. There are two types of calipers namely, firm joint calipers and spring calipers.

Fig 1



Firm joint calipers (Fig 1)

Firm joint calipers consist of two legs that are fixed together with a rivet or screw and nut. The capacity of the caliper is decided, based on the maximum opening dimension between the two legs. For example, 150mm capacity caliper is able to measure the maximum size or 150mm.

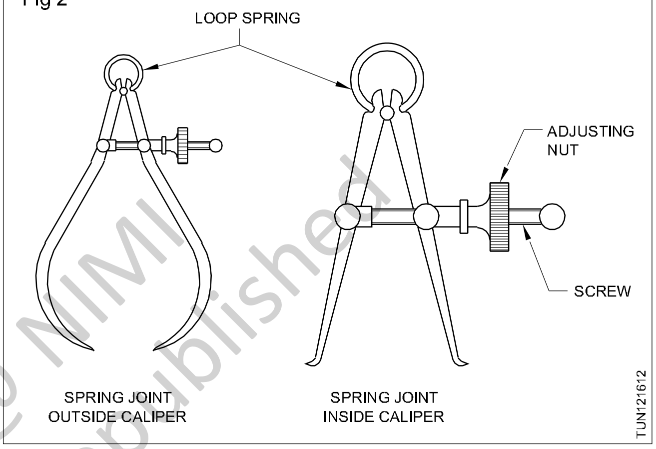
Firm joint calipers can be set very quickly for various measurements but there are chances of getting the set dimension disturbed, thereby causing errors in their use.

Spring calipers (Fig 2)

Spring calipers take more time in setting the dimensions but eliminate the possible errors arising out of the set being disturbed while using.

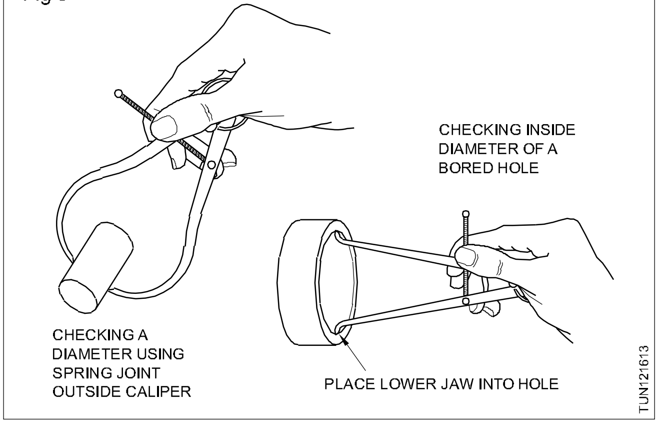
An inside caliper has its legs bent outwards and outside caliper has its legs bent inwards. Inside caliper are used for measuring the inside diameters of a hole of bore and outside calipers are used for measuring the outside diameter of the workpiece.

Fig 2



These calipers are also used for checking the external and internal dimensions as well as the parallelism of external and internal surfaces. (Fig 3)

Fig 3



Types of calipers

Objectives: At the end of this lesson you shall be able to
- **name the commonly used calipers**
- **state the advantages of spring joint calipers.**

Calipers are indirect measuring instruments used for transferring measurements from a steel rule to a job, and vice versa.

Calipers are classified according to their joints and their legs.

Joint

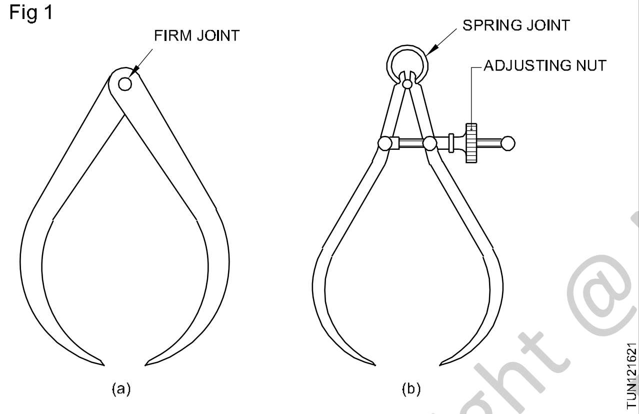
– Firm joint calipers (Fig 1a)

– Spring joint calipers (Fig 1b)

Legs

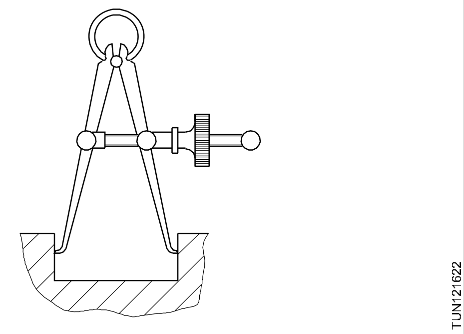
– Outside caliper for external measurement. (Figs 1a & b)

Fig 1



– Inside caliper for internal measurement. (Fig 2)

Fig 2



Calipers are used along with steel rules, and the accuracy is limited to 0.5 mm; parallelism of jobs etc. can be checked with higher accuracy by using calipers with sensitive feel.

Spring joint calipers have the advantage of quick setting with the help of an adjusting nut. For setting a firm joint caliper, tap the leg lightly on a wooden surface.

'V' - Blocks

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of 'V' blocks**
- **identify the types of 'V' blocks and state their uses**
- **specify 'V' blocks as per the standards recommended by B.I.S.**

Constructional features

'V' blocks are devices used for marking and setting up work on machines. The features of a common type of 'V' blocks are as given in Fig 1.

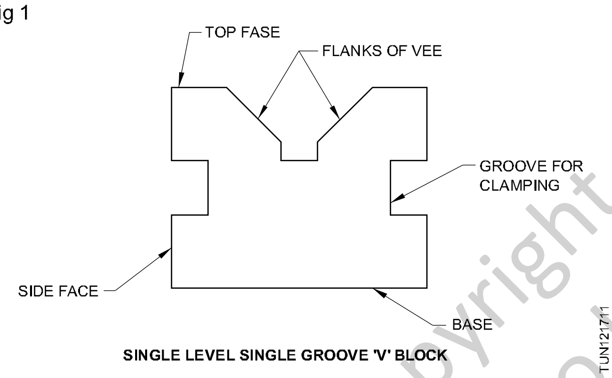
The included angle of the VEE is 90° in all cases. 'V' blocks are finished to a high accuracy in respect of dimension, flatness and squareness.

Types

'V' blocks of different types are available. As per B.I.S. they are:

- single level, single groove 'V' block (Fig 1)

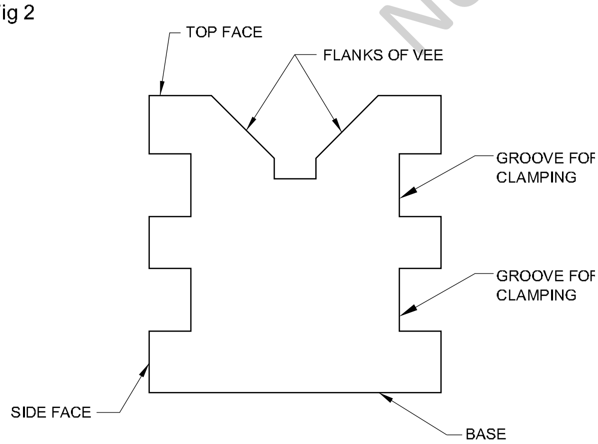
Fig 1



SINGLE LEVEL SINGLE GROOVE 'V' BLOCK

- single level, double groove 'V' block (Fig 2)

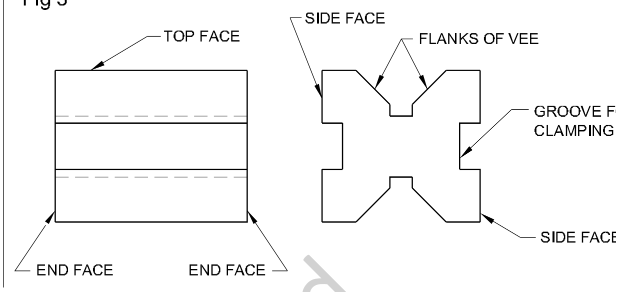
Fig 2



SINGLE LEVEL DOUBLE GROOVE BLOCK

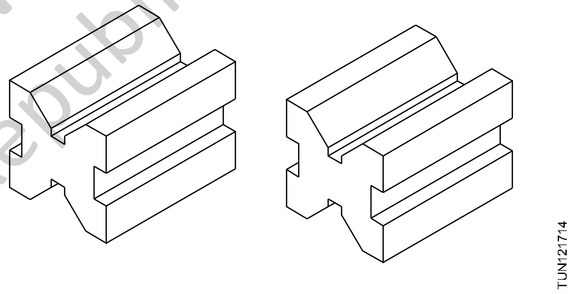
- double level, single groove 'V' Block (Fig 3)

Fig 3



- matched pair 'V' block. (Fig 4)

Fig 4



Single level, single groove 'V' block (Fig 1)

This type has only one 'V' groove and has single square slots cut on both the sides.

This slot on both the sides, accommodates the work-holding clamps.

Single level, double groove 'V' block (Fig 2)

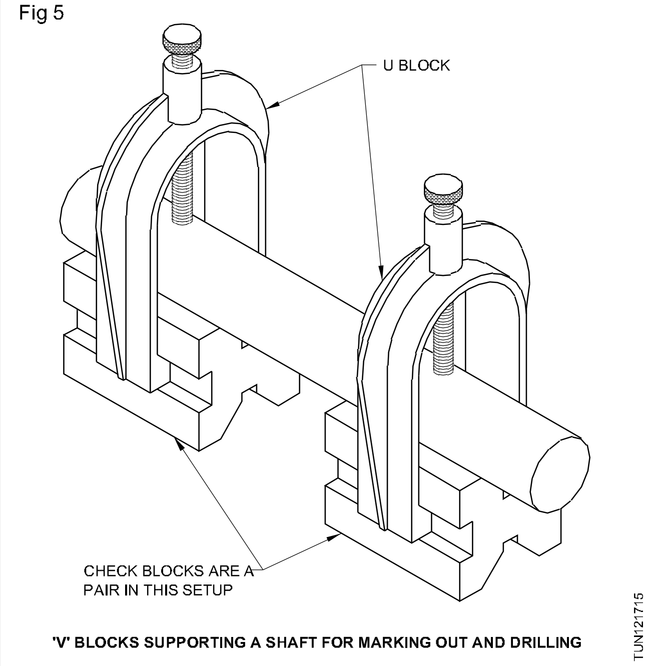
In this case, the 'V' block will have two slots on both sides. This permits for positioning the clamps depending on the diameter of the jobs.

Matched pair 'V' block (Figs 4 and 5)

These blocks are available in pairs which have the same size and same grade of accuracy. They are identified by the number or the letter given by the manufacturer. These sets of blocks are used for supporting long shafts parallel to the marking off or machine tables.

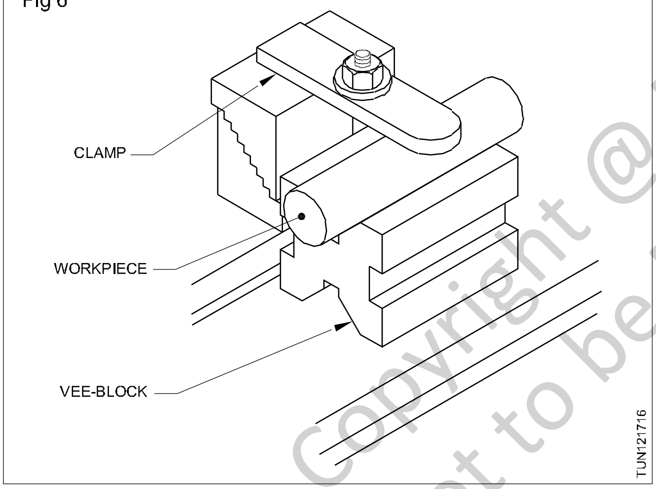
'V' blocks are made in pairs of exactly the same size and shape. They are ground parallel and square on all their sides, and have the 'Vee' groove cut in the centre, symmetrical to the centre line.

Fig 5



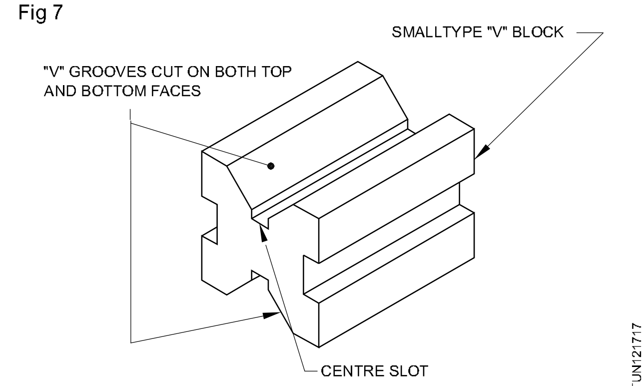
'V' blocks are used to support and clamp round workpieces. (Fig 6)

Fig 6



Smaller type 'V' blocks have the 'V' grooves cut both on the top and bottom faces. (Fig 7)

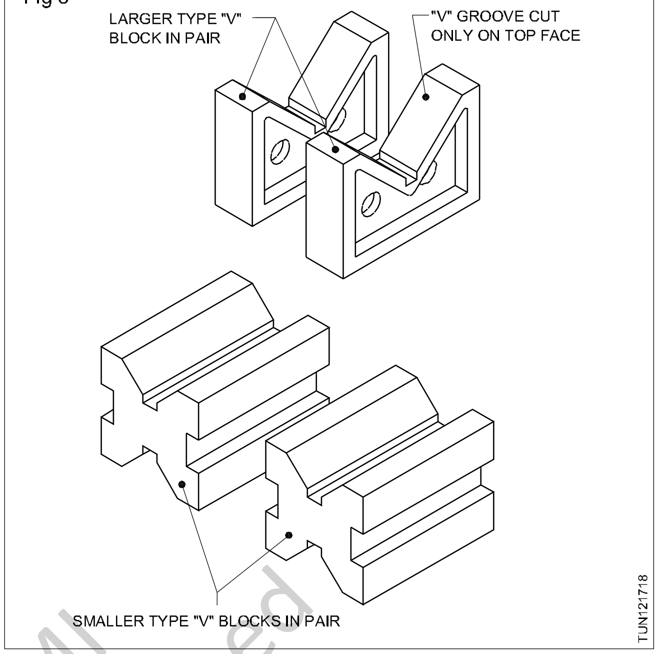
Fig 7



The narrow slots at the apex of the 'V' grooves provide clearance for the drill during drilling operations, and also provide space for chips to flow away during the machining operations.

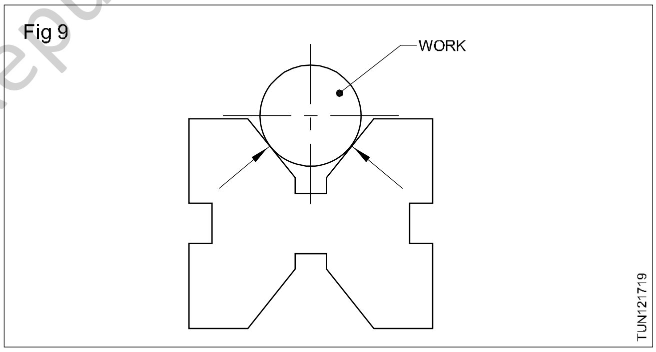
Small sizes of 'V' blocks are made of hardened steel, and larger sizes are made of cast iron. The larger sizes do not have slots on the side faces. (Fig 8)

Fig 8



When selecting a 'V' Block to support a round workpiece, the size of the 'V' block selected should be such that the workpiece touches the flanks of the 'V' groove at about the centre. (Fig 9)

Fig 9



Designation

'V' blocks are designated by the nominal size (length), the minimum and maximum diameters of the workpiece capable of being clamped and the grade and the number of the corresponding B.I.S. standard.

In the case of matched pairs it should be indicated by the letter 'M'.

For 'V' blocks with clamps it should be indicated as 'with clamps'.

Example

1 A 50 mm long (nominal size) 'V' block capable of clamping workpieces between 5 to 40 mm in diameter and Grade A will be designated as - 'V' block 50/5/5-40 A - B.I.S. 2949.

2 In the case of a matched pair, it will be designated as 'V' block M50/5-40 A B.I.S. 2949.

3 For'V' blocks supplied with clamps, the designation will be 'V' block with clamp 50/5-40 A B.I.S.2949.

Grades and materials

'V' blocks are available in Grade 'A' and Grade 'B'.

Grade A

A grade 'V' blocks are more accurate and are available only up to 100 mm length. These are made of high quality steel.

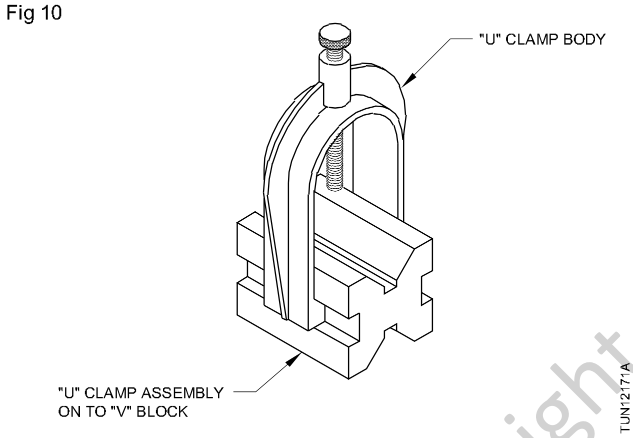
Grade B

B grade 'V' blocks are not as accurate as A grade 'V' blocks and these are useful for general machine shop work. These 'V' blocks are available up to 300 mm length. Grade B 'V' blocks are made of closely grained cast iron.

Clamping devices for 'V' blocks

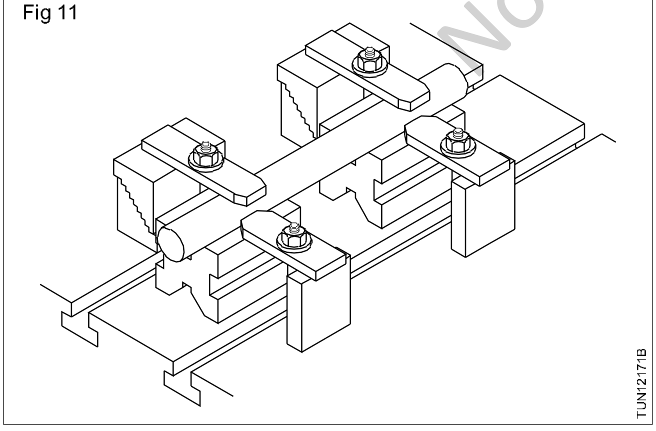
For holding cylindrical jobs firmly on V blocks, U clamps are provided (Fig 10)

Fig 10



Because 'V' blocks are supplied in pairs of the same size and shape, it is possible to support long workpieces so that they are parallel to the surface upon which the blocks rest, such as on a machine, worktable or a surface table. (Fig 11)

Fig 11



When round workpieces have to be clamped parallel to the edge of a machine worktable, one or two 'V' blocks are first set up parallel on the worktable, using clamps and setting blocks. (Fig 12)

Then a second clamp or pair of clamps is used to clamp the workpiece in the 'V' block(s). (Fig 13)

Fig 12

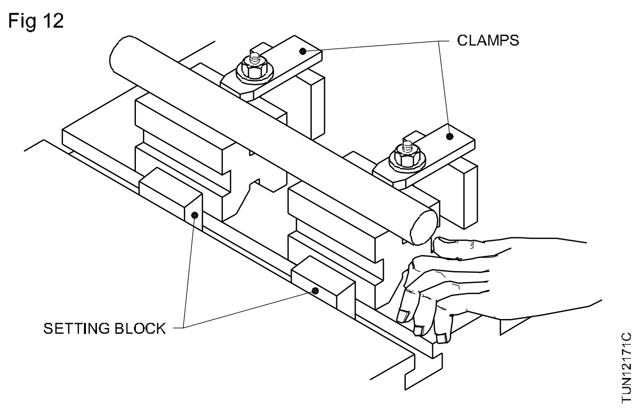
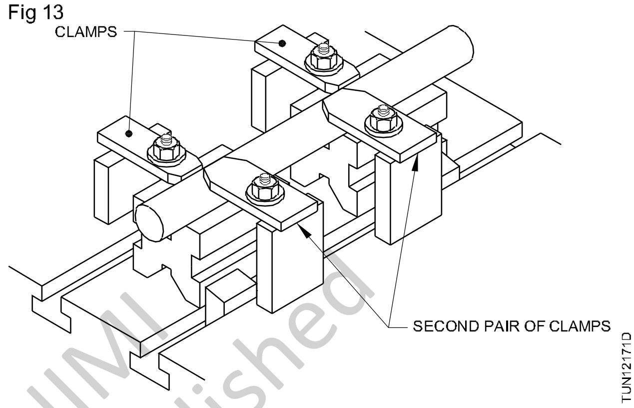
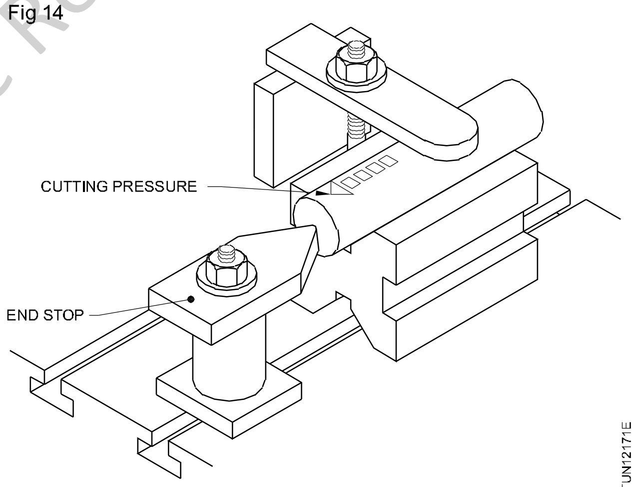


Fig 13



When machining operations are likely to push the workpiece out of position, an end stop can be used to prevent movement of the workpiece. The end stop is clamped to the machine work table as shown in Fig 14.

Fig 14



'V' blocks Grade 'A' will have a hardness of 650 to 700 HV (60 to 63 HRC)

'V' blocks Grade 'B' will have a hardness of 180 to 220 HB. 'V' blocks of both grades should be suitably stabilized.

Grade 'B' 'V' blocks are made from suitable quality closely grained cast iron.

In B.I.S. standard (IS: 2949-1974) a table is provided to indicate the dimensions of the 'V' blocks, together with the maximum and minimum diameters of the workpiece that can be accommodated on the 'V'block.

Straight edges

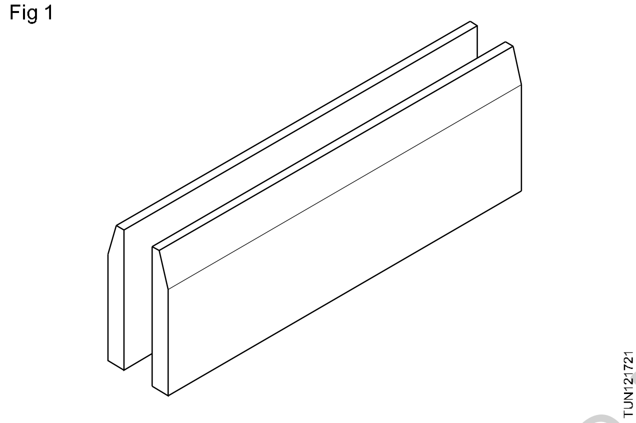
Objectives: At the end of this lesson you shall be able to
- **name the different types of straight edges**
- **state the features and uses of each type of straight edge**
- **state the different methods of testing straightness.**

For testing straightness and to use a guide for marking long straight lines, straight edges made of steel or cast iron are used.

Steel straight edges

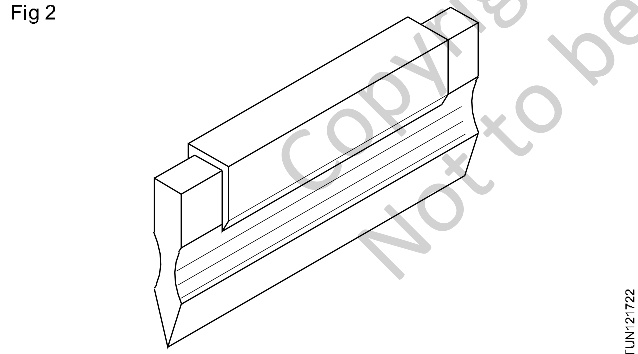
These are usually available up to 2 metres in length and may be rectangular in cross-section or have one edge bevelled. (Fig 1)

Fig 1



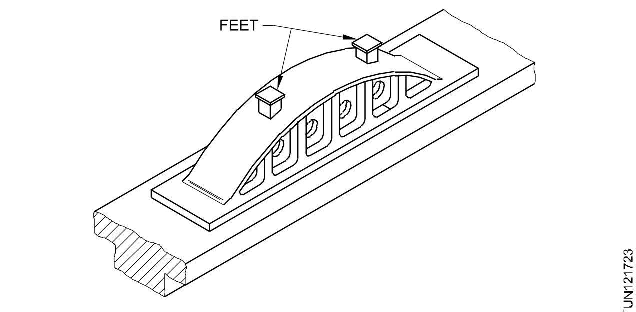
Toolmaker's steel straight edges are available in smaller lengths with bevelled edge. Some of these straight edges will have an acute angle of 60° for checking internal angles. (Fig 2)

Fig 2



Cast iron straight edges (Fig 3)

Fig 3



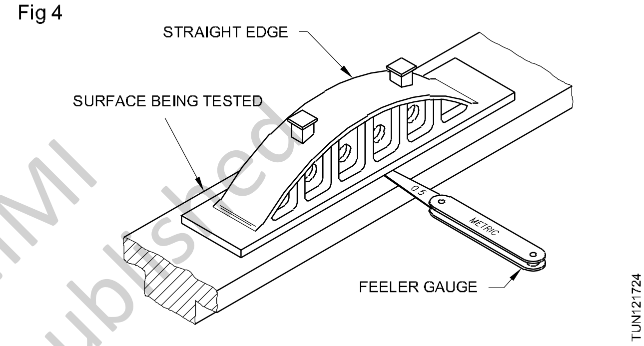
These are made from close-grained, grey, cast iron and can be considered as narrow surface plates. They are available up to 3 metres length and are used for testing machine tool slideways. Cast iron straight edges have ribs, and bow-shaped tops to prevent distortion. These straight edges are provided with feet to prevent distortion under their own weight.

Use of straight edges

Checking with feeler gauges

In certain situations when the gap between the surface and the straight edge is more, a feeler gauge can be used (Fig 4) to determine the extent of deviation.

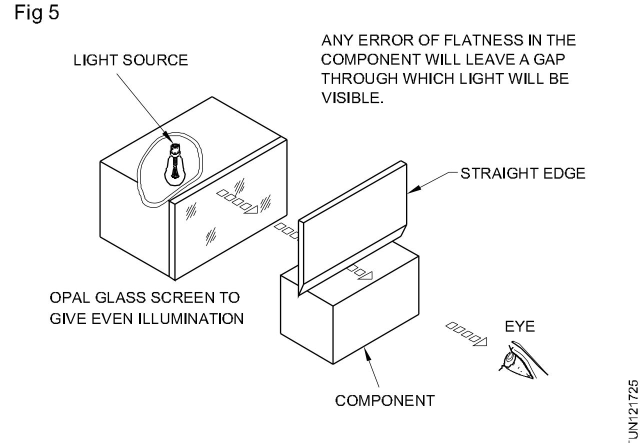
Fig 4



Use of light box

Where precision straight edges (toolmaker's) are used, a light box which can provide uniform illumination will be of advantage. Through the gap between the straight edge and the component a strip of light will be visible. (Fig 5) By practice the quality of surface can be determined by the amount of light passing through the non-contact surfaces.

Fig 5



From practice it is said that if the gap is more than 0.002 mm, white light will be seen, and if it is less than 0.002 mm, it will be tinted light.

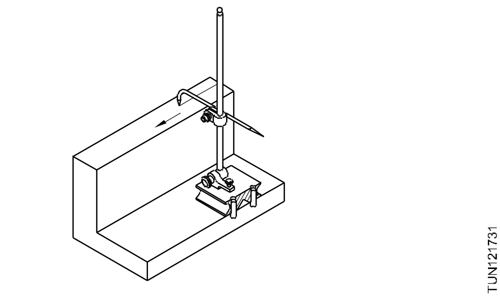
To make this judgement about the amount of deviation, one needs a great deal of practice. The same is applicable in the case of a try-square.

Surface gauges (or) Scribing block

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of surface gauges**
- **name the types of surface gauges**
- **state the uses of surface gauges**
- **state the advantages of universal surface gauges.**

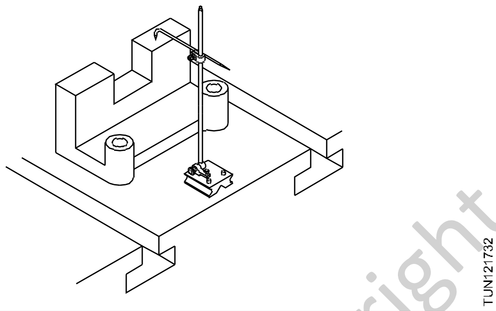
The surface gauge is one of the most common marking tools used for scribing lines parallel to a datum surface. (Fig 1)

Fig 1



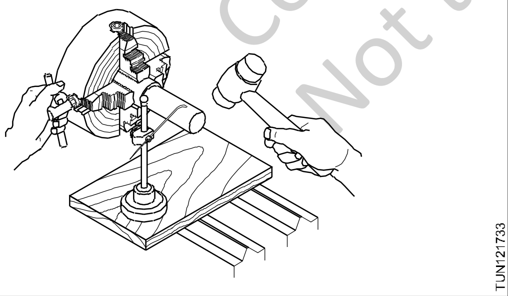
Setting jobs on machines parallel to a datum surface. (Fig 2)

Fig 2



Checking the height and parallelism of jobs, setting jobs concentric to the machine spindle. (Fig 3)

Fig 3



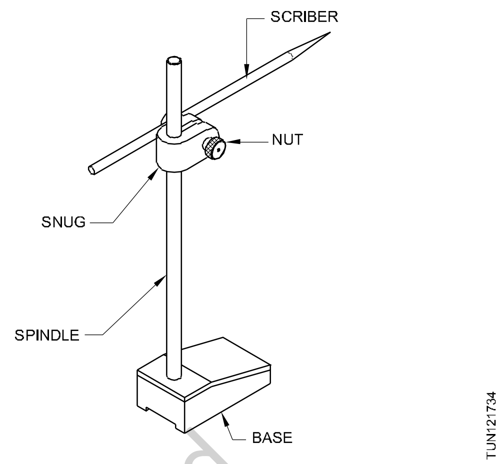
Types of surface gauges

Surface gauges/ scribing blocks are of two types, fixed and universal.

Surface gauge - fixed type (Fig 4)

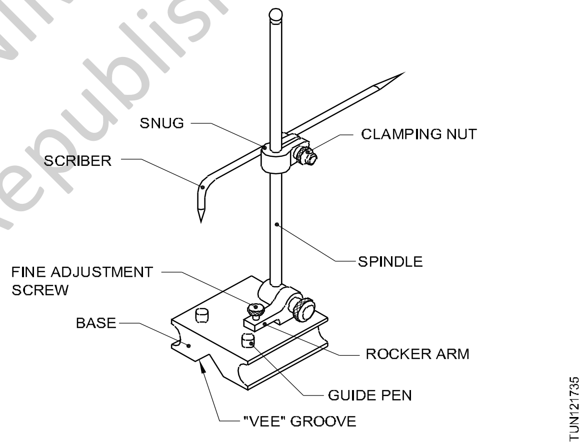
The fixed type of surface gauge consists of a heavy flat base and a spindle fixed upright, to which a scriber is attached with a spug and a clamp nut.

Fig 4



Universal surface gauge (Fig 5)

Fig 5



This has the following additional features.

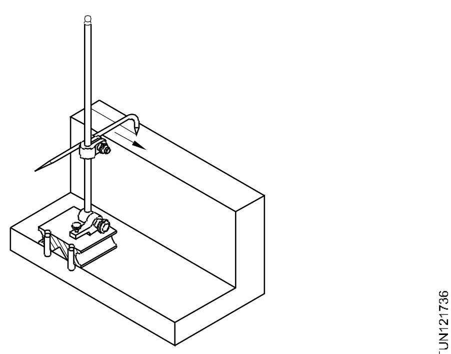
The spindle can be set to any position.

Fine adjustments can be made quickly.

Can also be used on cylindrical surfaces.

Parallel lines can be scribed from any datum edge with the help of guide pins. (Fig 6)

Fig 6



Parts and functions of a universal surface gauge

Base

The base is made of steel or cast iron with a V groove at the bottom. The 'V' groove helps to seat on circular work. The guide-pins, fitted in the base are helpful for scribing lines from any datum edge.

Rocker arm

The rocker arm is attached to the base along with a spring and a fine adjustment screw. This is used for fine adjustments.

Spindle

the spindle is attached to the rocker arm.

Scriber

The scriber can be clamped in any position on the spindle with the help of a snug and a clamping nut.

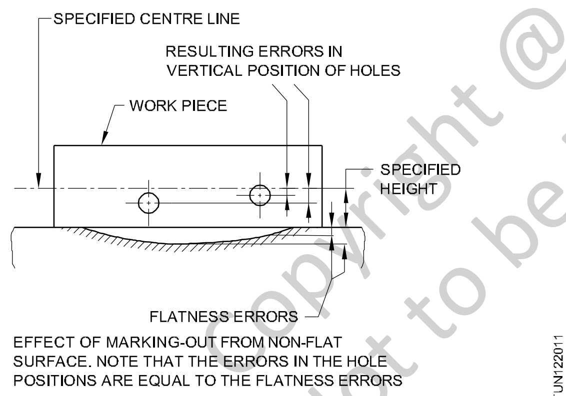
Surface plates

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of surface plates**
- **state the application of different grades of surface plates**
- **specify surface plates and state the constructional features and uses of marking tables.**

Surface plates - their necessity

When accurate dimensional features are to be marked, it is essential to have a datum plane with a perfectly flat surface. Marking using datum surfaces which are not perfectly flat will result in dimensional inaccuracies. (Fig 1) The most widely used datum surfaces in machine shop work are the surface plates and marking tables.

Fig 1

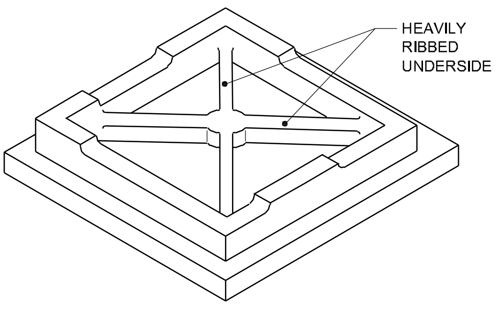


Materials and construction

Surface plates are generally made of good quality cast iron which are stress-relieved to prevent distortion.

The work-surface is machined and scraped. The underside is heavily ribbed to provide rigidity. (Fig 2)

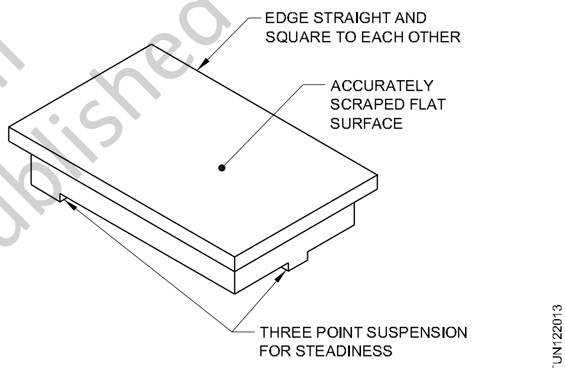
Fig 2



CAST IRON SURFACE PLATE

For the purpose of steadiness and convenience in levelling, a three point suspension is given. (Fig 3)

Fig 3



Smaller surface plates are placed on benches while the larger surface plates are placed on stands.

Other materials used

Granite is also used for manufacturing surface plates. Granite is a dense and stable material. Surface plates made of granite retain their accuracy, even if the surface is scratched. Burrs are not formed on these surfaces.

Classification and uses

Surface plates used for machine shop work are available in three grades - Grades 1, 2 and 3. The grade 1 surface plate is more acceptable than the other two grades.

Specifications

Cast iron surface plates are designated by their length, breadth, grade and the Indian Standard number.

Example

Cast iron surface plate 2000 x 1000 Gr1. I.S. 2285.

Drilling machines - Different parts

Objectives: At the end of this lesson you shall be able to
- **name the various types of drilling machine**
- **name the parts of the bench and pillar type drilling machines**
- **compare the features of the bench and pillar type drilling machines**
- **state the uses of centre punch.**

The principal types of drilling machines are

- the sensitive bench drilling machine
- the pillar drilling machine
- the column drilling machine
- the radial arm drilling machine (radial drilling machine).

(you are not likely to use the column and radial type of drilling machines now. Therefore, only the sensitive and pillar type machines are explained here.)

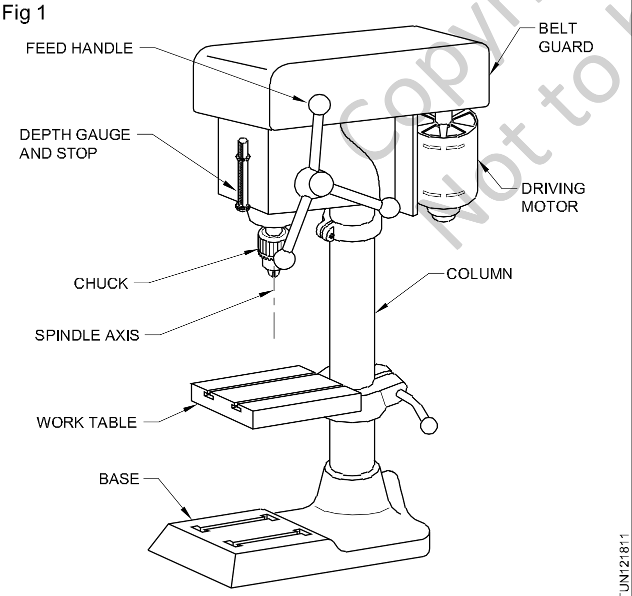
The sensitive bench drilling machine (Fig 1)

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. (Tilting arrangement not shown in Fig 1)

Fig 1



Different spindle speeds are achieved by changing the belt position in the stepped pulleys. (Fig 2)

The pillar drilling machine (Fig 3): 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.

Fig 2

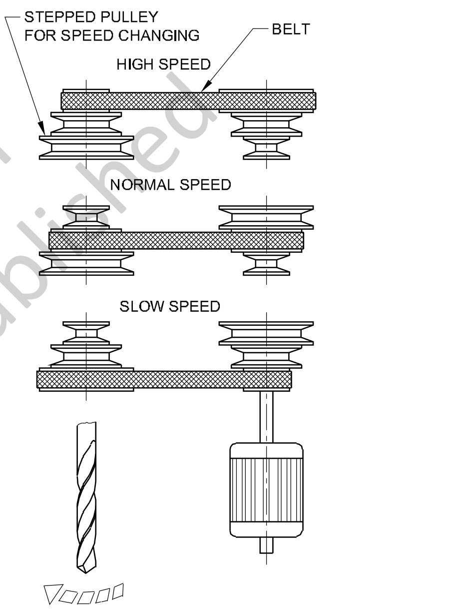
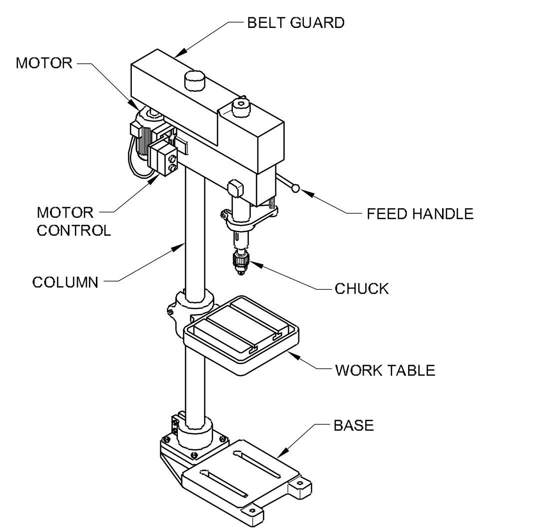
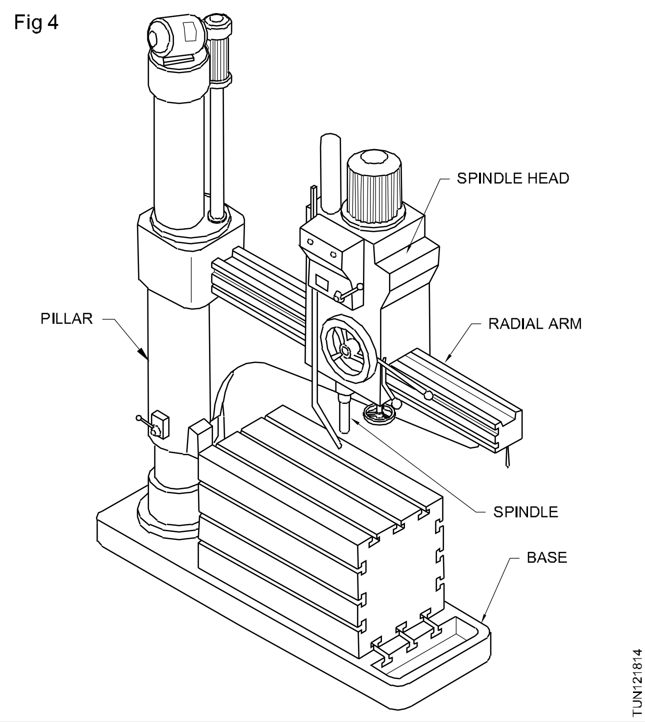


Fig 3



Radial drilling machines (Fig 4)

Fig 4



These are used to drill :

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

Features

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 centre. Therefore, the drill spindle can cover the entire working surface of the table. The arm can be lifted or lowered.

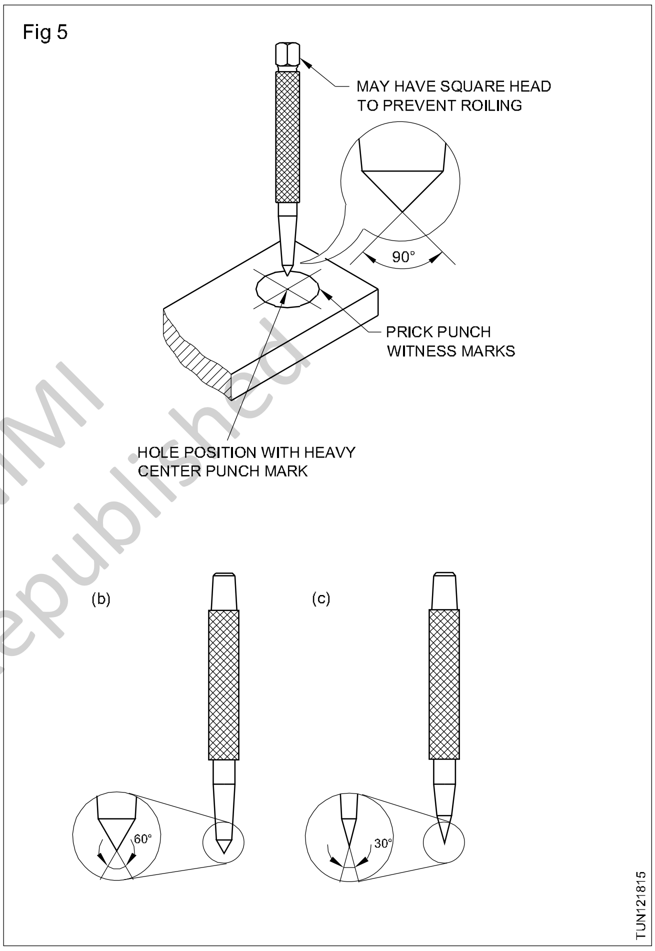
The motor mounted on the spindle head rotates the spindle.

The variable-speed gearbox provides a large range of r.p.m.

Centre punch

Centre punches are used to punch-mark centres of holes that are to be drilled, where a strong blow of hammer is needed to mark the centre point. A centre punch is made out of tool steel or high carbon steel, hardened, tempered and ground to an included angle of 90°. It is available in standard sizes; ranging from 8 mm to 12 mm in diameter to a length of 90 mm to 150 mm. The accuracy of a drilled hole depends to a certain extent by the mark of the centre punch. This will help the drill to guide in the required path. (Fig 5a)

Fig 5



Types of punches

Objectives: At the end of this lesson you shall be able to
- **name the different punches used in marking**
- **state the features of each punch and its uses.**

Punches are used in order to make certain dimensional features of the layout permanent. There are two types of punches. They are centre punch and prick punch made up of high carbon steel, hardened and ground.

Dot punch : The angle of the point is 60° It is used for witness marks. (Fig 5b)

Prick punch : The angle of the prick punch is 30°. The 30° point punch is used for making light punch marks needed to postion dividers. (Fig 5c)

The witness marks should not be too close to one another.

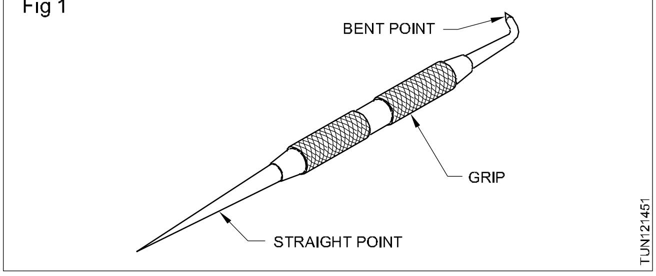
Scribers

Objectives: At the end of this lesson you shall be able to
- **state the features of scribers**
- **state the uses of scribers.**

In lay out work it is necessary to scribe lines to indicate the dimensions of the workpiece to be filed or machined. The scriber is a tool used for this purpose. It is made of high carbon steel and is hardened. For drawing clear and sharp lines, the point should be ground and lapped frequently for maintaining its sharpness.

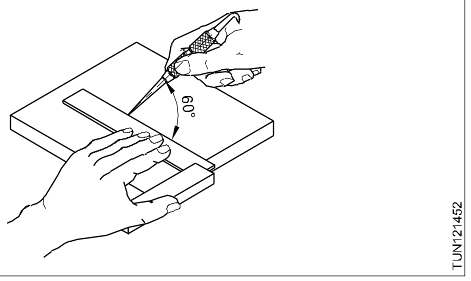
Scribers are available in different shapes and sizes. The most commonly used one is the plain scriber. (Fig 1)

Fig 1



While scribing lines, the scriber is used like a pencil so that the lines drawn are close to the straight edge. (Fig 2)

Fig 2



Scriber points are very sharp; therefore, do not put the plain scriber in your pocket.

Place a cork on the point when not in use to prevent accidents.

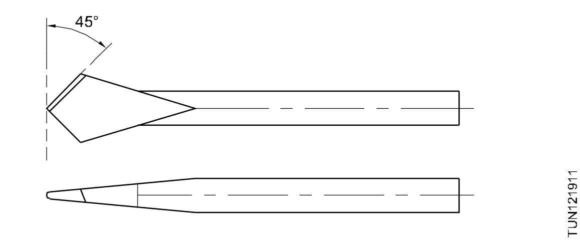
Nomenclature of drill

Objectives: At the end of this lesson you shall be able to
- **state the different types of drills**
- **identify the parts of a drill**
- **state the functions of each part of a drill.**

Drilling is a process of making holes on workpieces. The tool used for drilling is a drill and it is rotated with a downward pressure causing the tool to penetrate into the material.

Flat or spade drill (Fig 1)

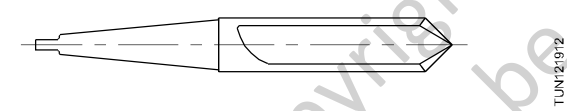
Fig 1



This type of drill is used where the required size of twist drill is not available. It is made from a round tool steel piece which is forged to shape and ground to size, and then hardened and tempered. This type of drill is used for hand drilling (without power) or with a ratchet brace.

Straight fluted drill (Fig 2)

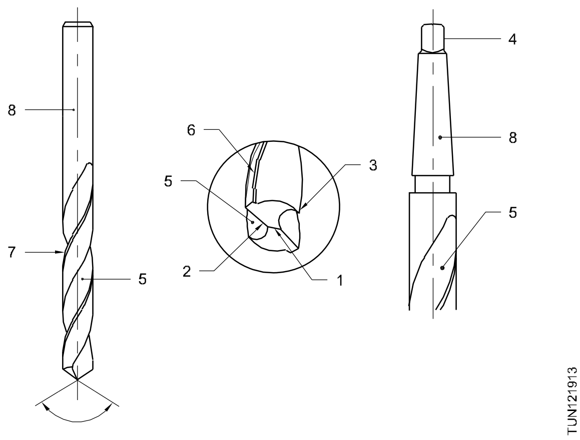
Fig 2



It has grooves or flutes running parallel to the drill axis. It is mainly used in drilling brass, copper or soft materials. This type of drill is inconvenient in standard practice as the chips do not come out from the hole automatically. It is used to drill sheet metals and cores in the castings.

Twist drills (Fig 3)

Fig 3



In this type, two spiral flutes or grooves run lengthwise around the body of the drill. It is the most common type of drill used for all purposes, and especially for faster drilling of accurate holes and for harder materials - in comparison with the other drills.

Parts of a twist drill (Fig 3)

Point

The cone shaped end which does the cutting is called the point. It consists of a dead centre (1), lips or cutting edge (2) and a heel (3).

Tang (4)

This is provided only on taper shank drills, for driving (giving torque to) the drill, which when overloaded, becomes twisted or gets sheared off.

Flutes (5)

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.

Shank (8)

This is the driving end of the drill which is fitted on to the machine. Shanks are of two types.

Taper shank, with Morse taper provided, is used for larger diameter drills, and the straight shank is used for smaller diameter drills.

Land/margin (6)

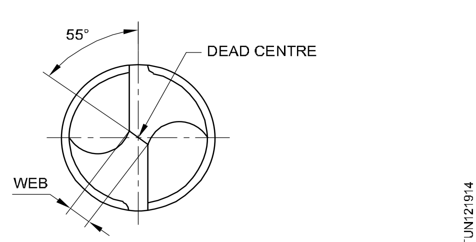
The land/margin is the narrow strip which extends to the entire length of the flutes. The diameter of the drill is measured across the land/margin.

Body clearance (7)

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

Web (Fig 4)

Fig 4



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

Material for twist drills

Twist drills, used in a machine shop, are usually made out of high speed steel. For drilling hard materials at higher cutting speeds, there are drills with carbide tips, brazed at the lips of the drill.

Hand taps and wrenches

Objectives: At the end of this lesson you shall be able to
- **state the use of hand taps**
- **state the features of hand taps**
- **distinguish between the different taps in a set**
- **name the different types of tap wrenches**
- **state the uses of the different types of wrenches.**

Use of hand taps: Hand taps are used for internal threading of components.

Features (Fig 1): 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.

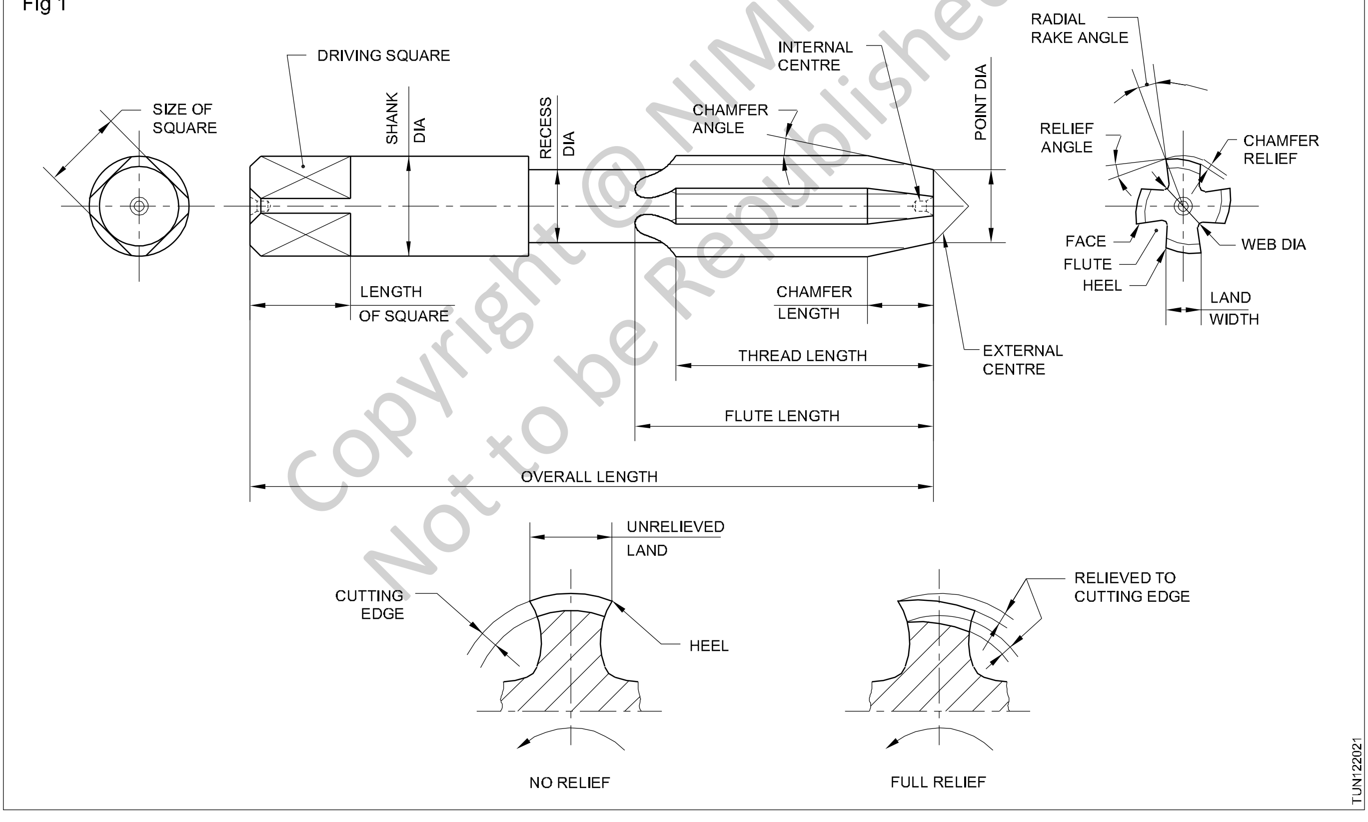
The end of the shank of the tap is made of square shape for the purpose of holding and turning the taps.

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.

Fig 1



Types of taps in a set: Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

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.

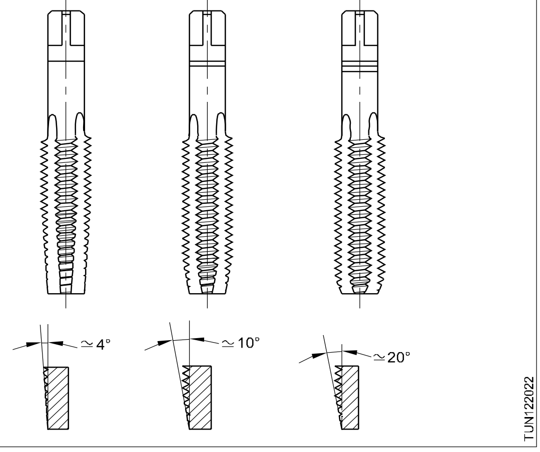
The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

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. (Fig 2)

Fig 2

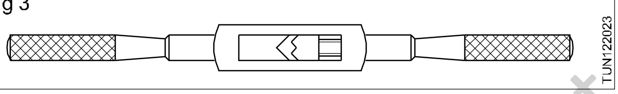


Tap wrenches: Tap wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

Tap wrenches are of different types, such as double-ended adjustable wrench, T-handle tap wrench, solid type tap wrench etc.

Double-ended adjustable tap wrench or bar type tap wrench (Fig 3)**:** This is the most commonly used type of tap wrench. It is available in various sizes - 175, 250, 350 mm long. These tap wrenches are more suitable for large diameter taps, and can be used in open places where there is no obstruction to turn the tap.

Fig 3

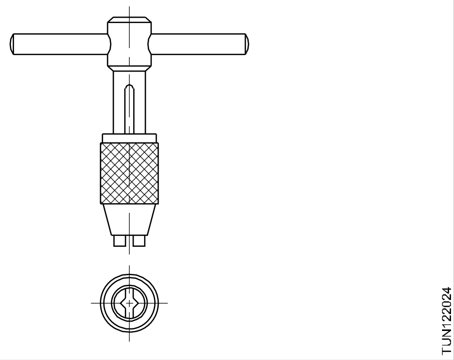


It is important to select the correct size of wrench.

T-handle tap wrench (Fig 4)**:** These are small, adjustable chucks with two jaws and a handle to turn the wrench.

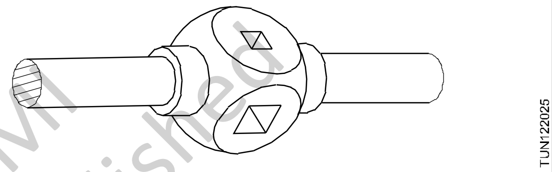
This tap wrench is useful to work in restricted places, and is turned with one hand only. Most suitable for smaller sizes of taps.

Fig 4



Solid type tap wrench (Fig 5)**:** These wrenches are not adjustable.

Fig 5



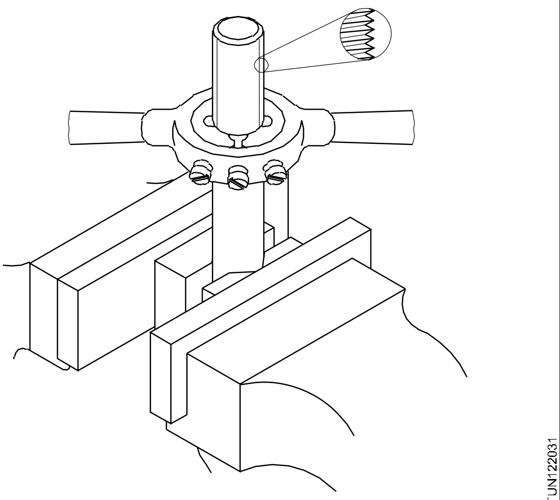
They can take only certain sizes of taps. This eliminates the use of wrong length of the tap wrenches, and thus prevents damage to the taps.

Die and die stock

Objectives: At the end of this lesson you shall be able to
- **list the different types of dies**
- **state the features of each type of die**
- **state the uses of each type of die**
- **name the type of the stock for each type of die**
- **determine the diameter of blank size for external thread cutting.**

Threading dies are used to cut external threads on cylindrical workpieces. (Fig 1)

Fig 1

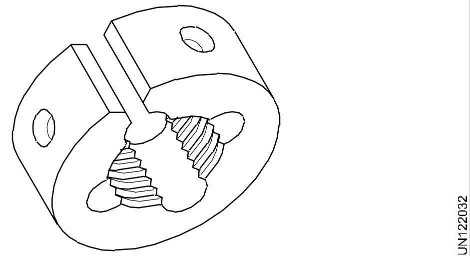


Types of dies: The following are the different types of dies.

- Circular split die (Button die)
- Half die
- Adjustable screw plate die.

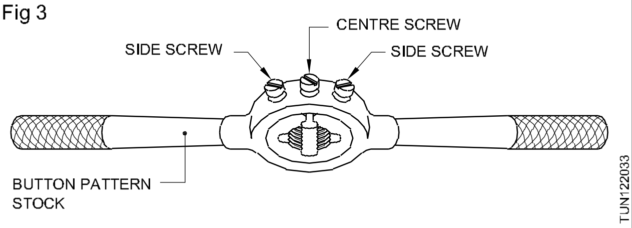
Circular split die/button die (Fig 2): This has a slot cut to permit slight variation in size.

Fig 2



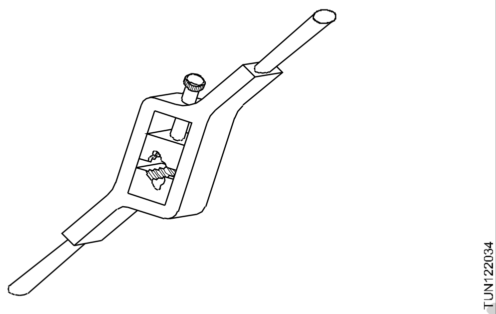
When held in the die stock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly. (Fig 3) For adjusting the depth of cut, the centre screw is advanced and locked in the groove. This type of die is called the button die.

Fig 3



Half die (Fig 4)**:** Half dies are stronger in construction.

Fig 4



Adjustments can be made easily to increase or decrease the depth of cut.

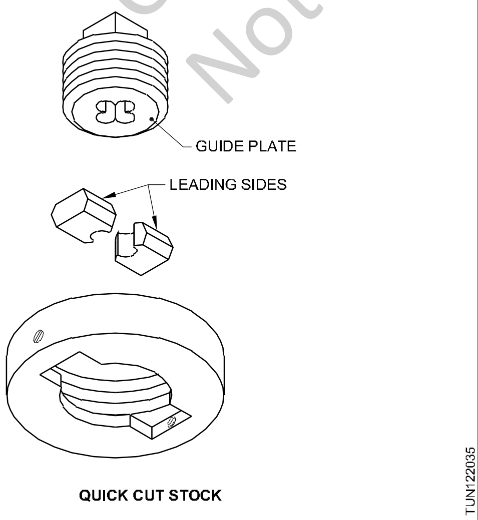
These dies are available in matching pairs and should be used together.

By adjusting the screw of the die, the die pieces can be brought close together or can be moved apart.

They need a special die-holder.

Adjustable screw plate die (Fig 5)

Fig 5



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.

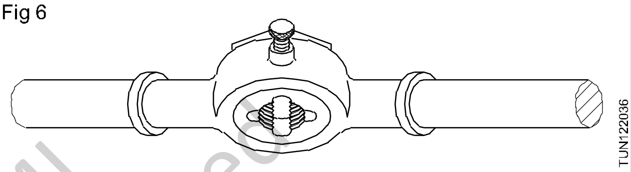
When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held.

The die pieces can be adjusted, using the adjusting screws on the collar.

The bottom of the die halves is tapered to provide the lead for starting the thread. On one side of each die head, the serial number is stamped. Both pieces should have the same serial numbers.

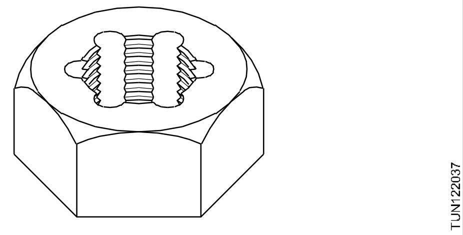
This type of die stock is called quick cut die stock. (Fig 6)

Fig 6



Die nut (Solid die) (Fig 7)**:** The die nut is used for chasing or reconditioning the damaged threads.

Fig 7



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.

Determining the diameter of blank size for external thread cutting

Why should the blank size be less?

It has been observed from practice that the threaded diameters of steel blanks show a slight increase in diameter. Such increase in the diameter will make the assembly of external and internal threaded components very difficult. To overcome this, the diameter of the blank is slightly reduced equal to 0.1 x pitch of the thread before commencing the threading.

Tap drill size

Objectives: At the end of this lesson you shall be able to
- **state what is tap drill size**
- **choose the tap drill sizes for metric and BSW thread tables**
- **calculate the tap drill sizes for metric ISO metric and ISO 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 minus 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 =

$$\text{Major diameter} - \frac{1\ \text{inch}}{\text{No.of threads per inch}}$$

$$= 1'' - \tfrac{1}{8}'' = \frac{8-1}{8}'' = \tfrac{7}{8}''$$

$$= \tfrac{7}{8}''$$

Compare this with the table of drill sizes for unified inch threads.

What will be the tap size for the following threads?

a) M20

b) BSW 3/8

Refer to the chart for determining the pitches of the thread.

Table for tap drill size

Nominal diameter M.M	ISO Metric (60°)		B.S.W. (55°)		Tap drill sizes
	Pitch	Tap drill sizes	Nominal diameter (inch)	Threads per inch (mm)	
3	0.5	2.50	1/8	40	2.5
4	0.7	3.30	5/32	32	3.2
5	0.8	4.20	3/16	24	4.0
6	1.0	5.00	1/4	20	5.0
8	1.25	6.80	5/16	18	6.5
10	1.50	8.0	3/8	16	8.0
12	1.75	10.20	1/2	12	10.5
14	2.00	12.00	9/16	12	12.5
16	2.00	14.00	5/8	11	14.00
18	2.50	15.50	3/4	10	16.00
20	2.50	17.50	13/16	10	18.00
22	2.50	19.50	7/8	9	19.5
24	3.00	21.00	1	8	22.2

Tap extractor

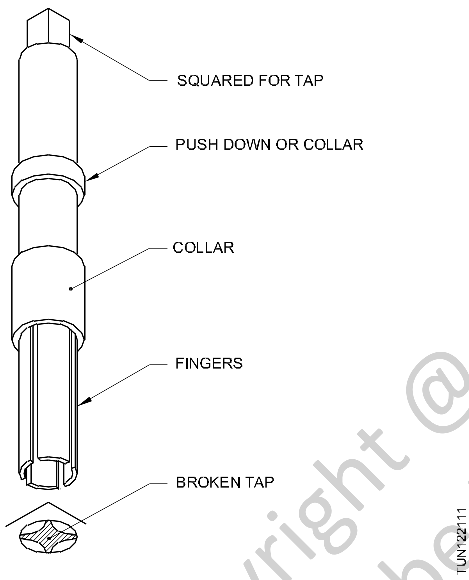
Objectives: At the end of this lesson you shall be able to
- **name the different methods of removing broken taps**
- **state the methods of removing broken taps.**

A tap broken above the surface of the workpiece can be removed using gripping tools like pliers.

Taps broken below the surface pose a problem for removing. Any one of the several methods given below can be used.

Use of tap extractor (Fig 1)

Fig 1



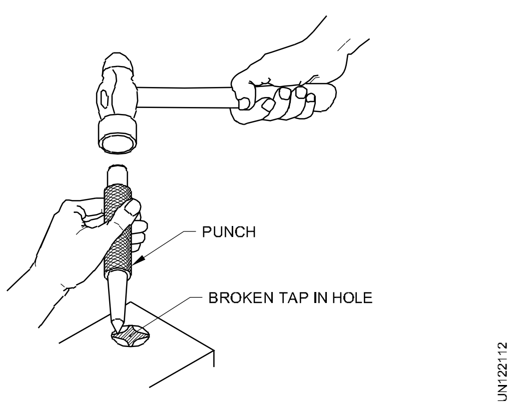
This is a very delicate tool and needs very careful handling.

This extractor has fingers which can be inserted on the flutes of the broken tap. The sliding collar is then brought to the surface of the work and the extractor turned anticlockwise to take out the broken tap.

A light blow on the broken tap with a punch will help to relieve the tap if it is jammed inside the hole.

Use of punch (Fig 2)

Fig 2

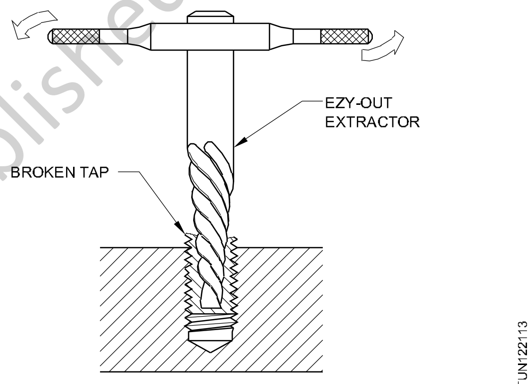


In this method the point of the punch is placed in the flute of the broken tap in an inclination and struck with a hammer. The positioning of the punch should be such that the broken tap is rotated anticlockwise when struck.

Annealing and drilling the tap

This is a method adopted when other methods fail. In this process the broken tap is heated by flame or by other methods for annealing. A hole is then drilled on the annealed tap. The remaining piece can be removed either by using a drift or using an EZY-OUT (extractor). This method is not suitable for workpieces with low melting temperatures such as aluminium, copper etc.(Fig 3)

Fig 3



Use of arc welding

This is a suitable method when a small tap is broken at the bottom of materials like copper, aluminium etc. In this method the electrode is brought in contact with the broken tap and stuck so that it is attached with the broken tap. The tap may be removed by rotating the electrode.

Use of nitric acid

In this method nitric acid diluted in a proportion of about one part acid to five parts of water is injected inside. The action of the acid loosens the tap and then it is removed with an extractor or with a nose plier. The workpiece should be thoroughly cleaned for preventing further action of the acid.

While diluting acid mix acid to water.

Use of spark erosion

For salvaging certain precision components damaged due to breakage of taps, spark erosion can be used. In this process, the metal (broken tap) is removed by means of repetitive spark discharges. The electrical discharge occurs between an electrode and the electro-conductive workpiece (tap) and the minute particles are eroded both from the electrode and the workpiece. In many cases it may not be necessary to remove the broken tap completely. (After a small portion has been eroded, a screwdriver or punch can be used to remove the remaining portion of the tap.)

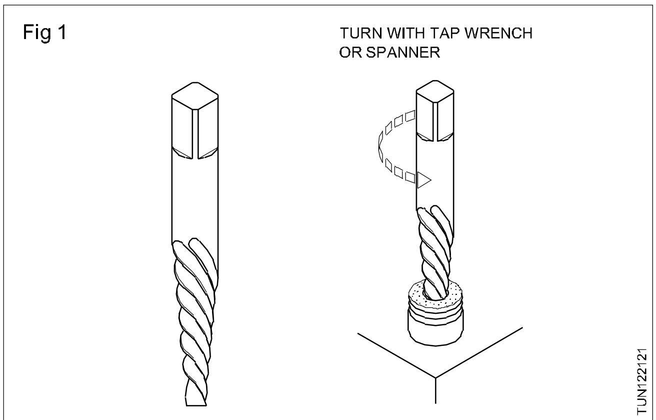
The shape of the electrode also need not be round. It can be square or in the form of a slot on the workpiece for assisting the tools for rotating the broken tap.

Methods of removing broken studs

Objectives: At the end of this lesson you shall be able to
- **name the different methods used for removing broken studs**
- **state the situations in which each of the above methods is applied.**

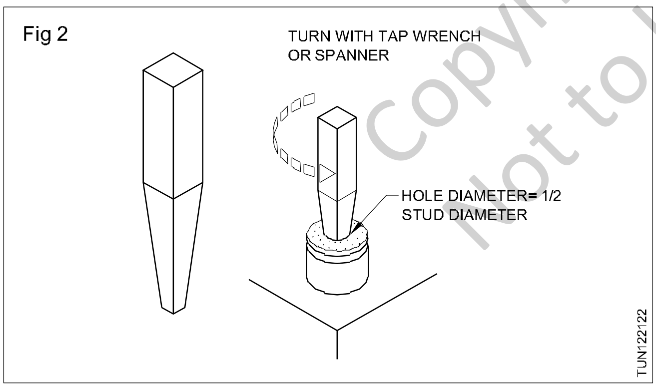
When studs or screws are broken the following methods are used for removing them.

Screw extractor (Fig 1)



Screw extractors are available in different sizes. Depending on the size of the broken stud a hole is first drilled. A screw extractor is then inserted into the hole and turned anticlockwise until it is tight. Turning further will loosen the stud.

Tapered square drift (Fig 2)

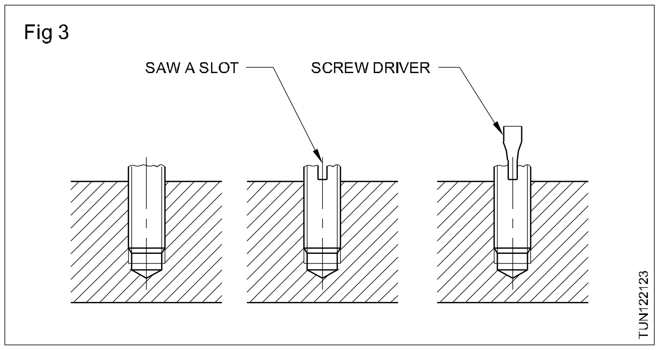


First a hole approximately to half the diameter and to about half the length of the broken stud may be drilled. A tapered drift with a square head is then driven into the hole.

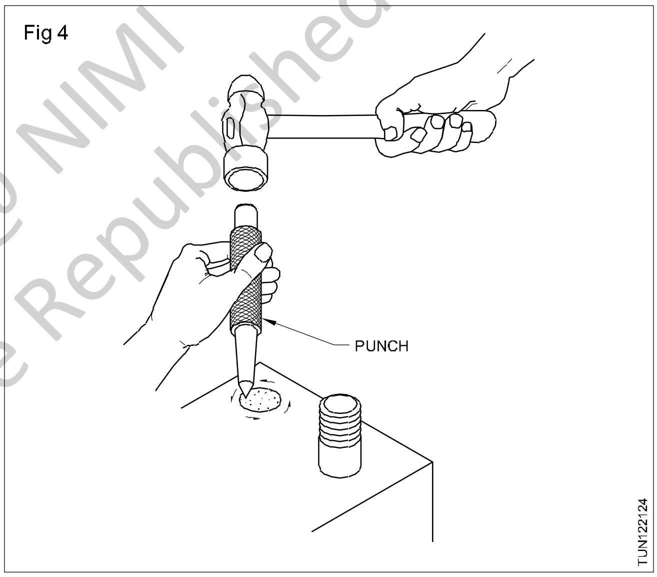
Use a tap wrench or spanner and rotate the drift for unscrewing the stud.

Using a screwdriver (Fig 3)

If there is sufficient projection of the broken stud, cut a slot with a saw and unscrew it with a screwdriver. This method is suitable only for small diameter studs.

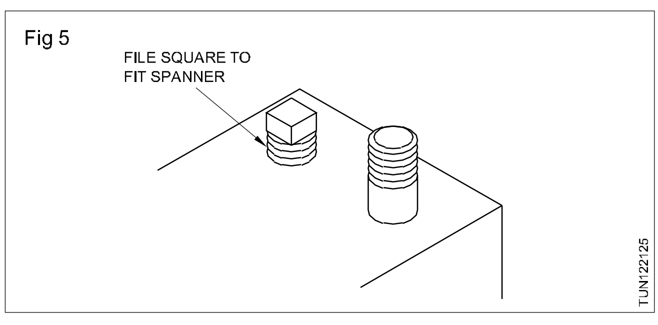


Punch and hammer (Fig 4)



If the breakage of the stud is near the surface, sometimes it can be removed by using a punch. The punch is used to direct blows at different points to loosen the stud. Be sure the punch is used in the direction of unscrewing.

Using spanner (Fig 5)



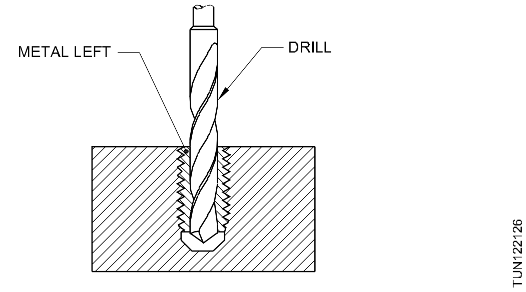
Large diameter studs which are broken above the surface can be removed by shaping a square head and then removing by a spanner.

By drilling (Fig 6)

Broken studs which are very stubborn can be drilled through. The remaining metal can be removed using a tap or a scriber point.

Sometimes it may be necessary to remove the stud completely by drilling and re-threading for oversize stud.

Fig 6



Centre lathe and its parts

Objectives: At the end of this lesson you shall be able to
- **name the main parts of a lathe**
- **state the safety precautions to be observed when working on a lathe.**

Turning and centre lathe

Turning is a machining process to bring the raw material to the required shape and size by metal removal. This is done by feeding a cutting tool against the direction of rotation of the work.

The machine tool on which turning is carried out is known as a lathe.

Constructional features of a lathe

A lathe should have provision :

- to hold the cutting tool, and feed it against the direction of rotation
- to have parts, fixed and sliding, to get a relative movement of the cutting tool with respect to the rotation of the work
- to have accessories and attachments for performing different operations.

The following are the main parts of a lathe. (Fig 1 & 2)

Headstock

Tailstock

Carriage

Cross-slide

Compound slide

Bed

Quick change gearbox

Legs

Feed shaft

Lead screw

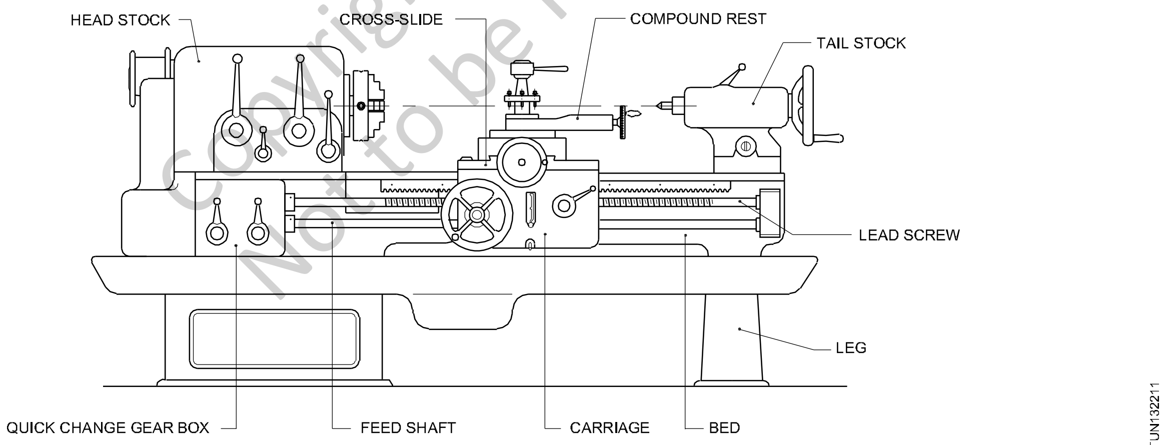
Safety precautions

Before working

Ensure that the electrical power supply is as needed for the machine.

Ensure that the safety guards are in proper condition. Ensure that the work area is clean and tidy.

Fig 1



Ensure that the meshing gears are in proper mesh, and the power feed levers are in neutral.

Ensure that the automatic lubricating system is functioning.

During working

Shift the levers to change the speeds and feeds only when the rotating parts are fully stationary.

Wear an apron (not too loose) with the sleeves of the shirt folded.

Avoid wearing rings and watches when working. Wear shoes to avoid injury to your feet.

Remove the chips by a hook, and use a brush to clear them.

After working

Clean the machine with a brush and wipe with cotton waste.

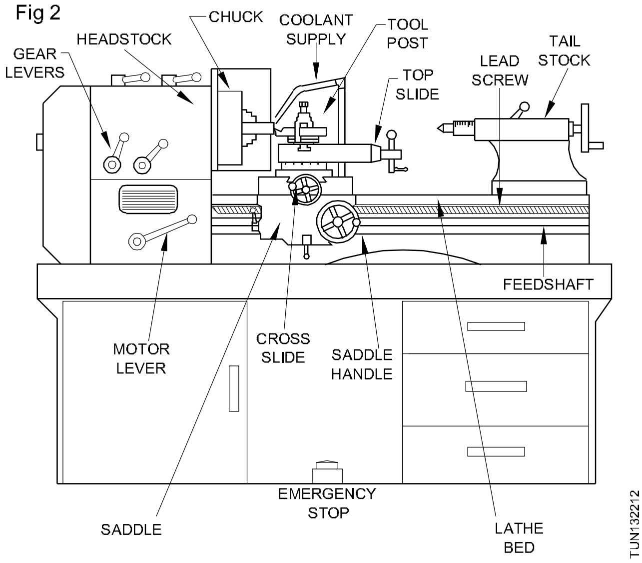
Oil the bed-ways and the lubricating points.

Clean the precision instruments and hand them over to the instructor for safe keeping.

Clean the cutting tools and place them in their respective places.

Clean the area surrounding the lathe by wiping the spilt oil and coolant, and remove the swarf.

Fig 2



Various Lubrication Points

1 Place a few drops of oil on the rockershaft bearing and cams every time the lathe is in use.

2 Countershaft roller bearing - Fill both grease cups with automotive cup grease every two weeks. Give the grease cup caps a turn or so every time the lathe is used.

3 Place a few drops of oil on the rockershaft lever bearings and lever fulcrum bearing every time lathe is used.

4 Motor bearings - sleeve type motors have two oil cups which should be filled once a week with S.A.E. No. 10. Motor oil or equivalent. Ball bearing motors have a sealed in - type bearing-every six months the small headless screw in these bearings should be removed and a moderate quantity of automotive cup grease forced around the bearing.

5 Left and right headstock bearings - oil with No.10 motor oil or equivalent every time the lathe is used.

6 Spindle pulley - every time the lathe is used in backgear, remove the small screw in the bottom of the second step of the idler pulley and oil freely with No. 10 motor oil or equivalent. Replace screw.

7 Back gear spindle - every time the back gears are used, remove the small screw in the centre of the back gear spindle and oil freely with No.10 motor oil or equivalent. Replace screw.

8 Back gears and change gears - A small amount of keystone No.122 heavy outer gear lubricant or equivalent applied to the gear teeth will aid in obtaining smoother, more quiet operation. Be sure to remove all oil in the gear teeth before applying this lubricant or it will not adhere.

9 Change gear bearings - put a few drops No.10 motor oil or equivalent on the change gear bearings each time the lathe is used.

10 Lead screw stub bearing and reversing gears - put a few drops of No. 10 motor oil or equivalent in the three oil holes on the top of the reversing gear box every time the lathe is used.

11 Carriage traverse gear case - every time the lathe is in use, put a few drops of No. 10 motor oil in oil hole on top of gear case on back of carriage apron.

12 Carriage hand wheel bearing - put a few drops of No.10 motor oil or equivalent in the ball spring oil hole every time the lathe is used.

13 Cross feed gear bearing - put a few drops of oil in the ball spring oil hole every time lathe is used.

14 Half-nut lever bearing-put a few drops of No.10 motor oil or equivalent in the ball spring oil hole every time the lathe is used.

15 Thread dial-once a week put a few drops of No.10 motor oil or equivalent around the rim of the top of the thread dial.

16 Wipers (front and back) - saturate the felts in the four wipers, located on the carriage with oil every time the lathe is used.

17 Cross slide screw - Put a few drops of No.10 motor oil or equivalent in the oil hole above the front cross slide screw bearing after removing the small screw. Replace the screw. This should be done every time the lathe is used. Clean the cross slide screw regularly with a small stiff brush. Oil the screw threads by running the compound rest back and forth.

18 Cross feed gears - put a few drops of oil in the oil hole above the cross feed screw after removing the small screw. Replace the screw. This should be done every time the lathe is used.

19 Cross slide ways - clean regularly and apply a liberal quantity of No. 10 motor oil or equivalent to the ways whenever the lathe is used.

20 Compound slide screw - every time the lathe is used put a few drops of No.10 motor oil or equivalent in the oil hole on top of the compound rest and above the compound screw bearing.

21 Compound slide ways - clean regularly and apply a liberal quantity of No.10 motor oil or equivalent to the ways whenever the lathe is used.

22 Lead screw - about once a month clean the lead screw threads with kerosene and a small stiff brush and apply a small amount of No.10 motor oil or equivalent.

23 Rack (on bed, under front way) - about once a month apply a small amount of cup grease to the rack after cleaning with kerosene and a small stiff brush.

24 Lead screw bearing (right end of lathe) - put a few drops of No.10 motor oil or equivalent in the oil hole on top of the bearing every time the lathe is used.

25 Place a few drops of oil between the handwheel and screw bearing when ever using lathe.

26 Tailstock center lubricant - fill the small cup on the tailstock with a mixture of white lead and oil and apply to the tailstock center whenever turning between centres. If white lead is not available, use a liberal amount of cup grease on the center.

27 Tailstock ram - keep the outside surface of the tailstock ram well oiled.

28 Lathe bed ways - keep the bed ways oiled at all times with No.10 motor oil or equivalent and free from chips. Wipe off the ways before using and cover with fresh oil. Always leave a generous film of oil on the ways when the lathe is not in use. The lathe should be completely covered when not in use. During all grinding operations cover bed ways with canvas or carboard.

Keep all the lathe bearing surfaces perfectly clean. Dirt is the natural enemy of accurate lathe work.

Machine and machine tool

Objectives: At the end of this lesson you shall be able to
- **distinguish between machine and machine tool**
- **history of lathe.**

Machine

Machine is a device that perform a particular work like sewing machine. Sewing machine sew and stich cloth. But can't make its own parts.

Fundamentals of amchine tools

Introduction

A machine tool is a device that utilizes electric energy for shaping and sizing a product by removing excess material in the form of chips, with the help of cutting tool.

Machine tools are used for producing components at a rapid rate. Optimum productivity from machine tool calls for a fairly high degree of skill. Properly carried out operations are capable of producing a large number of components at a fairly rapid rate.

Machine tools and machines are two different things. Machine tools when taken as a group cam produce a machine tool, which is not true of machines.

Lathe, milling machine, shaping machine, slotter etc., are all machine tools.

Define

A machine tool is a power driver machine, capable of holding and supporting the work and tool and the same time directing and guiding the cutting tool or job or both to perform various metal cutting operations for providing different shapes and sizes.

Every metal working machine cannot be called a machine tool merely because it removes material. Forging hammers, drawing dies, extruders, rolling machine etc., are not machine tools.

Functions of machine tools

1 To hold and support the workpiece to be machined.

2 To hold and support the cutting tool.

3 To provide requisite motion to the workpiece tool or both.

4 To regulate the cutting speed and feed of the tool and workpiece.

5 To hold variuos attachments for different operations. Jobs and tools are held in properly designed devices on a machine tool. Different machine tools are provided with different holding devices.

In a workshop, a machine tool is generally used for producing different shapes and for finishing the surfaces.

Classification of machine tools

1 According to the type of the surface generated.

   i) Cylindrical work machine tools - Lathes, capstan, turret etc.,

   ii) Flat surface machine tools - milling m/c, shapping m/c, planning m/c etc.,

2 Classification based on the purpose of the m/c tool.

   i) Single - purpose

   ii) Multi purpose

   iii) Special purpose

   iv) Transfer machine

   v) Numerically controlled

3 Classification based upon the size of chip

   i) Machine tools using cutting tools - lathe, milling, planner, slotter etc.,

   ii) Machine tools using abrasives - honing, lapping etc.,

Machine tool performance criteria

While designing a machine tool the following factors need consideration.

1 It should be safe and easy to operate.

2 It should be accurate.

3 It should have good production capacity.

4 The operational cost should be low.

5 Controls should be located at convenient points.

6 Blanks should be such that they can be loaded and clamped easily.

Factors in machining operations

The operations of removing metal by means of a cutting tool using some sort of machine tool in order to obtain a desired shape is called machining.

It includes number of operations such as turning boring, shaping, milling etc.,

The selection of a machine tool for a particular operation depends upon many factor such as

1 The shape and size of the product required.

2 The quantity of material to be removed.

3 The type of operation to be performed.

4 The number of components required.

5 The type of material to be handed.

6 the degree of accuracy required.

The - longitudinal axis tool holding equipment

Lathe introduction

Lathe is a machine widely used for wood works and machining of metal parts. Lathe is a machine which turns the work piece against a machine tool. The lathe is used for facing, turning, knurling, taper cutting, threading, gear cutting and many other metal and wood works.

History of lathe

Lathe is a very ancient tool and its first use dates back to 1300 BC in Egypt. LAthe was also known and used in assyria and greece. Ancient romans came to know about this machine and they further developed this machine. During the medieval period, the use of this machine had spread to most parts of Europe and it was during the industrial revolution when this machine gained popularity with its use in all the industries. After the development of electronics, automated lathes have been developed.

Evolution of lathe

The first lathe was a simple lathe which is now referred to as two person lathe. One person would turn the wood work piece using rope and the other person would shape the work piece using a sharp tool. This design was improved by ancient romans who added a turning bow which eased the wood work. Later a pedal (as in manual sewing machines) was used for rotating the work piece. This type of lathe is called “spring pole” lathe which was used till the early decades of the 20th century. In 1772, a horse-powered boring machine was installed which was used for making cannons. During the industrial revolution, steam engines and water wheels were attached to the lathe to turn the work piece at higher speed which made the work faster and easier. After 1950, many new designs were made improved the precision of work.

Lathes are classified depending upon their application and functionality as

Light duty lathe - These machine find their application in automobile, electronic, electrical industries and are manufactured from quality tested raw materials.

Medium duty lathe - These machines are powerful than the light duty lathes and can work on bigger work pieces and have more strength than the light duty lathes.

Heavy duty lathe - these machines are manufactured from hightest grades of materials like iron and steel. They are designed for high precision heavy duty operations.

All geared lathe - In all geared lathe, all the rotating components of the machines are driven by the same source at different speeds by using gears to perform various operations.

Imported lathe - Imported lathes are high quality lathes used for high precision operations.

Depending upon the modes of operation, the lathes can be classified as

Manual lathe - In these lathes, the tool handling is done manually and so the precision of work also depends upon the skill of the person handling the machine.

CNC lathe - CNC lathes are completely automated lathes. We just have to feed the instructions into the computer and the lathe will perform the operations according to the data fed to the computer.

Classification of lathe

Objectives: At the end of this lesson you shall be able to
- **state the different types of lathes and their uses**
- **state the method of specifying a centre lathe.**

Types of lathe

1 Speed lathe
   a) Wood working
   b) Centering
   c) Polishing
   d) Spinning
2 Engine lathe (or) centre lathe
   a) Belt drive
   b) Individual motor drive
   c) Gear head lathe
3 Bench lathe
4 Tool room lathe
5 Capstan and turret lathe
6 Special purpose
   a) Wheel lathe
   b) Gap bed lathe
   c) T-lathe
   d) Duplicating lathe
7 Automatic lathe
8 CNC machine

Speed lathe

- The speed lathe has been so named because of very high speed head stock spindle.
- It consists of head stock, tailstock and tool post mounted on adjustable slide.
- Tool is fed into the work by hand control.
- It has no gear box lead screw and carriage.
- Different speeds are obtained by cone pulley (1200-3600rpm)
- Wood working, spinning, polishing, centering operations can be performed.

Engine lathe (or) centre lathe

- The term engine is because of that early lathes were driven by steam engine.
- It consists of basic parts like bed, head-stock and tail stock but head-stock is more robust and has additional drive mechanism for multiple speeds.
- Engine lathe can feed cutting tool both in cross and longitudinal directions with the help of carriage, feed rod, and leadscrew.
- Belt drive lathe gets power from an over head line shaft equipped with speed cone and one or more back gears.
- Individual motor driven lathe gets power from individual motor.
- A geared head lathe gets its power from constant speed motor and all speed changes are obtained by shifting various gears located in the headstock.

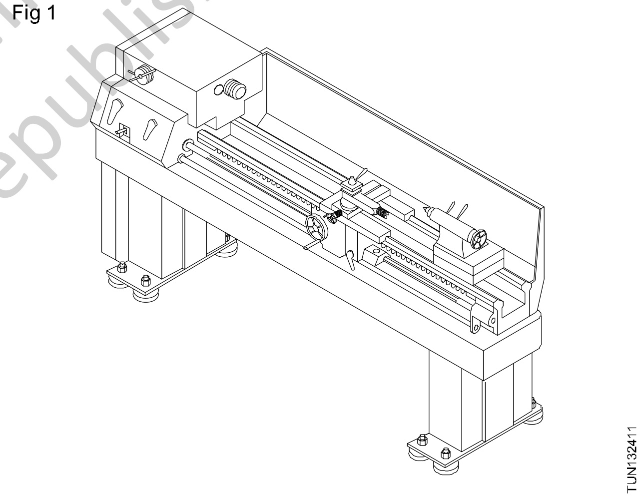
Bench lathe

- It is mounted on bench and has the same features like engine lathe.

Tool room lathe (Fig 1)

- It has the same features like engine lathe and has very low to high speed up to 2500rpm.

Fig 1



- It has taper turning attachment, draw in collet attachment, thread chasing dial, relieving attachment, steady and follower rest, pump for coolant.
- Used for precision work on tools, dies, gauges.

Capstan and turret lathe (Fig 2 & 3)

Fig 2

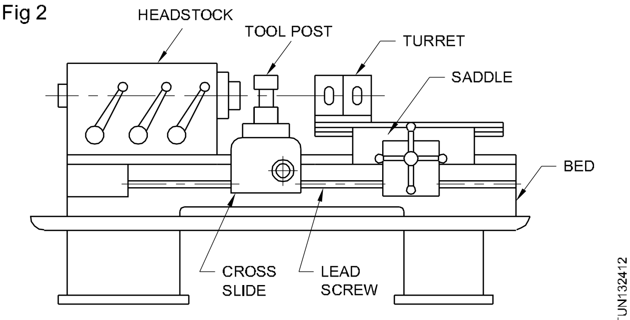
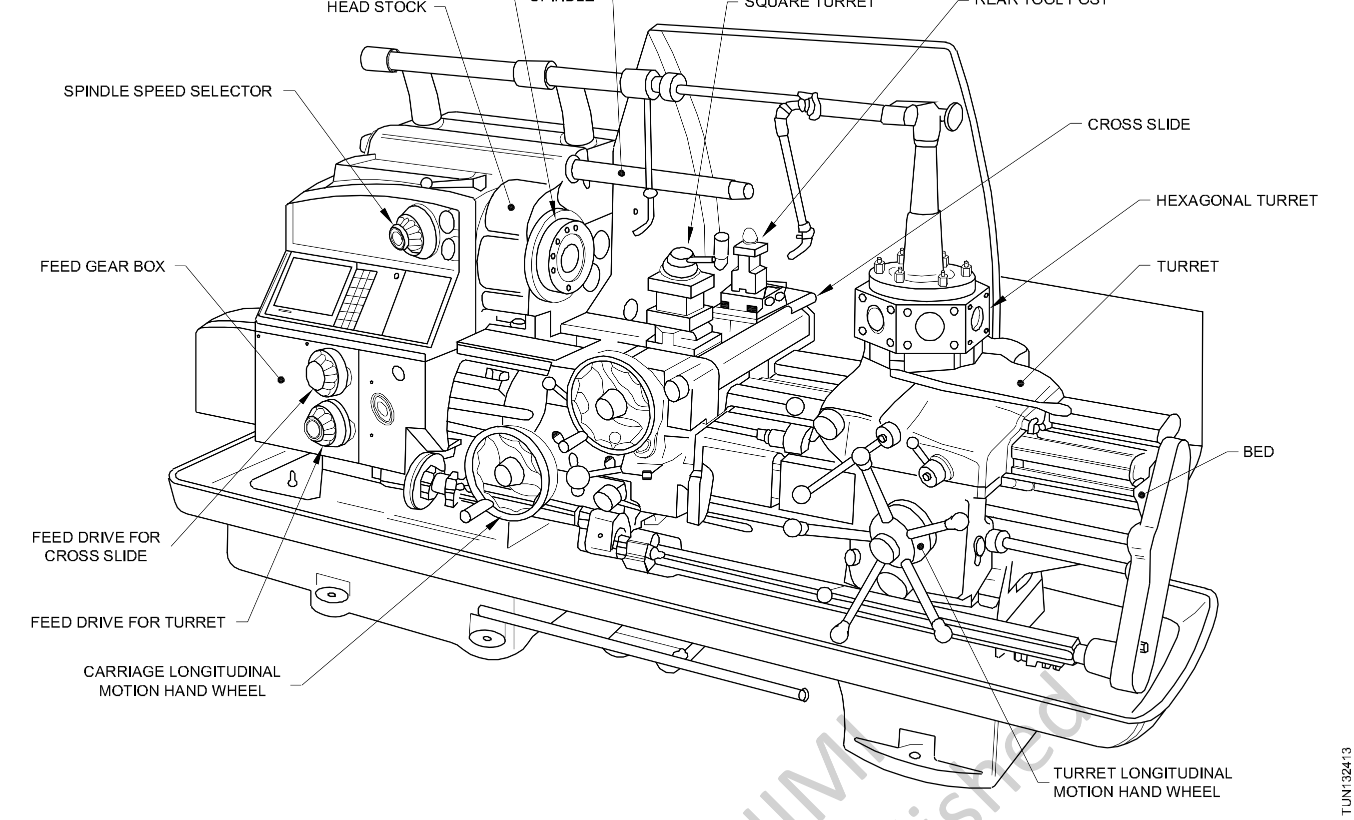


Fig 3



- These are developed from engine lathe, used for production work.
- Tailstock of an engine lathe is replaced by hexagonal turret where number of tools can be mounted.
- Number of identical parts can be produced in minimum time.

Special purpose lathe

- These are used for special purposes.
- Wheel lathe is used for finishing the journal and turning the thread on locomotive wheels.
- The gap bed lathe can accommodate the jobs having extra diameter.
- T-lathe is intended for machining the rotors for jet engines, axis of bed is right angles to the axis of head stock spindle.
- Duplicating lathe is used for duplicating the shape of given tamplate using mechanical or hydraulic system.

Special purpose lathe

- These are high speed, heavy duty, mass production lathes with complete automatic control.
- Once the tools are set and machine is started it performs automatically all the operations to finish at a time.
- Change of tools, speeds and feeds can be done automatically, operator can run 5 to 6 machines at a time.

CNC machine (CNC Fig)

- Complex shapes machined easily.
- High production rate.
- Accuracy and repeatability is achieved.
- Less operation skill and involvement.
- Reduced space.

Centre lathe specification

Objective: At the end of this lesson you shall be able to
- **specify the size of a lathe.**

The size of a lathe is generally specified by the following means:

a) Swing or maximum diameter that can be rotated over the bed ways.

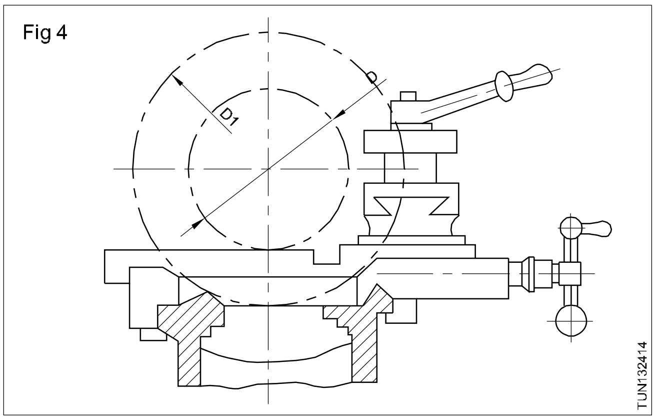
b) Maximum length of the job that can be held between head stock and tailstock centres.

c) Bed length, which may include head stock length also,

d) Maximum diameter of the bar that can pass through spindle or collect chuck of capstan lathe.

Fig 1 illustrates the elements involved in specifications of a lathe. the following data also contributes to specify a common lathe machine.

Fig 4



- Maximum swing over bed.
- Maximum swing over carriage.
- Height of centers over bed.
- Maximum distance between centers.
- Length of bed.
- Width of bed.
- Morse taper of center
- Diameter of hole through spindle.
- Face plate diameter.
- Capacity of tool post.
- Number of spindle speeds
- Lead screw diameter and number of threads per inch or pitch in mm.
- Capacity of electrical motor.
- Pitch range of metric and inch threads etc.

Lathe parts - tail stock

Objectives: At the end of this lesson you shall be able to
- **name the parts of a tailstock**
- **state the purposes of a tailstock**
- **state the functioning of a tailstock.**

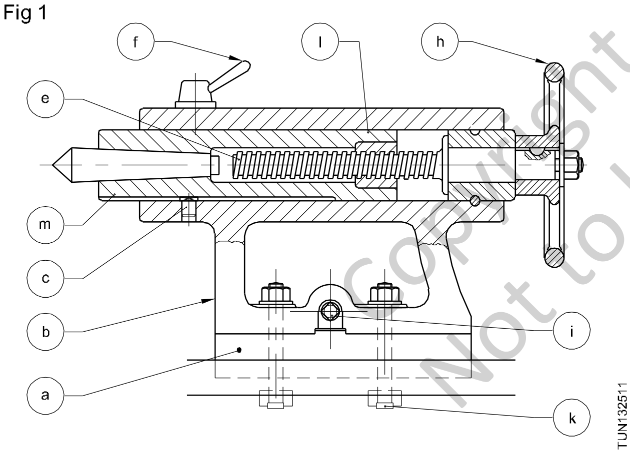
Tailstock

It is *a* sliding unit on the bed-ways of the lathe bed. It is situated on the right hand side of the lathe. It is made in two parts, namely the 'base' and the 'body'. The base bottom is machined accurately and has 'V'grooves corresponding to the bed-ways. It can be slided over the bed and clamped in any position on the bed by means of the clamping unit. The body of the tailstock is assembled to the base and has a corresponding longitudinal movement as to that of the base, along the bed. It has a limited transverse movement as well, with respect to the base. Graduations are marked on the rear end of the base and a zero line is marked on the body.

When both zero lines coincide the axis of the tailstock is in line with the axis of the headstock.

The body and base are made of cast iron. The parts of a tailstock are: (Fig 1)

Fig 1



- base (a)
- body (b)
- spindle (barrel) (c)
- spindle-locking lever (f)
- operating screw rod (e)
- operating nut (l)
- tailstock hand wheel (h)
- key(m)
- clamping unit (k)
- set over screw (i).

Functioning of tailstock

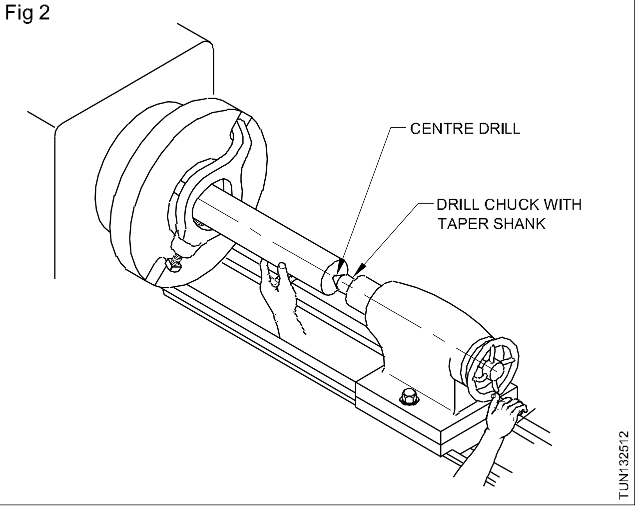
By rotating the hand wheel the screw rod is operated. This causes the barrel, which carries the nut, to move forward and backward according to the direction of rotation. The key, which fits in the keyway milled at the bottom of the barrel, prevents the barrel from rotation. The thread in the screw rod is mostly of left hand square thread to have forward movement for anticlockwise rotation of the hand wheel. The barrel may be locked in any required position. The hollow end of the barrel at the front is provided with a Morse taper to accommodate the cutting tools with the taper shank. Graduations may be marked on the barrel to indicate the movement of the barrel. The screw rod is made of alloy steel and the operating nut is made of bronze. With the help of the adjusting screws, the body can be moved over the base laterally and the amount of movement may be read approximately referring to the graduations marked.

Purpose of the tailstock

To accommodate the dead centre to support a lengthy work for carrying out lathe operations.

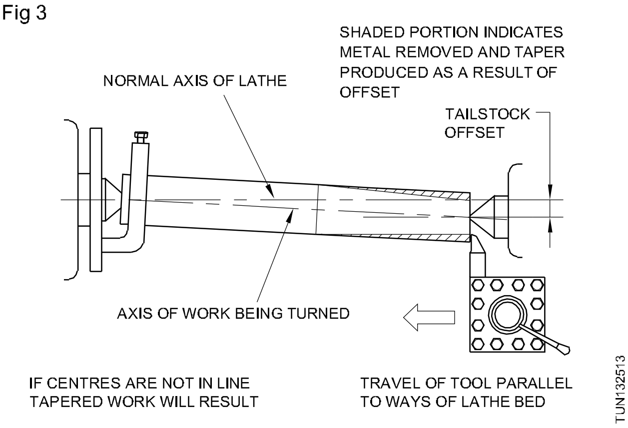
To hold cutting tools like drills, reamers, drill chucks which are provided with taper shank. (Fig 2)

Fig 2



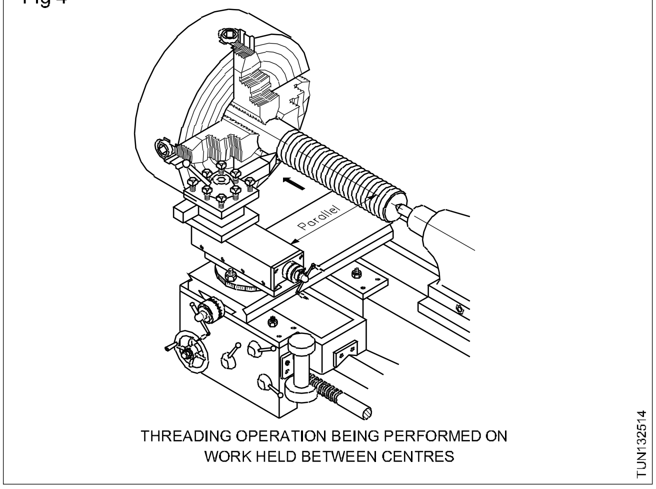
To turn the external taper by offsetting the body of the tailstock with respect to the base. (Fig 3)

Fig 3



To perform external operations on the shaft held between centres. (Fig 4)

Fig 4



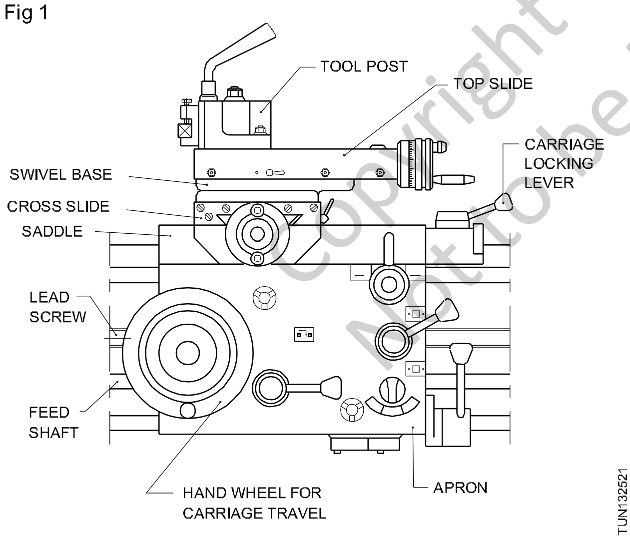
The carriage

Objectives : At the end of this lesson you shall be able to
- **state the purpose of a carriage**
- **list out the parts of a carriage**
- **state the functioning of the carriage.**

Purpose of a carriage

The carriage is the part of the lathe which slides over the bed-ways between the headstock and the tail stock. (Fig 1)

Fig 1



It provides various movements for the cutting tool manually as well as by power feed.

The carriage can be locked on the bed at any desired position by tightening the carriage lock-screw.

The tool is provided with the following three movements by the carriage.

Longitudinal feed - with the help of the carriage move-ment (parallel to the axis of work). (Fig 2)

Cross-feed - with the help of the cross-slide movement (perpendicular to the axis of the work). (Fig 3)

Fig 2

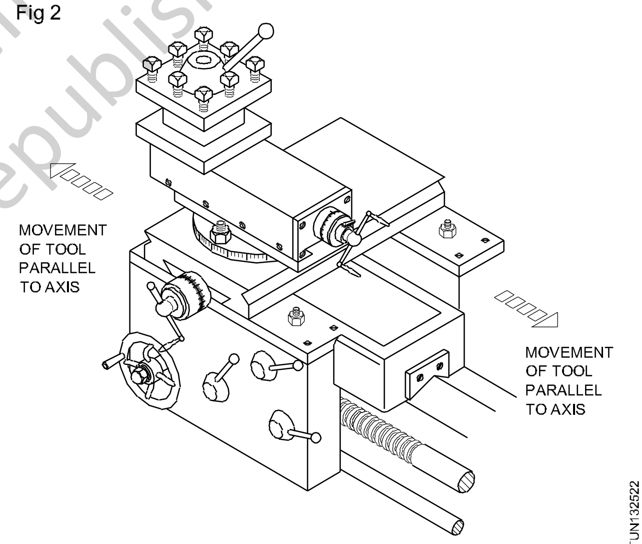
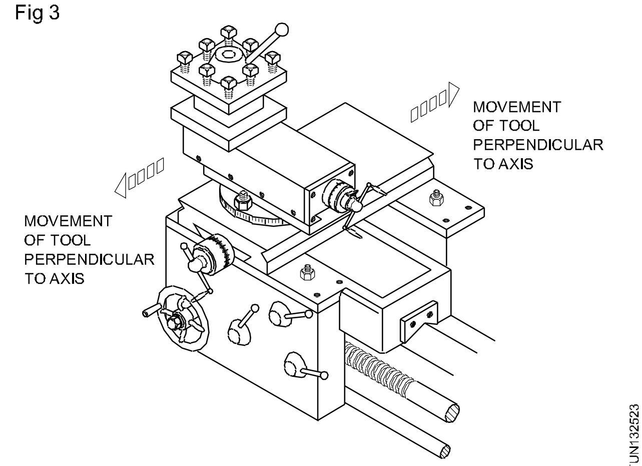
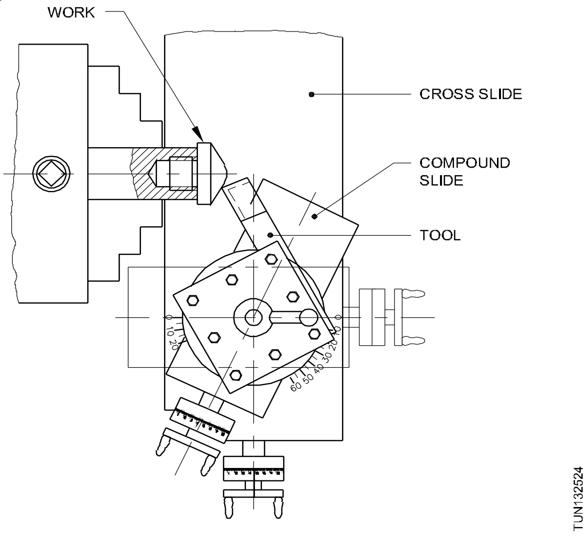


Fig 3



Angular feed - with the help of the compound slide movement positioned at an angle to the axis of the work. (Fig 4)

Fig 4



The carriage consists of the following parts. (Fig 5)

Saddle

Cross-slide

Compound rest swivel and top slide.

Tool post

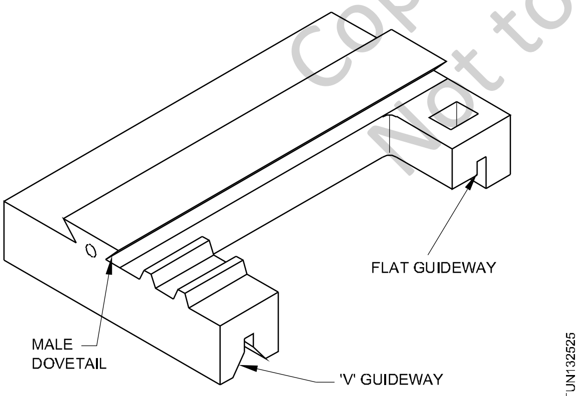
Apron

The saddle (Fig 5)

It is 'H' shaped casting and has 'V' guide grooves and flat grooves machined at the bottom face corresponding to the lathe bed-ways for mounting the saddle on the lathe bed and for sliding over the bed by the operation of the hand wheel.

The cross-slide (Fig 6 & 7)

Fig 5



The bottom of the cross-slide has got a dovetail groove machined, which corresponds to the external dovetail machined on the saddle. The cross-slide is assembled to the saddle with the help of a tapered jib. The adjustment of the jib facilitates the required fit for the movement of the cross-slide on the saddle. The cross-slide functions perpendicular to the lathe axis either by hand feed or by automatic feed.

A left hand square or acme thread screw-rod fitted with a hand wheel helps in the manual movement of the cross-slide. The automatic feeding is achieved through gearing. A graduated collar mounted on the screw-rod along with the hand wheel helps to set the fine, movements of the cross slide.

Fig 6

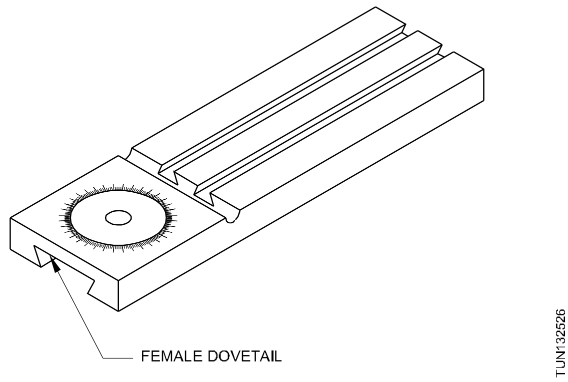
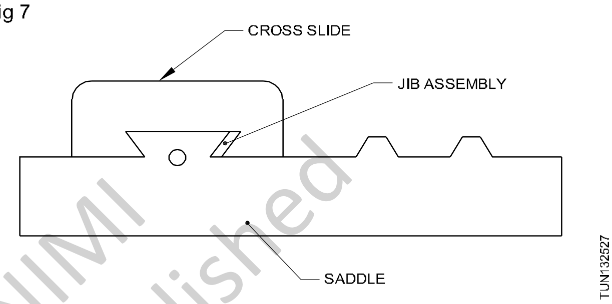
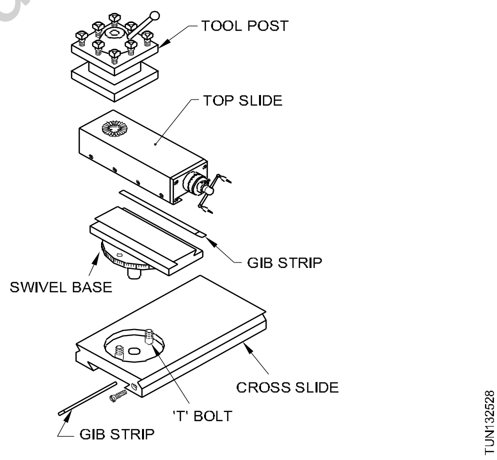


Fig 7



The compound rest (Fig 8)

Fig 8



It is of two parts.

- The swivel base
- The top slide

The swivel base is assembled to the top of the cross-slide and may be clamped at any required position between 0° to 360° by tightening the T' bolts. The head of the bolts moves in the T slot groove on the top of the cross-slide. The swivel base is provided with a dovetail on its top surface and the top slide has *a* corresponding dovetail groove. The assembly of the top slide to the swivel base is done by a tapered jib which can be adjusted to control the top slide movement. The sliding of the top slide on the swivel base is accomplished by the help of a screw-rod fitted with a hand wheel and a graduated collar. Only manual operation is possible for the top slide. The top slide assists in feeding the tool to the work.

Lathe bed

Objectives: At the end of this lesson you shall be able to
- **state the functions of a lathe bed**
- **list the different types of bed - ways**
- **state the reasons for manufacturing a lathe bed out of cast iron.**

Functions of a lathe bed

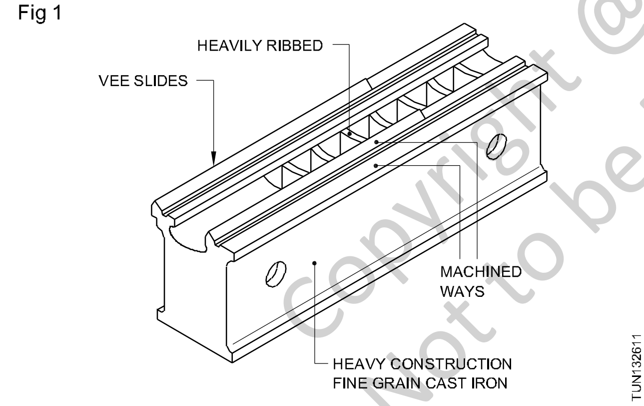
The two functions of a lathe bed are :

- to locate the fixed units in accurate relationship to each other
- to provide slideways upon which the operating units can be moved.

Constructional features of *a* lathe bed (Fig 1)

In the majority of cases, the bed generally, a single iron casting. In larger machines, the bed may be in two or more sections, accurately assembled together. Web bracings are often employed to increase the rigidity. For absorbing shock and vibration, the bed should be of considerable weight. Bed castings are usually rough machined and then allowed to 'age' naturally before finish machining to remove distortions.

Fig 1



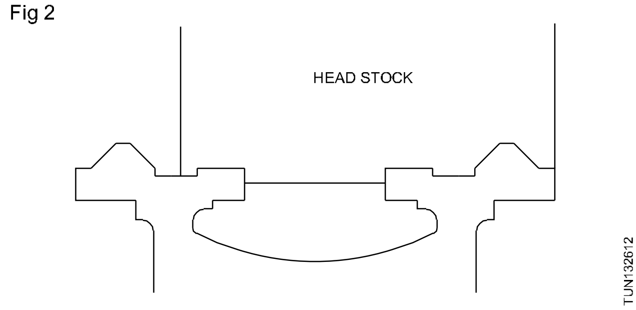
A swarf or a combined swarf and a coolant tray are provided on the lathes. This may be an integral part with the lathe bed. This increases the rigidity of the bed.

The bed generally rests on cast iron or welded sheet metal legs of box section. This provides the necessary working height for the lathe. Very often the electrical switch gear unit and the coolant pump assembly are housed in the box section legs at the headstock end.

Bed-ways (Fig 2)

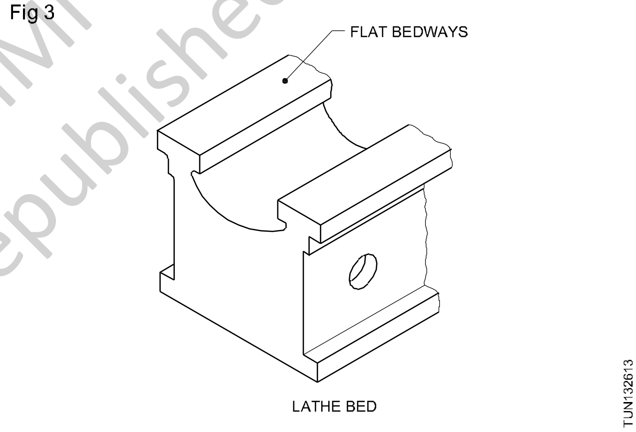
The surfaces of the bed in contact with the sliding units of the lathe are known as bed-ways or guideways or guide shoars. The beds are classified according to the shape ot of the ways. They are:

Fig 2



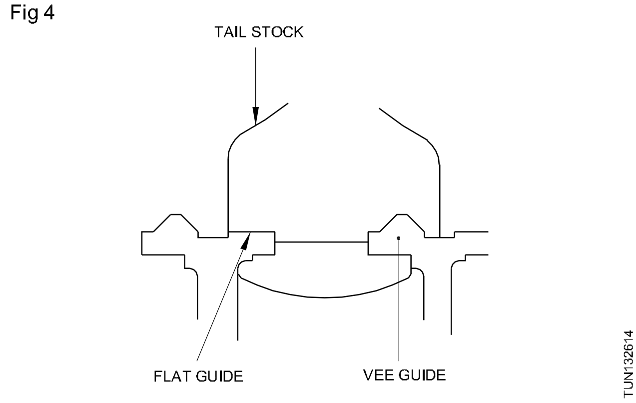
Flat bed-ways (Fig 3)

Fig 3

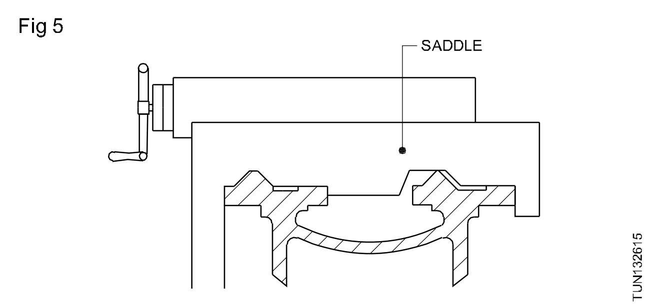


'V' bed (Fig 4)

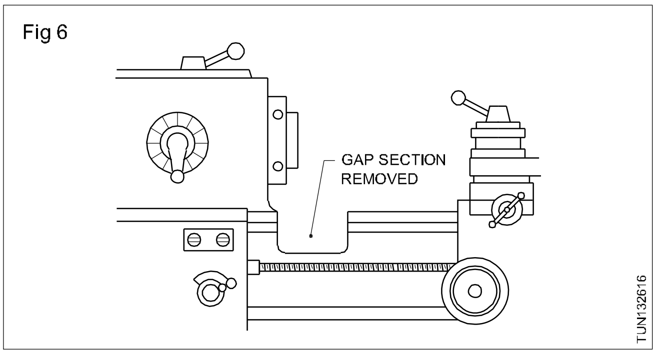
Fig 4



Combination bed (Fig 5)



Gap bed (Fig 6)



Normally the bed is positioned at several centimeters from the headstock, and the bed is reduced at this point. This enables for the swing of larger diameters of work.

A few lathes have at this point a detachable section of the bed which can be fitted when desired to enable the saddle to operate close to the headstock without over hanging the gap. (Fig 6)

In the case of flat bed shears, the machined bases of saddle and tailstock rest and they are guided by their machined edges. The inverted V ways support and guide the sliding units.

The bed-ways are fine-finished by grinding. Some lathes have their bed-ways hand- scraped. Some have their bed-ways hardened and ground. The wear resisting qualities of bearing surfaces are improved by employing chilled iron castings.

The beds are mostly made of close-grained grey cast iron.

The advantages are :

- easily available and costs comparatively less
- under load, cast iron will not bend but break
- in its molten state its fluidity is more so that it can occupy intricate parts of the mould
- carbon is in free state which has self-lubricating property
- grey cast iron is easily machinable
- can withstand more compressive load
- resists vibration.

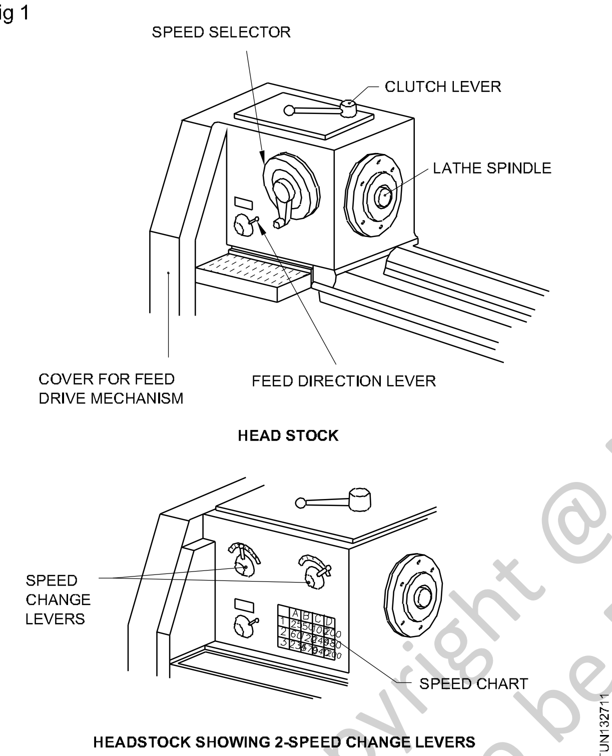
Lathe drive - cone pulley and all gear type

Objectives: At the end of this lesson you shall be able to
- **state the functions of the headstock**
- **differentiate between cone pulley headstock and all geared headstock.**

Headstock

It is a fixed unit of lathe on the left hand side. (Fig 1)

Fig 1



Its main functions are to :

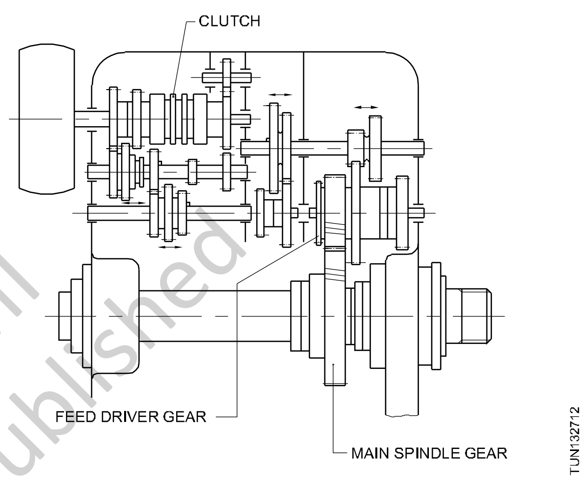
- provide a means to assemble work-holding devices
- transmit the drive from the main motor to the work to make it revolve
- accommodate shafts with fixed and sliding gears for providing a wide range of work speeds
- have shift levers to slide gears to bring in mesh for different speeds
- have a means for lubricating the gears, shafts and bearings.

Constructional features of all-geared headstock (Fig 2)

It is a box-section alloy iron casting having a top cover which can be removed, if needed. It has internal webs for stiffening and taking shaft bearings. It has an input shaft which is connected by means of 'V' belts to the main motor, and runs at constant speed. It is equipped with clutches and a brake.

There may be two or more intermediate shafts on which sliding gears are mounted. The main spindle is the last driven shaft in the headstock assembly. The nose of the spindle is outside the headstock casting and is designed to accommodate the work-holding devices.

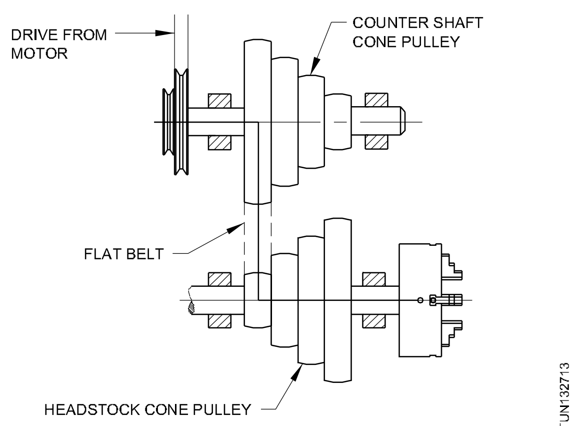
Fig 2



The levers operating the forks of the sliding gears are situated outside in the front of the headstock casting. A sight glass is provided on the top to indicate the functioning of the automatic lubricating system and side of sight glass is provided oil length of the machine.

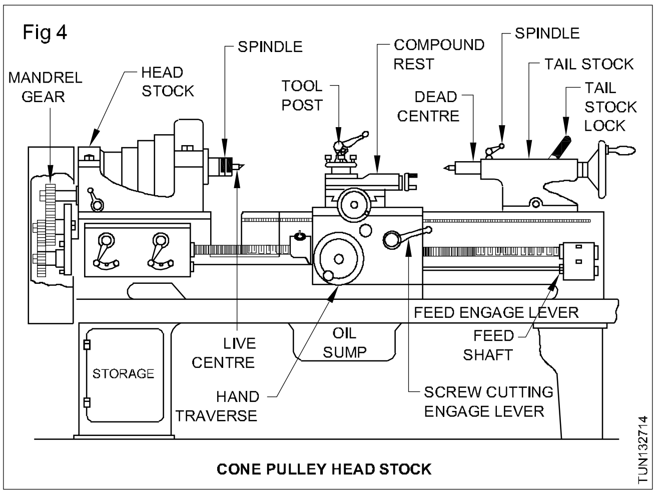
Cone pulley headstock (Fig 3)

Fig 3



It has a stepped cone pulley mounted on the main spindle and is free to revolve. It is connected by means of a flat belt to a similar cone pulley, the steps arranged in a reversing order. This cone pulley gets the drive from the main motor.

The spindle is mounted on the bush bearings in the headstock casting and a gear wheel called 'bull gear' keyed to it. A pinion is coupled to the cone pulley. The back gear unit has a shaft which carries a gear and a pinion. The number of teeth of the gear and pinion on the back gear shaft corresponds to the number of teeth on the bull gear and the pinion on the cone pulley. The axis of the back gear shaft is parallel to the axis of the main spindle, and the back gear is brought in engagement or disengagement with the cone pulley system by means of a lever. The back gear unit is engaged to have reduced spindle speeds. (Fig 4)



A three-stepped cone pulley headstock provides three direct ranges of speeds through the belt connection, and with the back gear in engagement, three further ranges of reduced speeds.

Advantages

Easy for maintenance.

Can take up heavy load.

Less noise during functioning.

During overloads, the belt slips off, and hence, no major damage to the lathe is caused.

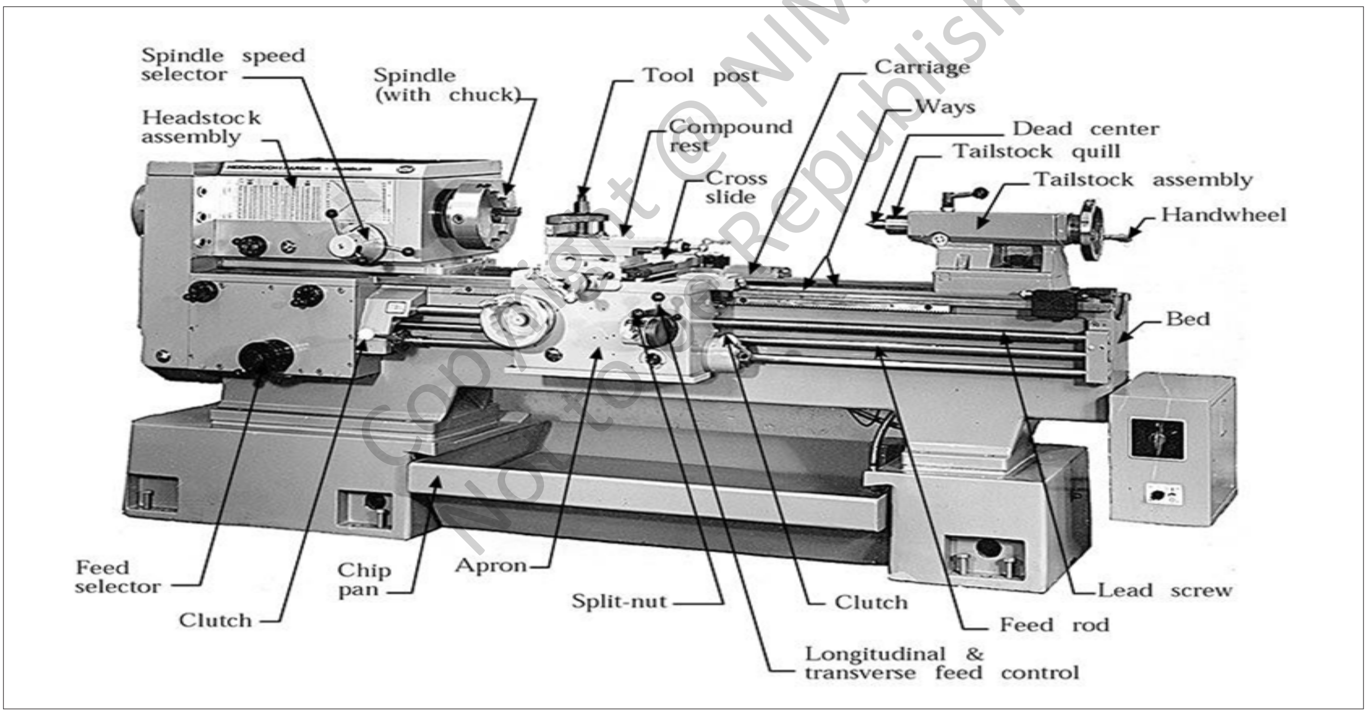
Positive drive when the back gear is in engagement.

Disadvantages

Number of spindle speeds limited to the number of steps in the cone pulley.

Takes time to change spindle speeds.

Needs adjustments of bush bearings.



Back gear unit has a shaft which carries a gear and a pinion. The number of teeth of the gear and pinion on the back gear shaft corresponds to the number of teeth on the pull gear and the pinion on the cone pulley. The axis of the back gear shaft is parallel to the axis of the main spindle, and the back gear is brought in engagement or disengagement with the cone pulley system by means of a ever. The back gear unit is engaged to have reduced spindle speeds. (Fig 6)

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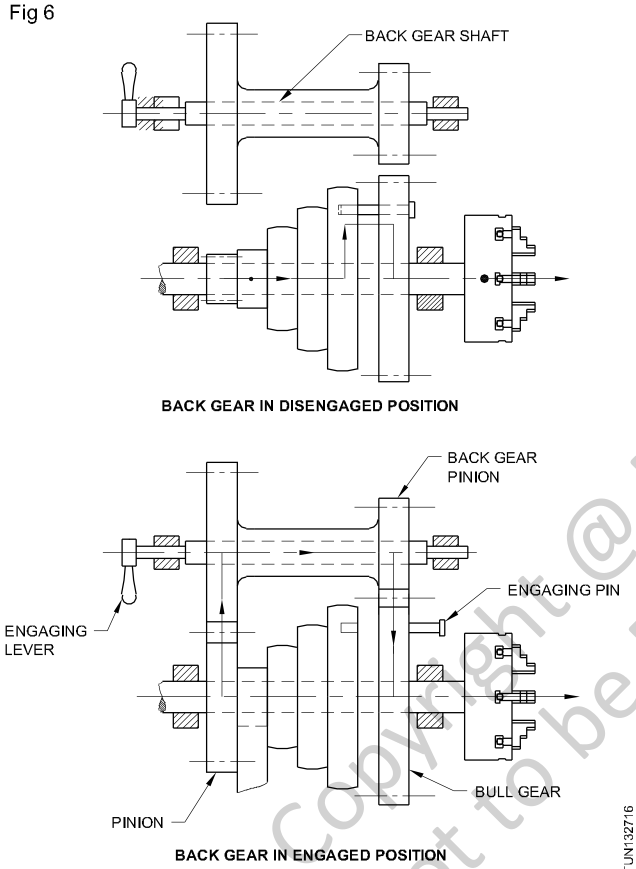
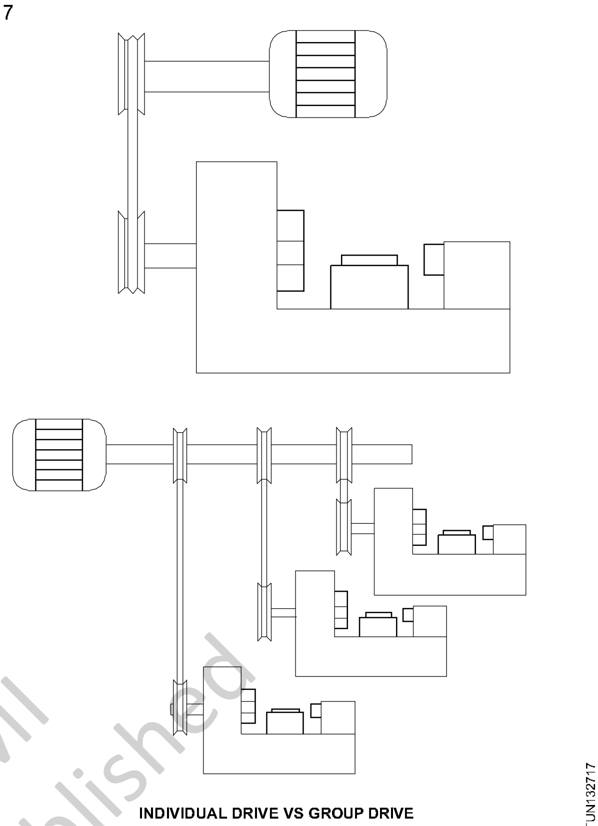
Fig 6



Difference between individual drive vs group drive

Fig 7



Difference between individual drive vs group drive

	Individual drive	Group drive
Initial cost	Low	High
Speed	More variation possible	Wider variation possible
Running cost	One	More than one
One time of breakdown	Only one machine get affected	All machine connected to group drive get affected
More likely used	For job production	For mass production
Efficiency	High	Less
Power required	Less	More

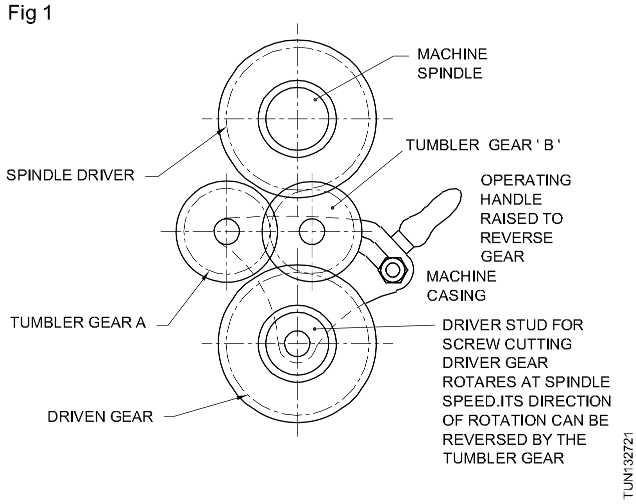
Tumbler gear

Objectives: At the end of this lesson you shall be able to
- **state the purpose of the tumbler gear mechanism**
- **state the construction details of the tumbler gear mechanism**

Tumbler gear mechanism (Fig 1)

The tumbler gear mechanism is used for changing the direction of rotation of the lead screw and feed shaft. It is normally situated between the spindle drive and the feed gear box. It consists of 3 gears arranged in a simple gear train, mounted on a bracket. The bracket can be shifted into 3 positions.

Fig 1



- For forward rotation of the lead screw and feed shaft.
- For neutral position (no rotation of lead screw and feed shaft).
- For the reverse rotation of the lead screw and feed shaft.

In practice, the first driver gear of a screw cutting train is not fitted directly to the lathe spindle but is mounted on a driver stud which rotates at the same speed as the spindle.

The driving gear on the spindle drives the fixed stud gear, and, since they have the same speed, they must be of the same size. Tumbler gear A is always in mesh with the driven gear and in mesh with the fellow tumbler gear B. In the figure, the drive is direct through the tumbler gear A, and tumbler gear B is idle.

If the tumbler bracket is moved upwards, tumbler gear A rolls around the driven gear until it is out of mesh with the driver gear, and tumbler gear B moves into mesh with the driver, reversing the direction of the driven gear. Thus the two trains available are:

Forward: Driver —>A—>Driven

Reverse: Driver —>B—>A—>Driven.

In yet another position of the tumbler bracket, tumbler gears A or B do not mesh with the driver gear and no drive is transmitted to the driven gear. No feed movement or thread cutting is possible.

Back gear

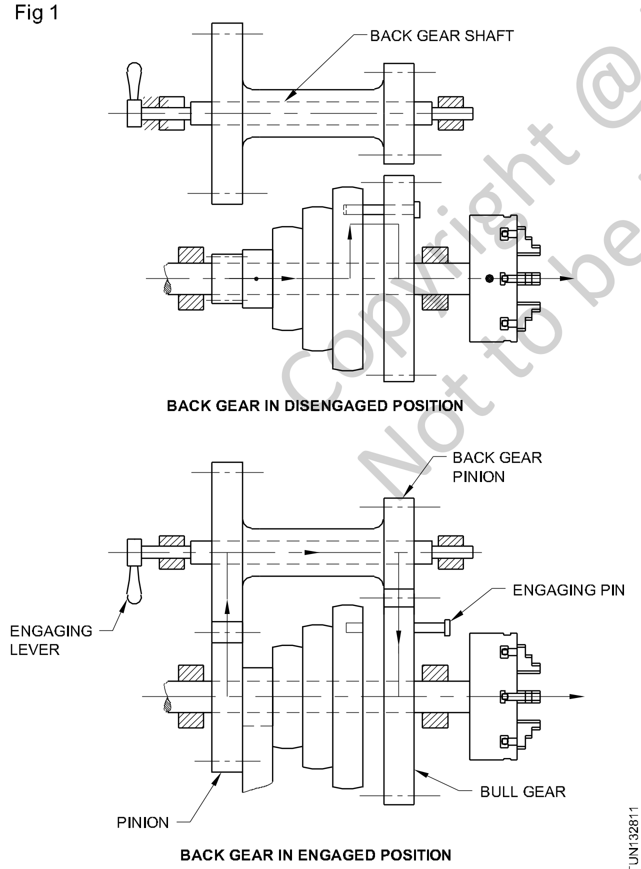
Objectives: At the end of this lesson you shall be able to
- **State the construction details of Back gear assembly**
- **State the function and purpose of Back gear.**

Back gear

As its name implies “back gear” is a gear mounted at the back of the head stock. It is used to reduce the speed.

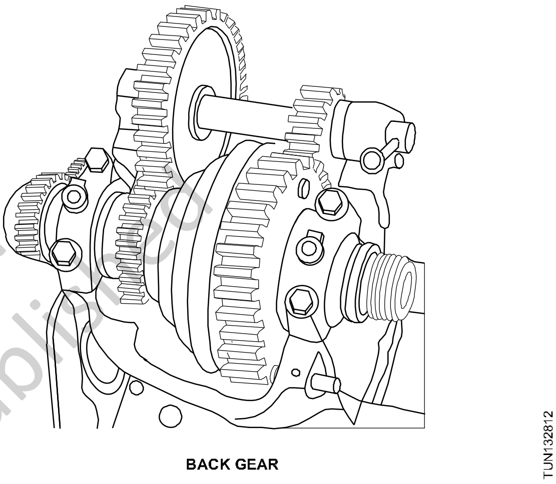
The spindle is mounted on the bush bearings in the headstock casting and a gear wheel called 'bull gear' keyed to it. A pinion is coupled to the cone pulley. The back gear unit has a shaft which carries a gear and a pinion. The number of teeth of the gear and pinion on the back gear shaft corresponds to the number of teeth on the bull gear and the pinion on the cone pulley. The axis of the back gear eccentric shaft is parallel to the axis of the main spindle, and the back gear is brought in engagement or disengagement with the cone pulley system by means of a lever. The back gear unit is engaged to have reduced spindle speeds. (Fig 1)

Fig 1



A three-stepped cone pulley headstock provides three direct ranges of speeds through the belt connection, and with the back gear in engagement, three further ranges of reduced speeds.

Fig 2



Properties of good cutting tool materials

Objectives: At the end of this lesson you shall be able to
- **state the qualities of good cutting tool material**
- **distinguish between the characteristics of cold hardness, red hardness and toughness**
- **state the factors to be noted when selecting a tool material.**

Tool materials

Metal cutting tool materials perform the function of cutting. These materials must be stronger and harder than the material to be cut. They must be sufficiently tough to resist shock loads that result during cutting operations. They must have good resistance to abrasion and a reasonable tool life.

The three most important basic qualities that any cutting tool material should possess are:

- cold hardness
- red hardness
- toughness.

Cold hardness

It is the amount of hardness possessed by a material at normal temperature. Hardness is the property possessed by a materially which it can cut other metals, and has the ability to scratch on other metals.

When hardness increases, brittleness also increases, and a material which is having too much of cold hardness is not suitable for the manufacture of cutting tools.

Red hardness

It is the ability of a tool material to retain most of its cold hardness even at very high temperature. During machining due to friction between tool and work, tool and chip, heat is generated, and the tool loses its hardness, and its efficiency to cut diminishes. If a tool maintains its cutting efficiency even when the temperature during cutting increases, then that metal possesses the property of red hardness.

Toughness

The property possessed by a material to resist sudden load that results during metal cutting is termed as toughness. This will avoid the breakage of the cutting edge.

Points to be noted when selecting a tool material

- Condition and form of material to be machined.
- Material to be machined.
- Condition of the machine tool available.
- The total quantity of production and the rate of production involved.
- The dimensional accuracy required and the quality of surface finish.
- The amount of coolant applied and the method of application.
- The skill of the operator.

Different tool materials

Objectives : At the end of this lesson you shall be able to
- classify the tool materials
- list the tool materials under each group
- state the merits and demerits of each tool material.

Classification of tool material

The tool materials may be classified into three categories, namely:

- ferrous tool materials
- non-ferrous tool materials
- non-metallic tool materials.

Ferrous tool materials

Ferrous tool materials have iron as their chief constituent.

High carbon steel (tool steel) and high speed steel belong to this group.

Non-ferrous tool materials

Non-ferrous tool materials do not have iron, and they are casted by alloying elements like tungsten, vanadium, molybdenum etc. Stellite belongs to this group.

Carbides which are also of non ferrous tool material are manufactured by powder metallurgy technique. Carbon and tungsten are the chief alloying elements in this process.

Non - Metallic tool materials

Non-metallic tool materials are made out of non-metals. Ceramics and diamonds belong to this category.

High carbon steel is the first tool material introduced for manufacturing cutting tools. It has poor red hardness property, and it loses its cutting efficiency very quickly. By adding alloying elements like tungsten, chromium and vanadium to high carbon steel, high speed steel tool material is produced. Its red hardness property is more than high carbon steel. It is used as solid tools, brazed tools and as inserted bits. It is costlier than high carbon steel.

Carbide cutting tools can retain their hardness at very high temperatures, and their cutting efficiency is higher than that of high speed steel. Due to its brittleness and cost, carbide cannot be used as a solid tool. It is used as brazed tool bit and throw-away tool bit.

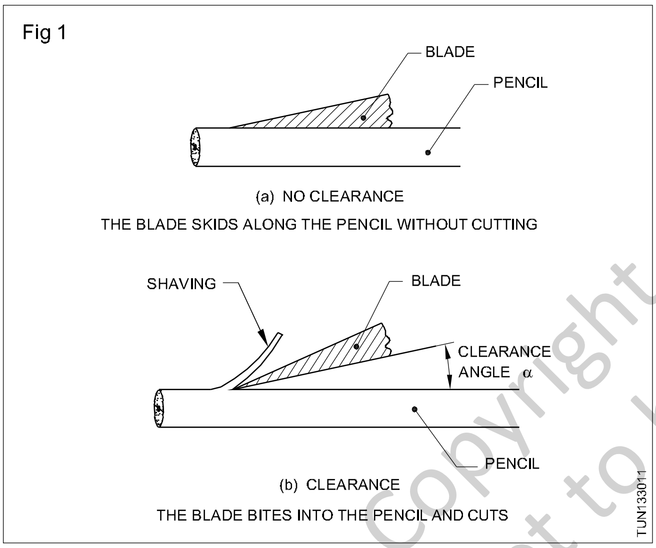
Specification of lathe - tools

Objectives : At the end of this lesson you shall be able to
- **state the necessity of providing angles and clearances on cutting tools**
- **name the angles of a lathe cutting tool**
- **state the characteristics of a rake angle**
- **state the characteristics of a clearance angle**
- **refer to a chart to determine the recommended rake and clearance angles for turning different metals.**

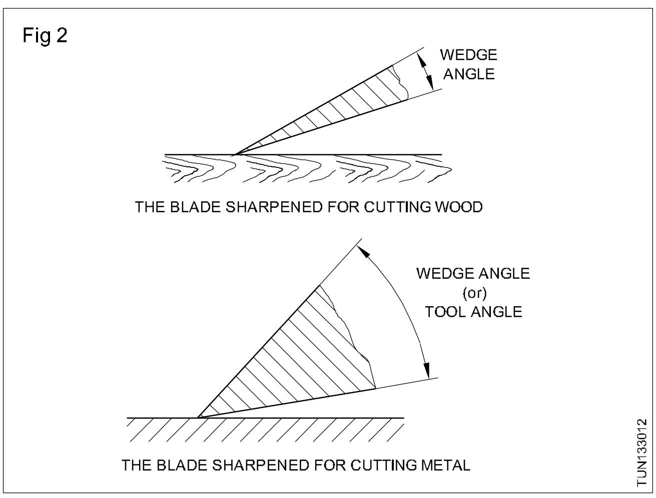
Need to provide angles and clearances

The cutting action of a lathe tool during turning is the wedging action. The wedge-shaped cutting edge has to penetrate into the work and remove the metal. This necessitates the grinding of the solid tool bit to have the wedge formation for the cutting edge.

When we sharpen a pencil with a pen knife by trial and error, we find that the knife must penetrate into the wood at a definite angle, if success is to be achieved. (Fig 1)



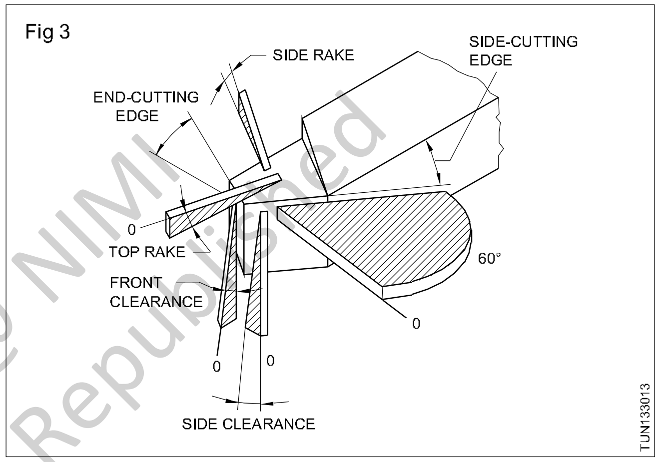
If, in the place of a wooden pencil, a piece of soft metal, such as brass is cut, it will be found that the cutting edge of the blade soon becomes blunt, and the cutting edge has crumbled. For the blade to cut brass successfully,



the cutting edge must be ground to a less acute angle to give greater strength as can be seen in Fig 2.

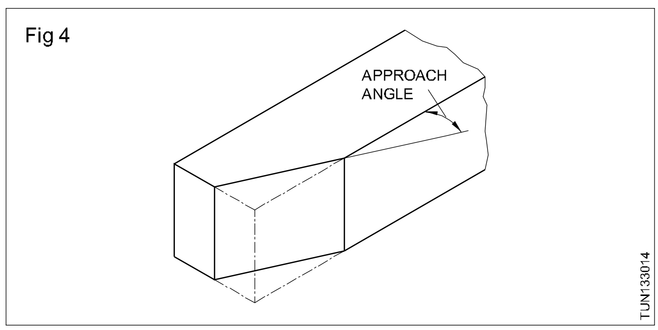
The angle shown in Fig 1 is known as a clearance angle and that shown in Fig 2 is a wedge angle.

Angles ground on a lathe cutting tool (Fig 3)



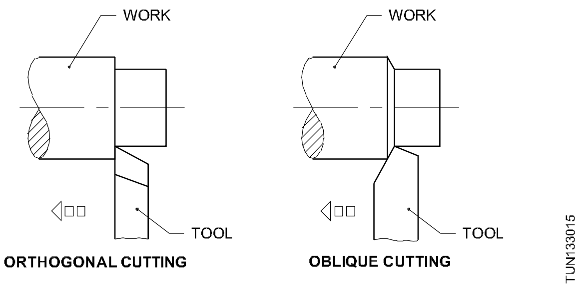
Side cutting edge angle

(Approach angle) (Fig 4)



This is ground on the side of the cutting tool. The cutting will be oblique. The angle ground may range from 25°to 40° but as a standard a 30° angle is normally provided. The oblique cutting has certain advantages over an orthogonal cutting, in which the cutting edge is straight. More depth of cut is given in the case of oblique cutting since when the tool is fed to the work, the contact surface of the tool gradually increases as the tool advances, whereas, in the case of orthogonal cutting, the length of the cutting edge for the given depth fully contacts the work from the beginning itself, which gives a sudden maximum load on the tool face. The area, over which heat is distributed, is more in oblique cutting. (Fig 5)

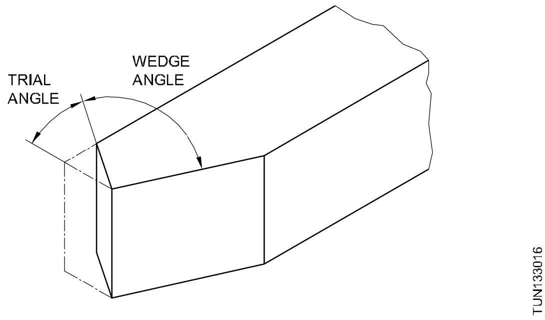
Fig 5



End-cutting edge angle (Trial angle) (Fig 6)

The end-cutting edge angle is ground at 30° to a line perpendicular to the axis of the tool, as illustrated in Fig 3. The side-cutting edge angle and the end-cutting edge angle, when ground, form a nose (wedge) angle of 90° for the tool.

Fig 6

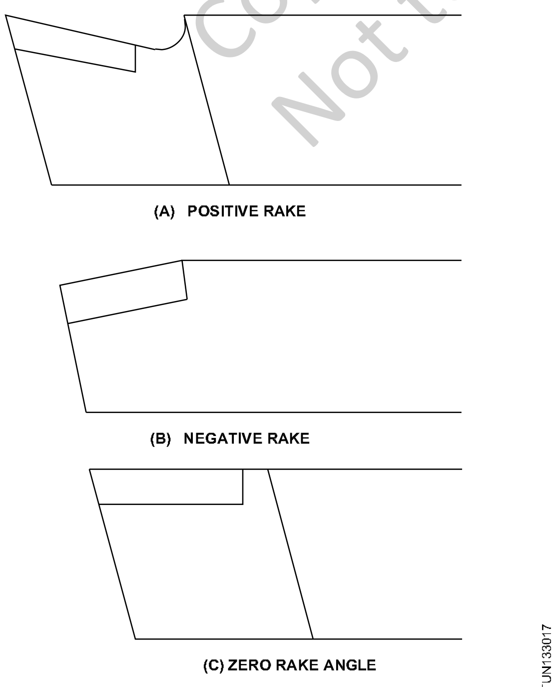


Top or back rake angle (Fig 7)

The rake angle ground on a tool controls the geometry of chip formation for any given material. It controls the mechanics of the cutting action of the tool. The top or back rake angle of the tool is ground on the top of the tool, and it is a slope formed between the front of the cutting edge and the top face.

Resistive top rake angle (Fig 7A)

Fig 7



If the slope is from the front towards the back of the tool, it is known as a positive top rake angle. When turning soft materials which form curly chucks and good surface finish. Cutting tool life is very short.

Negative top rake angle (Fig 7B)

If the slope is from the back of the tool towards the front of the cutting edge, it is known as the negative top rake angle. When turning the hard brittle metals with carbide tools it is usual practice to give a negative top rake.

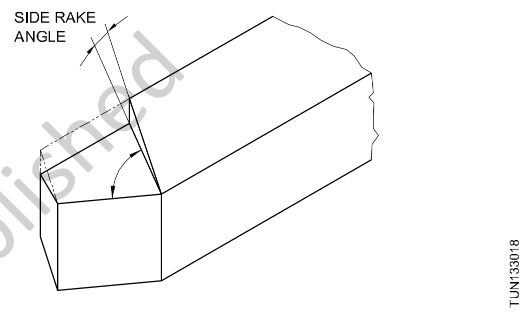
Negative top rake tools have more strong than positive top rake angle tools. Tool life is too long. Chip should be broken and rough surface finish.

Zero top rake angle (Fig 7C)

If the cutting edge is straight line is called zero top rake angle when turning soft, ductile materials i.e. aluminium, brass, copper.

Side rake angle (Fig 8)

Fig 8

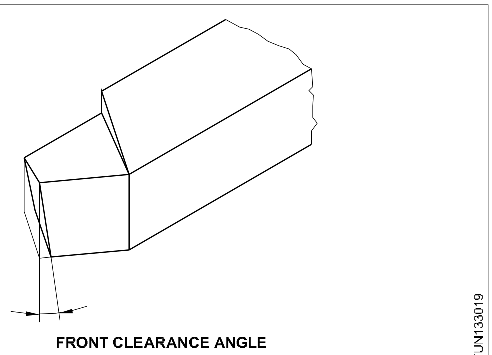


The side rake angle is the slope between the side of the cutting edge to the top face of the tool widthwise. The slope is from the cutting edge to the rear side of the tool. It varies from 0° to 20° according to the material to be machined. The top and side rakes, ground on a tool, control the chip flow and this results in a true rake angle which is the direction in which the chip that shears from the work passes.

Front clearance angle (Fig 9)

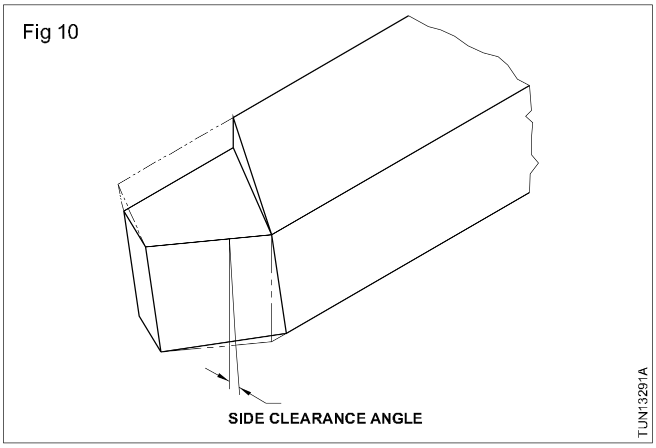
This angle is the slope between the front of the cutting edge to a line perpendicular to the axis of the tool drawn downwards. The slope is from the top to the bottom of the tool, and permits only the cutting edge to contact the work, and avoids any rubbing action. If the clearance ground is more, it will weaken the cutting edge.

Fig 9



Side clearance angle (Fig 10)

Fig 10

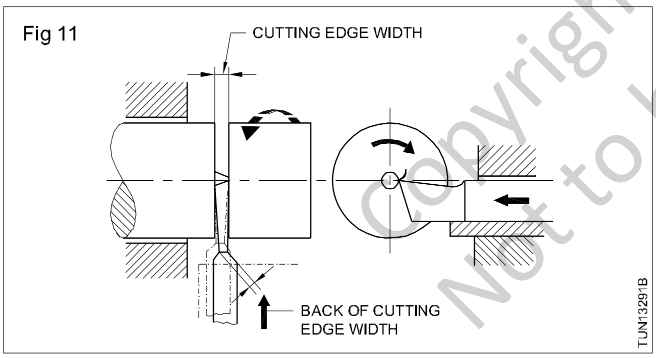


The side clearance angle is the slope formed between the side cutting edge of the tool with a line perpendicular to the tool axis drawn downwards at the side cutting edge of the tool. The slope is from the top of the side cutting edge to the bottom face. This is also ground to prevent the tool from rubbing with the work, and allows only the cutting edge to contact the work during turning. The side clearance angle needs to be increased when the feed rate is increased.

When grinding the rake and clearance angles, it is better to refer to the standard chart provided with the recommended values, and then grind. However, actual operation will indicate the performance of the tool and if any modification is needed for the angles ground on the tool.

Side relief angle (Fig 11)

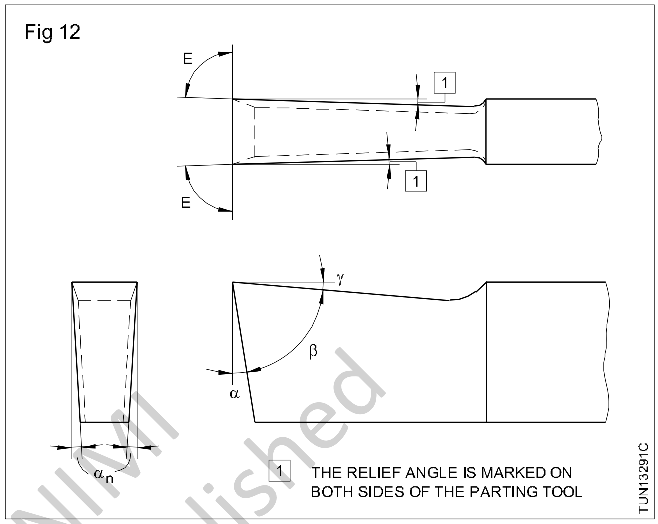
Fig 11



This angle is ground on the parting and the undercutting tools on both sides. This will provide the width of the cutting edge slightly broader than the back of the cutting edge.

This permits clearance between the sides of the tool and the groove walls formed by the plunging action of the tool, thereby, preventing the tool from getting jammed in the groove and causing breakage. The relief is kept as minimum as possible. Too much of relief will weaken the tool cutting edge, and also permit the chips to clog in the gap, causing the tool in both cases to break. Side relief is also provided sometimes to the main cutting edge of the facing tools, permitting only the cutting point performing the operation, when the tool axis is set perpendicular to the lathe axis. The side relief angle normally does not exceed 2°.

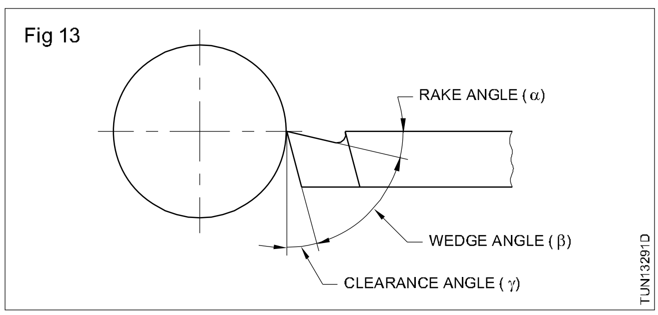
Fig 12



Relationship between rake, clearance and wedge angles (Fig 13)

The rake angle ($\propto$), clearance angle (γ) and the wedge angle (β) have close relationship for efficiency in cutting. Excessive rake angle reduces the wedge angle, which helps in good penetration and it is particularly useful for cutting soft metals. A decreased wedge angle weakens the tool strength. Therefore, for cutting hard metals, the rake angle is zero or negative. The clearance angle is generally fixed depending on the geometry of the surface being cut.

Fig 13

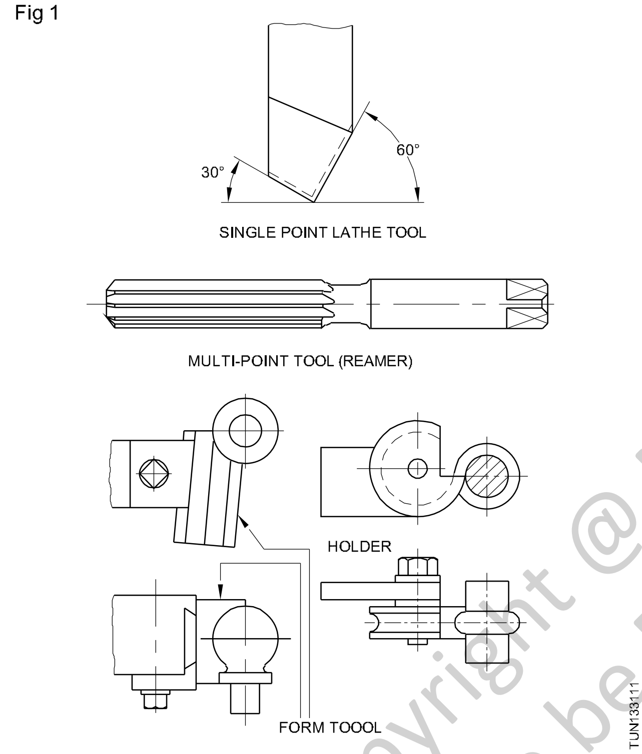


Lathe cutting tools - Different types

Objectives : At the end of this lesson you shall be able to
- **classify lathe cutting tools**
- **list the types of lathe cutting tools**
- **state the features of each type.**

Cutting tool classification (Fig 1)

Fig 1



Cutting tools are classified as:

- single point cutting tools
- multi-point cutting tools
- form tools.

Single point cutting tools

Single point cutting tools have one' cutting edge which performs the cutting action. Most of the lathe cutting tools are single point cutting tools.

Single point cutting tools used on lathes may be grouped into:

- side cutting tools
- end cutting tools.(Fig 2)

Side cutting tools

Side cutting edge tools have their cutting edges formed on the side of the cutting tool, and are used on lathes for most of the operations. They are again classified as right hand tools and left hand tools. (Fig 3) A right hand tool operates from the tailstock end towards headstock and a left hand tool operates from the headstock end towards the tailstock. The cutting edge is formed accordingly.

Fig 2

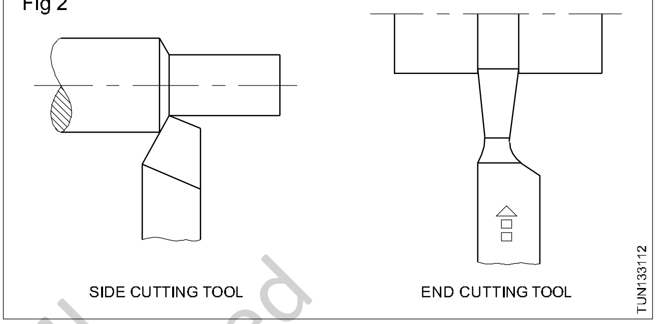
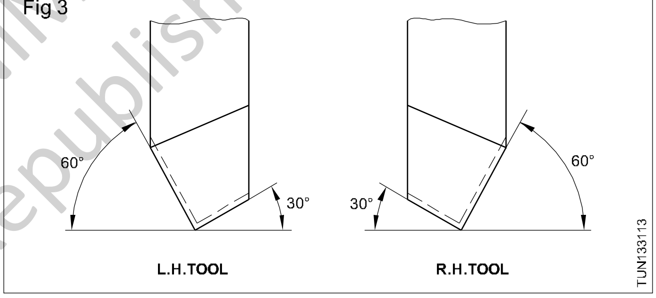


Fig 3



End cutting tools

End cutting tools have their cutting edge at the front end of the tools and are used on lathes for plunge cut operations.

Multi-point cutting tools

These tools have more than one cutting edge, and they remove metal from the work simultaneously by the action of all the cutting edges. The application of the multi-point cutting tools on the lathe is mostly done by holding the tool in the tailstock and feeding it to the work.

Form tools (Fig 1)

These tools reproduce on the work the form and shape of the cutting edge to which they are ground. The form tools perform the operations on the work by a plunging action, and are fixed on the tool post square to the axis of the work and fed by a cross-slide. They may have their cutting edges formed on square or rectangular section tool blanks acting radially. The form tools may be circular form tools and tangential form tools. They may require special holders to which they can be fixed, and the holders are clamped on the tool posts for operation.

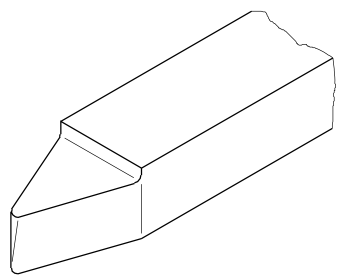
Lathe cutting tool types

The tools used on lathes are classified as :

- solid type tools
- brazed type tools
- inserted bits with holders
- throw-away type tools.

solid bits of square, rectangular and round cross sections. Most of the lathe cutting tools are of solid type, and high carbon steel and high speed steel tools are used. The length and cross-section of the tool depend upon the capacity of the machine, the type of tool post and the nature of the operation.

Fig 4

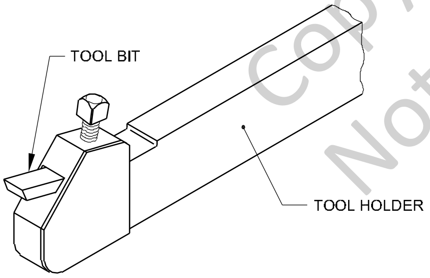


Inserted bits with holders (Fig 5)

Solid high speed steel tools are costly, hence they are sometimes used as inserted bits. These bits are small in sizes and inserted in the holes shaped according to the cross-section of the bit to be inserted. These holders are held and clamped in the tool posts to carry out the operations.

The disadvantage in these types of tools is that the rigidity of the tool is poor in the slot.

Fig 5

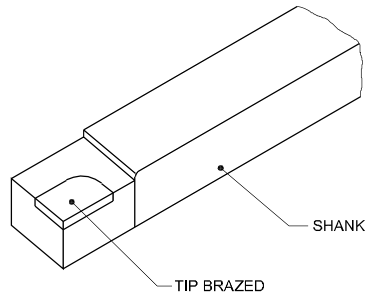


Brazed tools (Fig 6)

These tools are made of two different metals. The cutting portions of these tools are good cutting tool materials, and the body of the tools does not possess any cutting ability and is tough. Tungsten carbide tools are mostly of the brazed type. Tungsten carbide bits of square, rectangular and triangular shape with proportionately less thickness are brazed to the tips of the shank metal.

The tips of the shank metal pieces have machined top surface according to the shape of the bit to accommodate the carbide bits. These tools are economical and give better rigidity to the tools than the inserted bits clamped in the tool-holders. This is applicable to high speed steel brazed tools also.

Fig 6

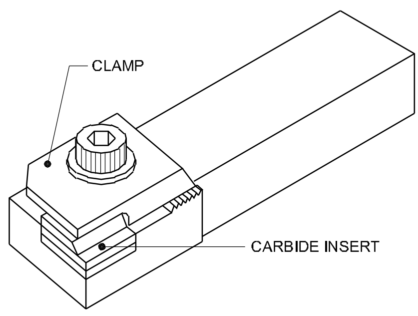


Throw-away type tools (Fig 7)

Carbide-brazed tools, when blunt or broken, need grinding which is time absorbing and expensive. Hence they are used as throw-away inserts in mass production. Special tool-holders are needed, and the carbide bits of rectangular, square or triangular shapes are clamped in the seating faces machined in these types of special holders.

The seating faces are machined such that the rake and clearances needed for the cutting bits are automatically achieved when the bits are clamped. As these tools are to be operated at very high cutting speeds, the capacity of the machine must also be high and the rigidity of the machine must be good as well.

Fig 7



HOLDER FOR THROW-AWAY CARBIDE INSERTS

Types and specifications of carbide tools

Objectives : At the end of this lesson you shall be able to
- **identify the different types of carbide tools**
- **state the specifications of carbide tools.**

Cemented carbide tools are available as brazed tipped tools and throw away tips held in specially designed tool holders.

Standard terms for carbide tools as specified in ISO

ISO 1 straight turning tool (Fig 1)

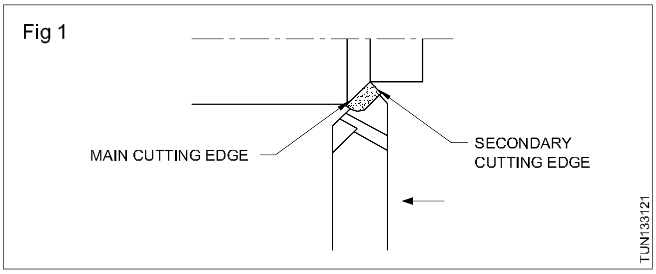


Fig 1

ISO 2 Cranked turning tool (Fig 2)

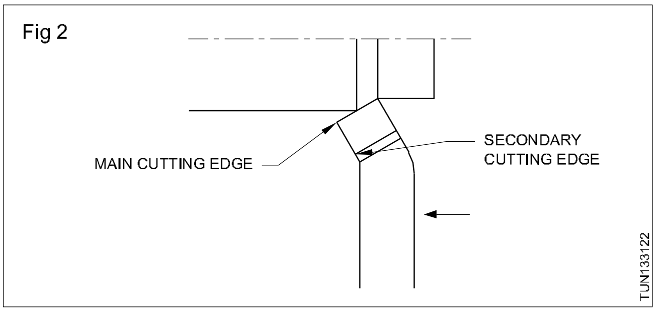


Fig 2

ISO 3 Offset facing tool (Fig 3)

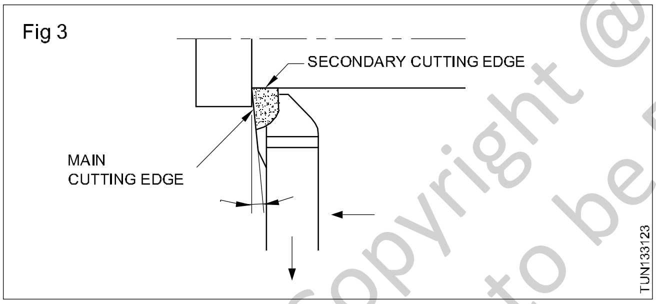


Fig 3

ISO 4 Wide nose square turning tool (Fig 4)

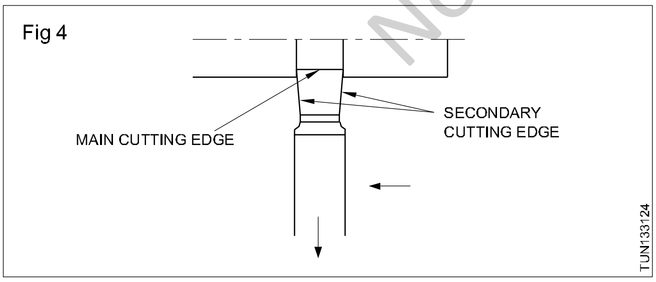


Fig 4

ISO 5 Offset turning and facing tool (Fig 5)

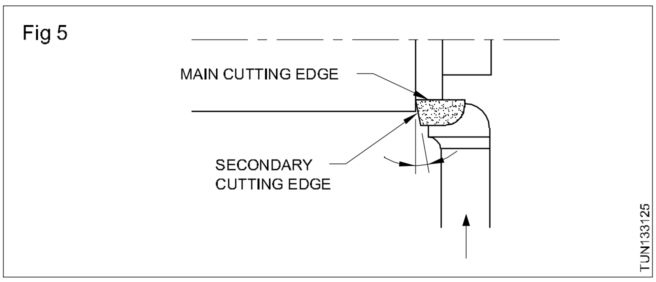


Fig 5

Standard shapes of carbide-tipped turning and facing tools are shown in the Figs. Carbide tipped cut off and boring tools are also available. these tools are resharpened as needed using special silicon carbide and diamond wheels.

ISO 6 Offset side cutting tool (Offset knife tool) (Fig 6)

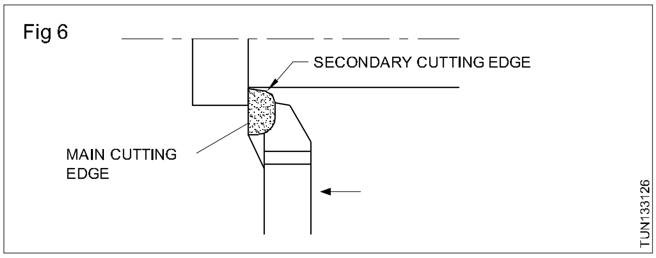


Fig 6

ISO 7 Recessing tool (parting tool) (Fig 7)

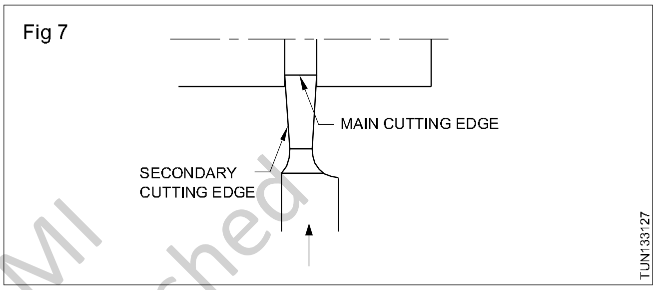


Fig 7

ISO 8 Boring tool (Fig 8)

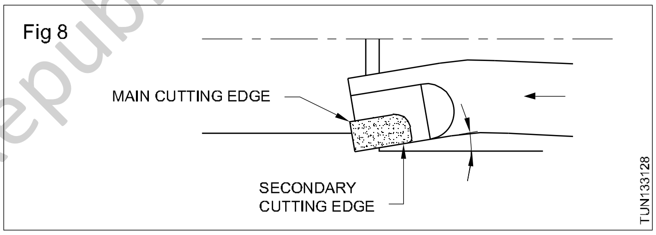


Fig 8

ISO 9 Corner boring tool (finishing) (Fig 9)

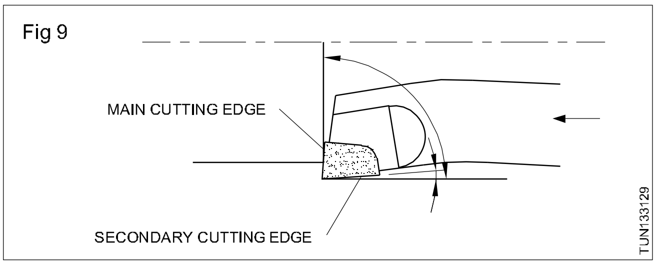


Fig 9

The carbide tools are specified according to (1) the operations (rough and finish) (2) right hand or left hand (3) material being turned and machining conditions.

Kinds of lathe cutting tools

Objectives : At the end of this lesson you shall be able to
- **list out the kinds of lathe cutting tools**
- **state their constructional and functional features.**

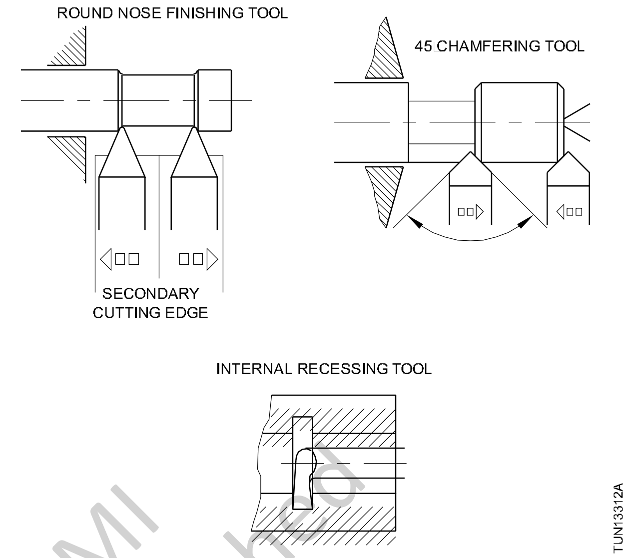
Kinds of lathe cutting tools (Fig 10)

The different types of lathe cutting tools are distinguished by the shape of the cutting edge and the operations which they have to perform. Some of the lathe cutting tools are listed here.

- Facing tool
- Knife edge tool
- Roughing tool
- Round nose finishing tool
- Broad nose finishing tool
- Chamfering tool
- Undercutting tool
- External threading tool
- Parting off tool
- Boring tool
- Internal recessing tool
- Internal threading tool

The tools and their application are illustrated in the figures.

Fig 10



Combination drill

Objectives : At the end of this lesson you shall be able to
- **state what is centre drilling**
- **state the purpose of centre drilling**
- **state the defects in centre drilling**
- **indicate the causes for the defects**
- **state the remedies to avoid the defects.**

Centre drilling (Fig 1)

It is an operation of drilling and countersinking a hole on the face of the work, and on the axis of the work. It is done by a cutting tool known as centre or combination drill held in a drill chuck. The drill chuck is mounted in a tailstock spindle and the feeding on the drill to work is done by rotating the tailstock hand wheel. The spindle speed for the work rotation is calculated, taking into consideratiion the plain drilling diameter and the recommended cutting speed for the drilling. (Fig 2)

Fig 1

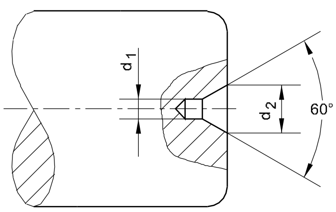
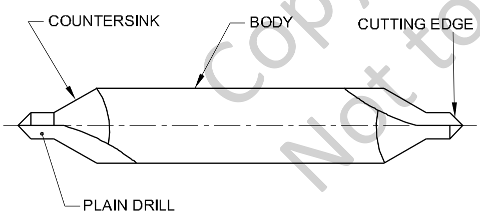


Fig 2



Defects in centre drilled holes

The two major defects in centre drilling are:

- insufficient depth of plain drilled portion (Fig 3)
- centre drilling-done too deep. (Fig 4)

Fig 3

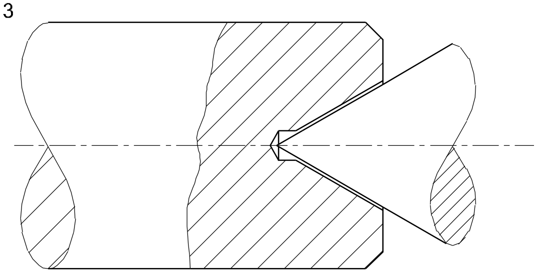
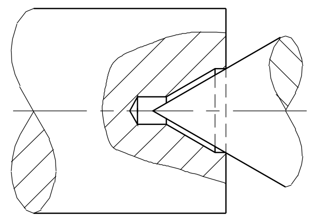


Fig 4



The first defect results in making the tip of the centre to contact the work surface, and the conical portion of the centre does not have any contact with the bearing surface of the centre drilled hole. Undue friction and overheating will be noticed which will damage the tip of the centre. Sometimes breakage is also possible and the broken part of the centre may get welded to the centre hole. By feeding the centre drill up to 3/4th of the 60° countersink, this defect is avoided.

when the centre arm feeding is too much, a plain drilled portion by the body of the centre drill will be formed at the nose of the bearing surface of the centre hole, and the area of contact between the bearing surface and the work-supporting centre will be the only point of contact, as illustrated in Fig 4. This will not provide proper support to the work and any operation if carried out, may result in dimensional inaccuracy, chatter and poor surface finish.

To rectify this defect, face the work, if the length of the work permits, and feed the centre drill to the recommended length.

Centre drills

It is made of high speed steel and is cylindrical in shape. At both the ends, it has a plain drill and countersink as its integral part. It is hardened and ground. It is available in standard sizes.

Classification as per Indian Standard

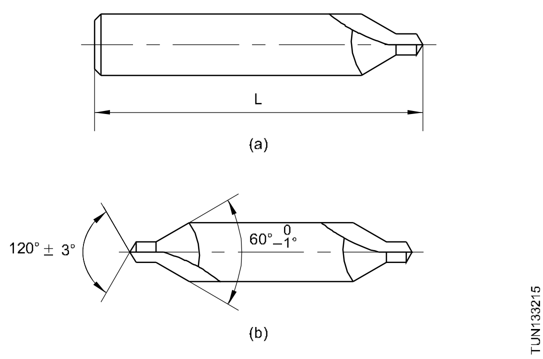
Indian Standard classifies centre drills into three types. They are Type A, Type B and Type R.

The difference lies in the formation of the countersink by each type.

Uses and specifications

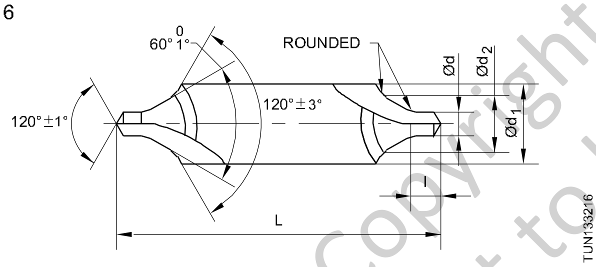
Type 'A' centre drill is used to produce centre holes with plain drilled portion and countersink. It is designated as Centre Drill A. 1.6 x 4.0 JS : 6708 which means that the centre drill is of Type 'A' with the plain drill portion having a diameter .of 1.6 mm and a shank diameter 4 mm. (Fig 5a and b)

Fig 5



Type 'B' centre drill is used to produce a centre hole with a plain drilled portion and a countersink, and has a further conical portion to form additional countersinking to protect the centre hole. The countersinking for providing the bearing surface for centres has an angle of 60° and the countersinking surface has an angle of 120°. This type is designated as Centre Drill B1.6 x6.3 IS: 6709 which means that the pilot diameter is 1.6 mm and shank diameter is 6.3 mm (Fig 6)

Fig 6



The third type, 'R' is designated as Centre Drill R 1.6 x 4.0 IS : 6710. This also has provision to provide a protected centre hole. This has an enlarged radius, machined along with the countersinking portion. (IS : 6710) (Fig 7)

TABLE 1

d	d_1
K_{12}	h_g
(0.5)	3.15
(0.63)	3.15
(0.8)	3.15
1.0	3.15
(1.25)	3.15
1.6	4.0
2.0	5.0
2.5	6.3
3.15	8.0
4.0	10.0
(5.0)	12.5
6.3	16.0
(8.0)	20.0
10.0	25.0

TABLE 2

d	d_1	d_2
K_{12}	h_g	K_{12}
1.0	4.0	2.12
(1.25)	5.0	2.65
1.6	6.3	3.35
2.0	8.0	4.25
2.5	10.0	5.30
3.15	11.2	6.70
4.0	14.0	8.50
(5.0)	18.0	10.60
6.3	20.0	13.20
(8.0)	25.0	17.00
10.0	31.5	21.20.

TABLE 3

d	d_1
K_{12}	h_g
1.0	3.15
(1.25)	3.15
1.6	4.0
2.0	5.0
2.5	6.3
3.15	8.0
4.0	10.0
(5.0)	12.5
6.3	16.0
(8.0)	20.0
10.0	25.0

Data for centre Holes : Types A, B and R
(Dimensions in mm)

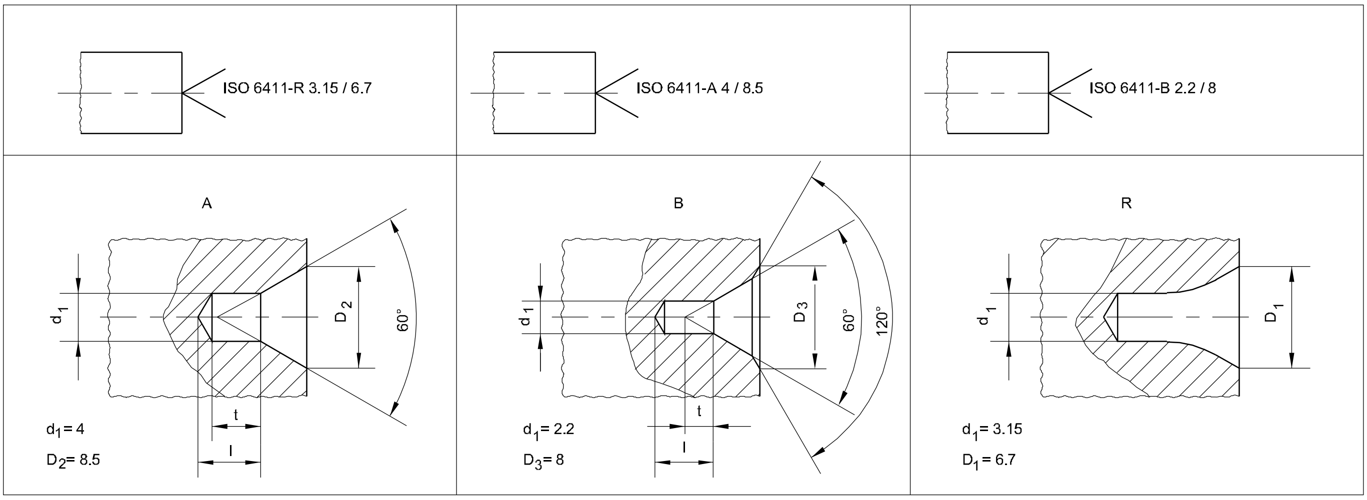
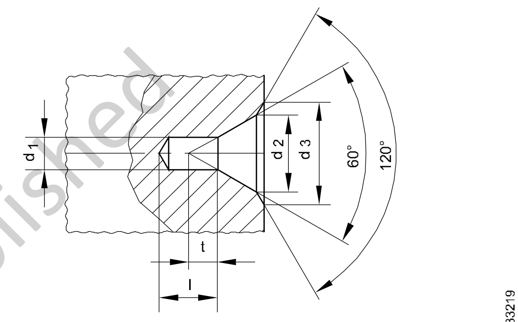


Figure 6 is an additional class of centre hole formed. The end of the bearing surface has a protective countersinking of its convex radius.

The protective countersinking and convex radius are provided to safeguard the bearing surface of the centre holes from getting damaged. (Fig 8 & Fig 9)

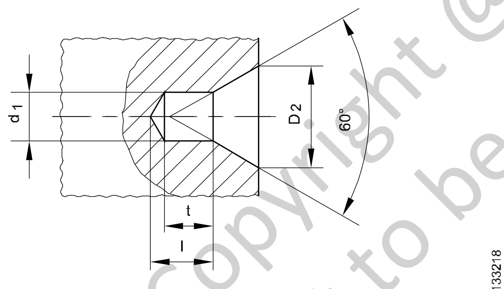
Any damage caused to the bearing surface will not allow the work to run true.

Fig 9



WITH CONICAL PROTECTIVE CHAMFER AND STRAIGHT RUNNING SURFACES

Fig 8



WITHOUT PROTECTIVE CHAMFER AND WITH STRAIGHT RUNNING SURFACES

Drill chuck

Objectives : At the end of this lesson you shall be able to
- **state what is a drill chuck**
- **list out the various types of drill chucks**
- **name the parts of a 3 jaw drill chuck**
- **state the constructional features and functioning of the 3 jaw drill chuck**
- **brief the number drills and letter drills.**

Drill chuck

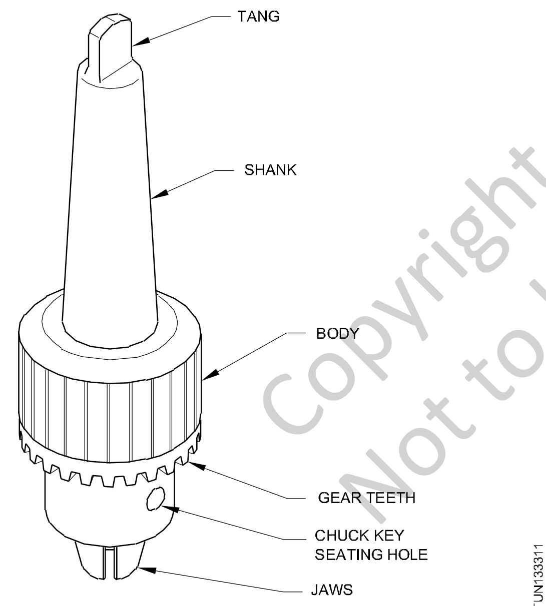
A drill chuck is a holding device, used to hold straight shank drill bits up to 13 mm diameter. It can be fitted in the tapered bores of the lathe tailstock spindle and in the drilling machine spindle.

Types of drill chucks

Various types of drill chucks are available according to the construction and utility. The three commonly used drill chucks are:

- 3 jaw drill chuck (Fig 1)

Fig 1



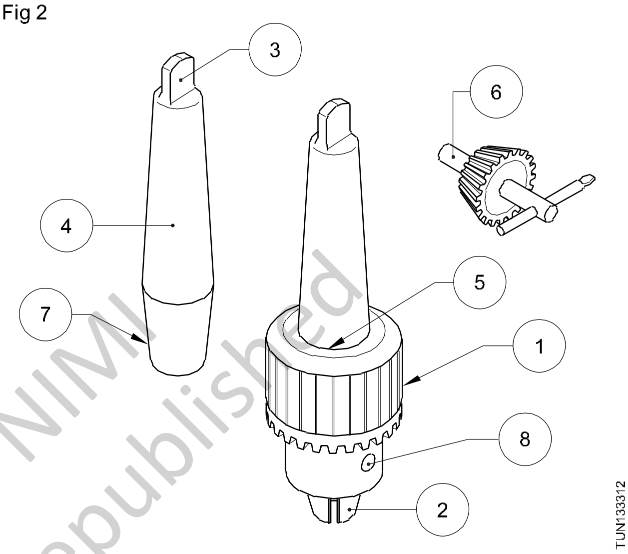
- 2 jaw drill chuck
- quick releasing drill chuck.

Parts of a 3 jaw drill chuck (Fig 2)

The figure shows the different parts of a 3 jaw drill chuck. They are :

1 Sleeve
2 Jaws
3 Tang
4 Shank
5 Arbor hole in chuck body (the arobor assembled in the hole)

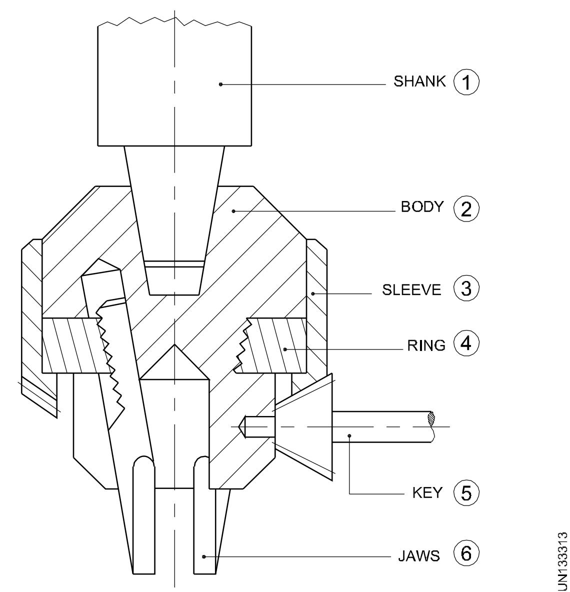
Fig 2



6 Chuck key
7 Taper to fit the arbor hole in the chuck body
8 Chuck key slot

Constructional features and functioning of a 3 jaw drill chuck (Fig 3)

Fig 3



The figure shows the sectional view of a 3 jaw drill chuck. The drill bit is gripped by the jaws (6). These jaws can expand grid contract while moving in the slot of the body (2). The jaws have teeth which are in mesh with threads of the inside surface of the ring (4). The chuck key (5) has a pinion' which meshes with the bevel teeth of sleeve (3). When the chuck key is rotated, the sleeve rotates along with the ring which drives the jaw up and down, according to the direction of rotation. The taper shank (1) serves to mount the chuck into the tailstock spindle.

Lathe accessories

Objectives : At the end of this lesson you shall be able to
- **identify and name the accessories used on a centre lathe.**
- **identify the accessories used for in-between centre work.**
- **name the types of lathe carriers.**
- **state the uses of each type of lathe carriers.**

The lathe accessories are machined, independent units supplied with the lathe. The accessories are essential for the full utilization of the lathe. The accessories can be grouped into:

- work-holding accessories
- work-supporting accessories.

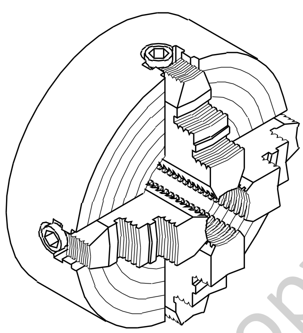
Work-holding accessories

The work can be directly mounted on these accessories and held.

The accessories are :

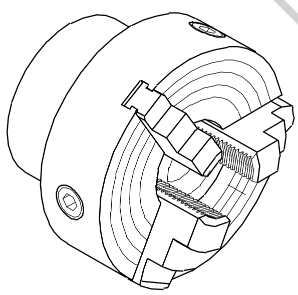
- four jaw independent chuck (Fig 1)

Fig 1



- three jaw self-centering chuck (Fig 2)

Fig 2



- face plates (Fig 3)
- lathe mandrels. (Fig 4)

Fig 3

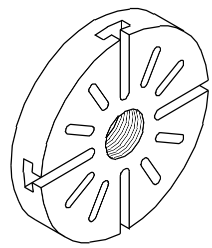
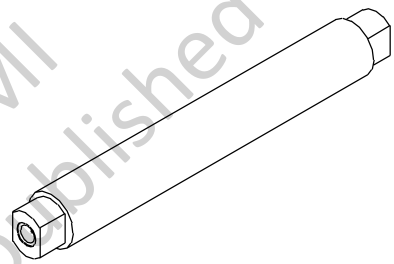


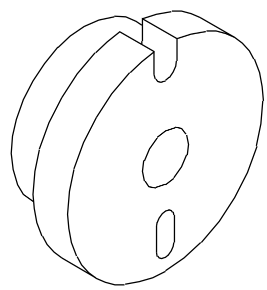
Fig 4



These accessories do not hold the work themselves. They support the work. The following are the work sup-porting accessories.

- Catch plate (Fig 5)

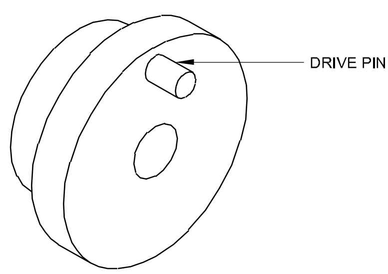
Fig 5



CATCH PLATE

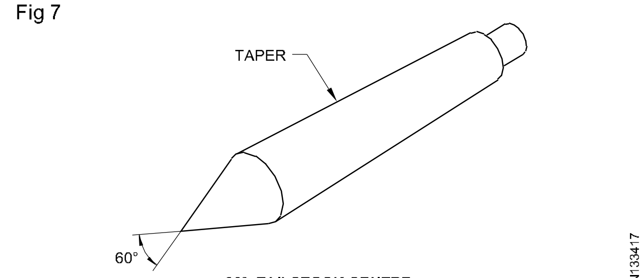
- Driving plate (Fig 6)

Fig 6



- Lathe centres (Fig 7)

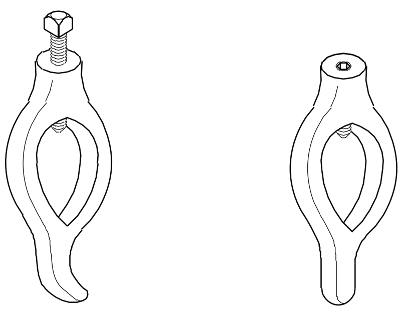
Fig 7



60° TAILSTOCK CENTRE

- Lathe carriers (Fig 8)

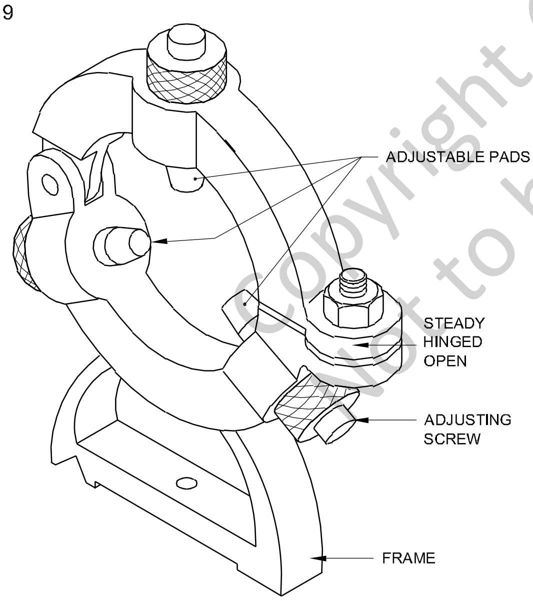
Fig 8



BENT TAIL STRAIGHT TAIL

- Lathe fixed steady (Fig 9)

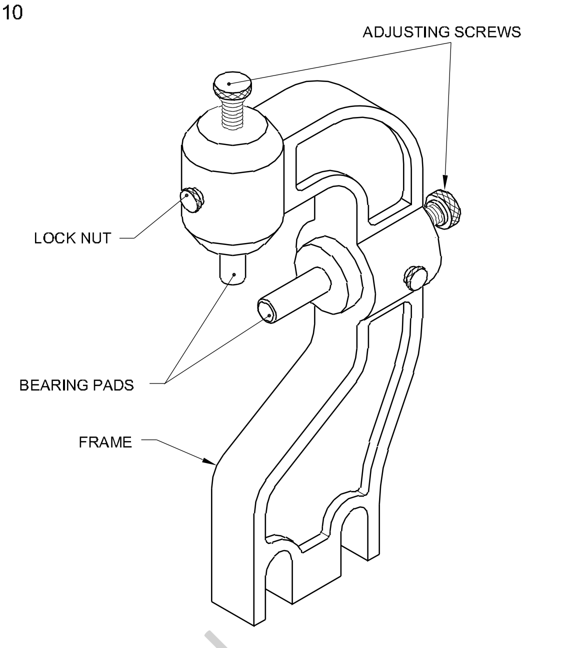
Fig 9



FIXED STUDY

- Lathe travelling steady (Fig 10)

Fig 10



TRAVELLING STEADY

Lathe accessories - work - holding devices : 3 Jaw chuck

Objectives : At the end of this lesson you shall be able to
- **name the parts of a 3 jaw chuck**
- **state the constructional features of a 3 jaw chuck**
- **distinguish between a 3 jaw chuck and a four jaw chuck**
- **state the merits and demerits of the 4 jaw chuck over a 3 jaw chuck**
- **specify a chuck.**

The 3 jaw chuck (Fig 1)

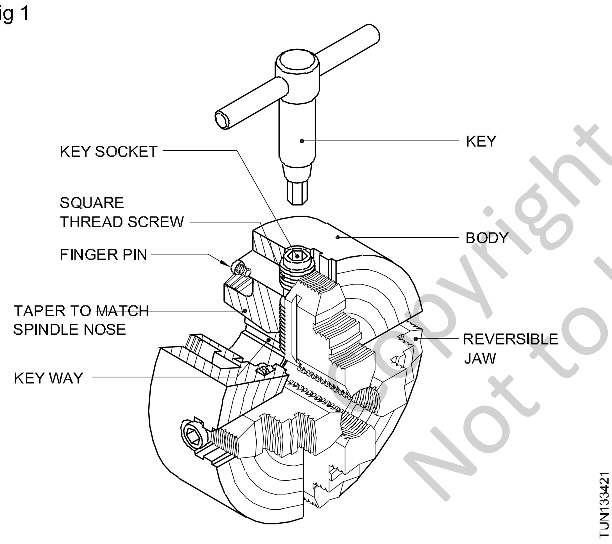
The 3 jaw chuck is also known as self-centering chuck. The majority of the chucks have two sets of jaws for holding internal and external diameters. Only perfectly round work, or work with equally spaced flats, divisible by three, should be held in a 3 jaw chuck.

The construction of a 3 jaw chuck shows that the scroll not only clamps a component in place but also locates the component. This is fundamentally a bad practice, since any wear in the scroll and / or the jaws impairs the accuracy of location. Further, there is no means of adjustment possible to compensate for this wear.

The jaws of this type of chuck are not reversible, and separate internal and external jaws have to be used.

Parts of a 3 jaw chuck (Fig 1)

Fig 1



- Back plate
- Body
- Jaws
- Crown wheel
- Pinion

Back plate

The back plate is fastened at the back of the body by means of allen screws. It is made out of cast iron. Its bore is tapered to suit the taper of the spindle nose. It has a key-way which will fit into the key provided on the spindle nose. There is a step in the front on which the thread is cut. The threaded collar, which is mounted on the spindle, locks the chuck by means of the thread, and locates by means of the taper and the key.

Body

The body is made out of cast steel, and the face is hardened. The body has three openings - 120° apart to assemble the jaws and operate them. Three pinions are fixed on the periphery of the body to operate the jaws by means of a chuck key. The body is hollow in cross-section. The crown wheel is housed inside the body.

Jaws

The jaws are made out of high carbon steel, hardened and tempered, which slide on the openings of the body. Generally there are two sets of jaws, viz. external jaws and internal jaws. External jaws are used for holding solid works. Internal jaws are used for holding hollow works. The steps on the jaws increase the clamping range. The back side of the jaws are cut out of scroll thread. Each jaw is numbered in a sequential manner, which will help in fixing the jaws in the corresponding numbered slots.

Crown wheel

The crown wheel is made out of alloy steel, hardened and tempered. On one side of the crown wheel a scroll thread is cut to operate the jaws and the other side is tapered on which bevel gear teeth are cut to mesh the pinion. When the pinion is rotated by means of the chuck key, the crown wheel rotates, thus causing the jaws to move inward or outward depending upon the rotation.

Pinion

The pinion is made out of high carbon steel, hardened and tempered. It is fitted on the periphery of the body. On the top of the pinion, a square slot is provided to accommodate the chuck key. It has a tapered portion on which the bevel gear teeth are cut, which match with the crown wheel.

Comparison Between a 3 Jaw Chuck and 4 Jaw Chuck

3 Jaw Chuck	4 Jaw Chuck
Only cylindrical or hexagonal work can be held	A wide range of regular and irregular shaped
Internal and external jaws are available	Jaw are reversible for external and internal
Setting up of work is easy	Setting up of work is difficult
Less gripping power	More gripping power
Depth of cut is comparatively less	More depth of cut can be given
Heavier jobs cannot be turned	Heavier jobs can be turned
Workpieces cannot be set for ecentric turning	Workpieces can be set for ecentric turning
Concentric circles are not provided on the face	Concentric circles are provided
Accuracy decreases as chuck gets worn out	There is no loss of accuracy as the chuck gets

Merits of a 4 jaw chuck

A wide range of regular and irregular shapes can be held.

Work can be set to run concentrically or eccentrically at will.

Has considerable gripping power; hence, heavy cuts can be given.

The jaws are reversible for internal and external work.

Work can be readily performed on the end face of the job.

There is no loss of accuracy as the chuck gets worn out.

De-merits of a 4 jaw chuck

Workpieces must be individually set.

The gripping power is so great that a fine work can be easily damaged during setting.

Merits of a 3 jaw chuck

Work can be set quickly and trued easily.

A wide range of cylindrical and hexagonal work can be held.

Internal and external jaws are available.

De-merits of a 3 jaw chuck

Accuracy decreases as chuck gets worn out.

Run out cannot be corrected.

Only round and hexagonal components can be held.

When accurate setting or concentricity with an existing diameter is required, a self-centering chuck is not used.

Specification of a chuck

To specify a chuck, it is essential to provide details of the:

- type of chuck
- capacity of the chuck
- diameter of the body
- width of the body
- the method of mounting to the spindle nose.

Examples

3 jaw self-centering chuck

Gripping capacity 450 mm

Diameter of the body 500 mm

Width of the body 125 mm

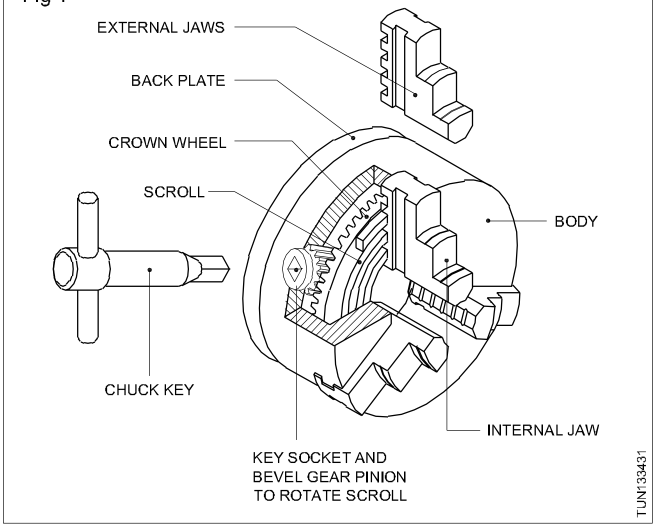
Tapered or threaded method of mounting

Lathe accessories - work - holding devices : 4 Jaw chuck

Objectives : At the end of this lesson you shall be able to
- **name the parts of a 4 jaw chuck**
- **state the constructional features of a 4 jaw chuck.**

4 jaw chuck (Fig 1)

Fig 1



The four jaw chuck is also called as independent chuck, since each jaw can be adjusted independently; work can be trued to within 0.001" or 0.02 mm accuracy.

This type of chuck is much more heavily constructed than the self-centering chuck, and has much greater holding power. Each jaw is moved independently by a square thread screw, and is reversible.

The independent 4 jaw chuck has four jaws, each working independently of the others in its own slot in the chuck body and actuated by its own separate square thread screw. By suitable adjustment of the jaws, a workpiece can be set to run either true or eccentric as required. 'T' slots are provided on the face of the chuck to accommodate 'T' bolts for clamping irregular works or for assembling balance weights.

To set the job for the second time it can be trued with the

help of a dial test indicator. The check on the workpiece should be carried out near the chuck and repeated as far from it as the workpiece permits, to ensure that the work is not held in the chuck at an angle to the axis of rotation.

The independent adjustment also provides the facility of deliberately setting the work off-centre to produce an eccentric workpiece.

Figure 1 shows a setting of an independent 4 jaw chuck for turning on eccentric crankpin.

The parts of a 4 jaw chuck are:

- back plate
- body
- jaws
- screw shaft

Back plate

The back plate is fastened to the back of the body by means of Allen screws. It is made out of cast iron/steel. Its bore is tapered to suit the taper of the spindle nose. It has a keyway which fits into the key provided on the spindle nose. There is a step in front on which the thread is cut. A threaded collar which is mounted on the spindle locks the chuck by means of the thread, and locates by means of the taper and key. Some chucks do not have back plates.

Body

The body is made out of cast iron/cast steel and the face is flame-hardened. It has four openings at 90° apart to assemble the jaws and operate them. Four screw shafts are fixed on the periphery of the body by means of finger pins. The screw is rotated by means of a chuck key. The body, hollow in the cross-section, has equi-spaced circular rings provided on the face, which are marked by numerical numbers. Number 1 starts in the middle and increases towards the periphery.

Jaws

Jaws are made out of high carbon steel. hardened and tempered, which slide on the openings of the body. These jaws are reversible for holding hollow work.

The back side of the jaws are square-threaded which will help in fixing the jaws with the operating screws.

Screw shaft

Screw shaft is made out of high carbon steel, hardened, tempered and ground. The top portion of the screw shaft is provided with a square slot to accommodate the chuck key. On the body portion, a left hand square thread is cut. In the middle of the screw shaft, a narrow step is made and held by means of finger pins. The finger pins permit the screws to rotate but not to advance.

Chucks other than 3 Jaw and 4 Jaw types and their uses

Objectives : At the end of this lesson you shall be able to
- list the name of the chucks other than the 3 jaw and 4 jaw types
- state their constructional features
- state the uses of each of these chucks.

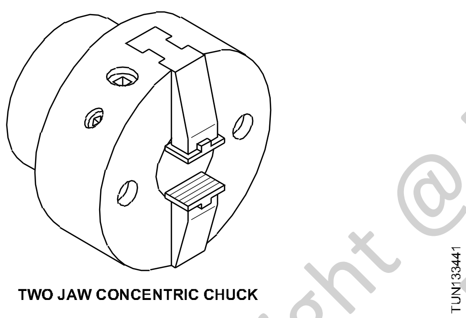
Apart from the four jaw independent chucks and self-centering chucks, other types of chucks are also used on a centre lathe. The choice depends upon the component, the nature of the operation, the number of components to be machined.

Some of the other types of chucks are:

- two jaw concentric chuck
- combination chuck
- collect chuck
- magnetic chuck
- hydraulic chuck or air operated chuck.

Two jaw concentric chuck (Fig 1)

Fig 1



TWO JAW CONCENTRIC CHUCK

The constructional features of this chuck are similar to those of 3 jaw and 4 jaw chucks.

Each jaw is an adjustable jaw which can be operated independently. In addition to this feature, both jaws may be operated concentric to the centre. Irregular shaped works can be held. The jaws may be specially machined to hold a particular type of job.

Combination chuck

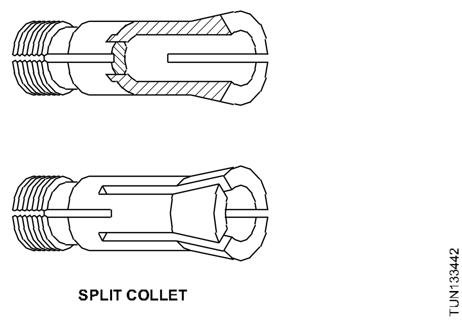
The combination chuck is normally a four jaw chuck in which the jaws may be adjusted either independently as done in a 4 jaw chuck, or together, as done in a 3 jaw universal chuck.

This kind of chuck is used in places where duplicate workpieces are to be machined. One piece is accurately set as done in a 4 jaw chuck, and the subsequent jobs are held by operating the centering arrangement.

Collet chuck (Fig 2)

A collet is a hardened steel sleeve having slits cut partly along its length. It is held by a draw-bar which can be drawn in or out in the lathe spindle. The collet is guided in the collet sleeve, and held with the nose cap. It is possible to change the collet for different cross-sections depending on the cross-section of the raw material.

Fig 2



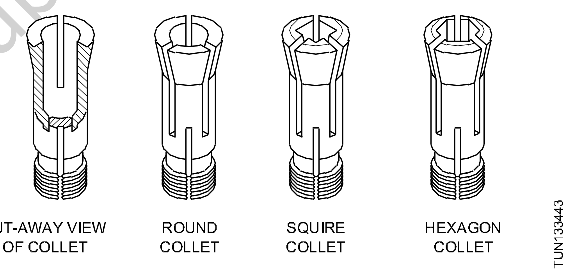
SPLIT COLLET

There are three most commonly used types of collet chucks.

- Push-out chucks
- Draw-in chucks
- Dead length bar chucks

The operation of these chucks may be manual, pneumatic, hydraulic or electrical. They are mainly used to hold round, square, hexagonal or cast profile bars. (Fig 3)

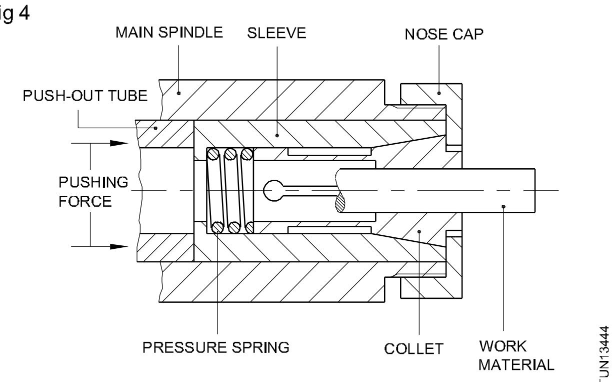
Fig 3



Push-out chucks (Fig 4)

the collet closes on the workpiece in a forward direction and consequently an end-wise movement of the work results. The cutting pressure tends to reduce the grip of the collet on the workpiece.

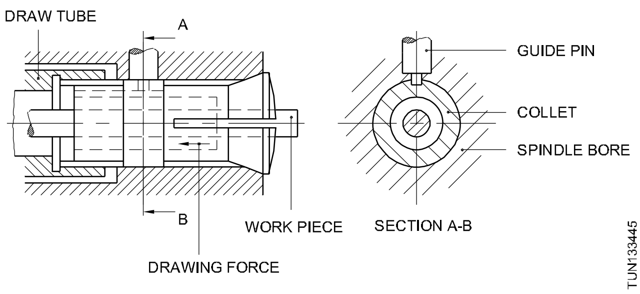
Fig 4



Draw-in chuck (Fig 5)

The collet closes on the workpiece in a backward direction and movement of the work. Take special care to avoid increases the grip of the collet on the workpiece.

Fig 5

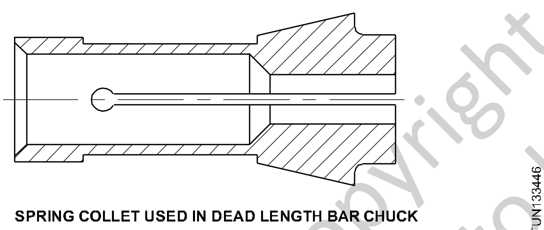


Dead length bar chucks (Fig 6)

These chucks are widely used in modern machines as they provide an accurate end-wise location of the workpiece. The chuck does not move end-wise during gripping or closing operation. These chucks are made to hold round, hexagonal or square bars, and when they are not gripping, they maintain contact with the core thus preventing swarf and chips collecting between the collet and the core

The disadvantage with these chucks is that each collet cannot be made to grip bars which vary by more than about 0.08 mm without adjustment.

Fig 6



SPRING COLLET USED IN DEAD LENGTH BAR CHUCK

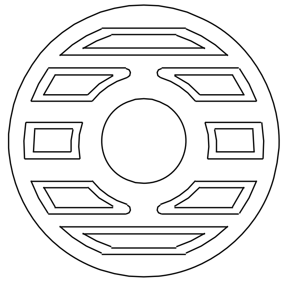
Magnetic chuck (Figs 7a & 7b)

This chuck is designed to hold the job by means of magnetic force. The face of the chuck may be magnetized by inserting a key in the chuck and turning it to 180°. The amount of magnetic force may be controlled by reducing the angle of the key. The truing is done with a light magnetic force, and then the job is held firmly by using the full magnetic force.

Hydraulic chuck or air-operated chuck (Fig 8)

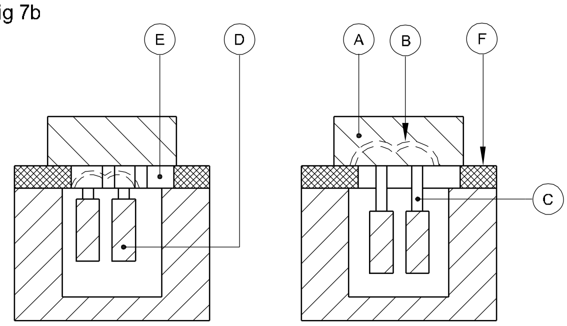
These chucks are mainly used for getting a very effective grip over the job. This mechanism consists of a hydraulic or an air cylinder which is mounted at the rear end of the headstock spindle, rotating along with it. In the case of a hydraulically operated chuck the fluid pressure is transmitted to the cylinder by operaring the valves. This mechanism may be operated manually or by power. The movement of the piston is transmitted to the jaws by means of connecting rods and links which enable them to provide a grip on the job.

Fig 7a



MAGNETIC CHUCK

Fig 7b



INSIDE DETAILS OF MAGNETIC CHUCK

A WORKPIECE
B MAGNETIC FIELD
C CONNECTION
D MAGNETS
E KEEPERS
F FACE PLATE

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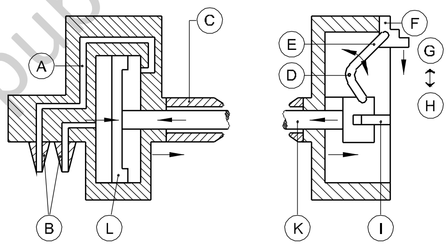
Fig 8



A. AIR PASSAGE
B. VALVES
C. HEADSTOCK
D. PIVOT HINGE
E. LINK
F. JAW
G. CHUCK OPENING
H. CHUCK CLOSING
I. GUIDE
K. PISTON ROD
L. PISTON

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Uses of a two jaw concentric chuck

It is mainly employed to hold an irregularly shaped job. As the chuck is designed with two jaws, it can be used as a turning fixture.

Uses of a combination chuck

This chuck may be used both as a universal 3 jaw chuck and as a 4 jaw independent chuck. This chuck is very useful where duplicate workpieces are involved in the turning.

Uses of a collet chuck

It is mainly used for holding jobs within a comparatively small diameter. The main advantage of collets lies in their ability to centre work automatically and maintain accuracy for long periods. It also facilitates to hold the bar work.

Uses of a magnetic chuck

This type of a chuck is mainly used for holding thin jobs which cannot be held in an ordinary chuck. These are suitable for works where a light cut can be taken on the job.

Uses of hydraulic or air-operated chuck

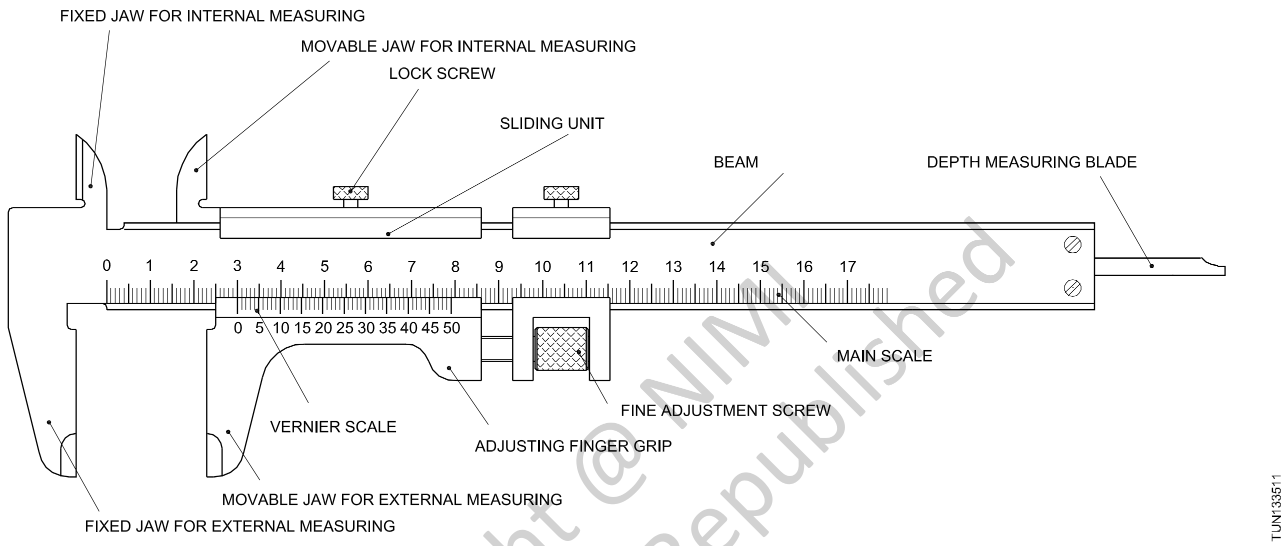
These chucks are mainly used in mass production because of their speedy and effective gripping capacity.

Vernier caliper

Objectives : At the end of this lesson you shall be able to
- **list out the parts of a vernier calliper**
- **state the constructional features of the vernier calliper**
- **state its functional features**
- **read a measurement .**

One of the precision instruments having the principle of vernier applied to it is the vernier caliper. It is known as a vernier caliper because of its application to take outside, inside and depth measurements. Its accuracy is 0.02 mm.

Fig 1



Parts of a vernier caliper

A universal vernier caliper consists of a:

- Beam
- Fixed jaw for external measurements
- Movable jaw for external measurements
- Movable jaw for internal measurements
- Blade for depth measurement
- Main scale
- Vernier scale
- Fine adjustment screw
- Set of locking screws.

All parts are made out nickel-chromium steel or invested heat-treated and ground. They are machined to a high accuracy. They are stabilized to avoid distortion due to temperature variations.

Constructional features

The beam is the main part and the main scale graduations are marked on it. The markings are in millimeters and every tenth line is drawn a little longer and brighter than the other graduations and numbered as 1,2,3 ….

To the left of the beam the fixed jaws for external and internal measurements are fixed as integral parts., The vernier unit slides over the beam.

At the bottom face of the beam a keyway-like groove is machined for its full length, permitting the blade to slide in the groove.

At the bottom right hand end, a unit is fixed serving as a support for the blade when it slides in the groove.

The vernier unit has got the vernier graduations marked on it. The movable jaws for both external and internal measurements are integral with this.

The fixed and movable jaws are knife-edged to have better accuracy during measurement. When the fixed and movable jaws are made to contact each other, the zero of the vernier scale coincides with the zero of the main scale.

At this position in the blade will be in line with the right hand edge of the beam.

When the vernier scale unit slides over the beam, the movable jaws of both the measurements as well as the blade advance to make the reading.

To slide the vernier unit, the thumb lever is pressed and pulled or pushed according to the direction of movement of the vernier unit.

Sizes

Vernier calipers are available in sizes of 150 mm, 200 mm, 900 mm and 1200 mm. The selection of the size depends on the measurements to be taken. Vernier calipers are precision instruments, and extreme care should be taken while handling them.

Never use a vernier caliper for any purpose other than measuring.

Vernier calipers should be used only to measure machined or filed surfaces.

They should never be mixed with any other tools.

Clean the instrument after use, and store it in a box.

Graduations and reading of vernier calipers

Objectives: At the end of this lesson you shall be able to
- **determine the least count of vernier calipers**
- **state how graduations are made on vernier calipers with 0.02mm least count**
- **read vernier caliper measurements.**

Vernier calipers

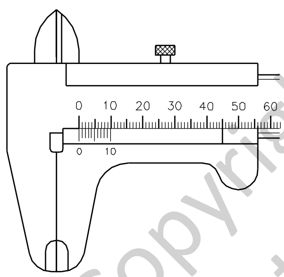
Vernier calipers are available with different accuracies. The selection of the vernier caliper depends on the accuracy needed and the size of the job to be measured.

This accuracy/least count is determined by the graduations of the main scale and vernier scale divisions.

Determining least count of vernier calipers

In the vernier caliper shown in Fig 1, the main scale divisions (9mm) are divided into 10 equal parts in the vernier scale.

Fig 1



i.e.	One main scale division (MSD)	=	1 mm
	One vernier scale division? (VSD)	=	9/10 mm
	Least count is 1 mm - 9/10 mm	=	1/10 mm
	The difference between one MSD and one VSD	=	0.1 mm

Example

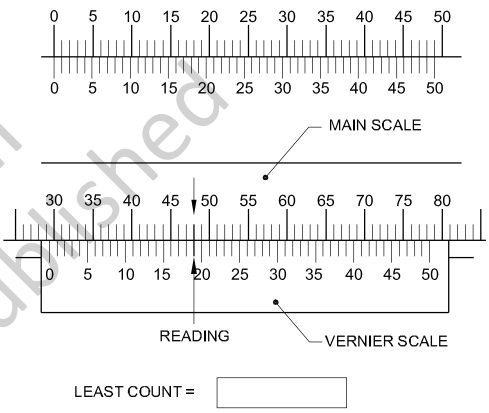
Calculate the least count of the vernier given in Fig 2.

Reading vernier measurements

Vernier calipers are available with different graduations and least counts. For reading measurements with a vernier caliper the least count should be determined first. (The least count of calipers is sometimes marked on the vernier slide).

The figure above shows the graduations of a common type of vernier caliper with a least count of 0.02 mm. In this, 50 divisions of the vernier scale occupy 49 divisions (49 mm) on the main scale.

Fig 2



i.e One main scale division (MSD) = 1mm

One Vernier scale division? (VSD) = 49/50 mm

Least count = 1 MSD - 1 VSD

= 1mm - 49/50

= 50 - 49/50 = 1/50 = 0.02 mm

Example for vernier caliper (Fig 3)

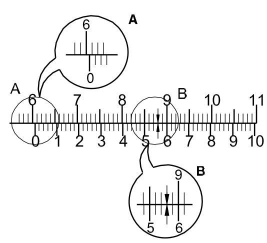
Main scale reading 60 mm.

The vernier division coinciding with the main scale is the 28th division. Value = 28 x 0.02

= 0.56 mm

Reading = 60+0.56 = 60.56mm

Fig 3



Classroom Exercise

In figures 3, 4, 5, 6 and 7, 49 main scale divisions are divided into 50 equal parts on the vernier scale. Value of-one M.S.D. is 1 mm.

Fig 4

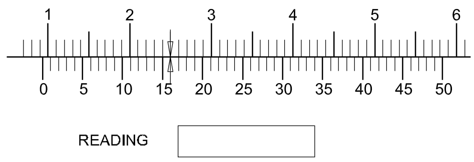


Fig 5

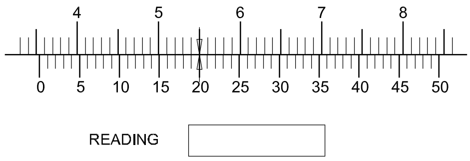


Fig 6

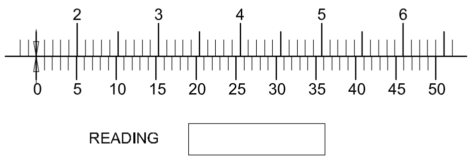
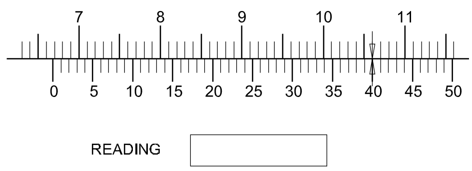


Fig 7



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1 Calculate the least count.

2 Record the reading of each, figure in the space pro-vided.

Disadvantages

Accuracy of reading depends on the skill of the operator.

Loses its accuracy by constant usage as slackness in the sliding unit develops.

Cannot be used to measure components having devia-tions less than ± 0.02 mm.

Possibility of parallax error during noting down the coinciding line may cause the reading of the measurement to be wrong.

To read a measurement

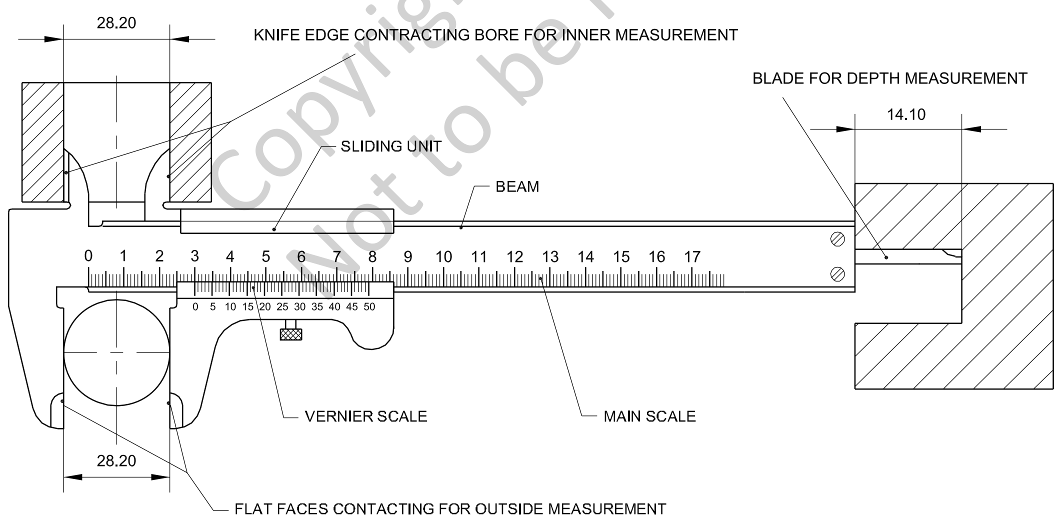
Note the number of graduations on the main scale passed by the zero of the vernier. This gives the full mm.

Note which of the vernier scale division coincides with any one line on the main scale.

Multiply this number with the least count.

Add the multiplied value to the main scale reading.

Fig 8



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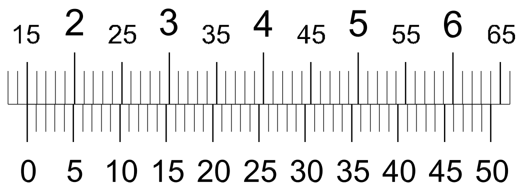
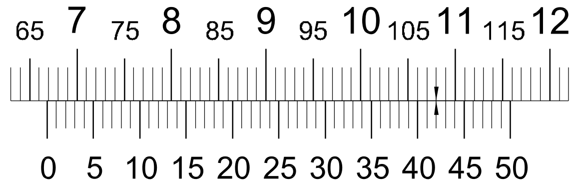
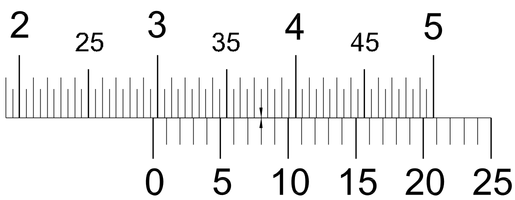
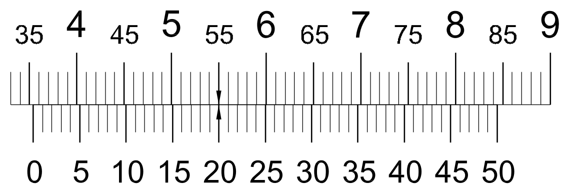
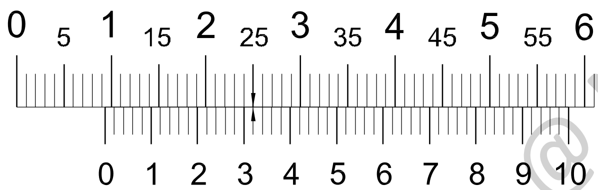
Metric vernier reading exercises

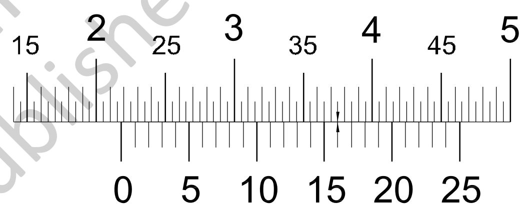


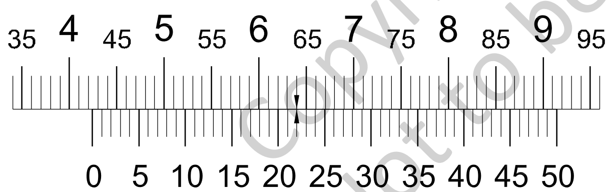


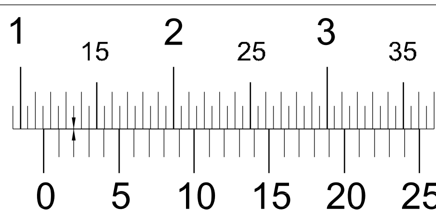


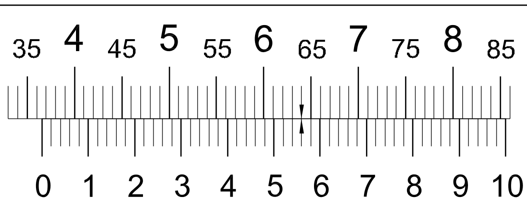


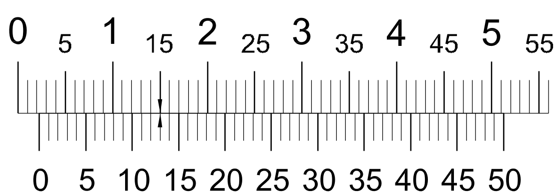












Digital vernier caliper

Objectives: At the end of this lesson you shall be able to
- **state the uses of digital caliper**
- **name the parts of a digital caliper**
- **brief the zero setting of a digital caliper.**

The digital caliper (sometime incorrectly called the digital vernier caliper) is a precision instrument than can be used to measure internal and external distance accurately to 0.01mm, The digital vernier caliper is shown in Fig 1. The distance or the measurements are read from LED drawing. The parts of digital calipers are similar to the ordinary vernier caliper except the digital display and few other parts. The parts are indicated in Fig 1.

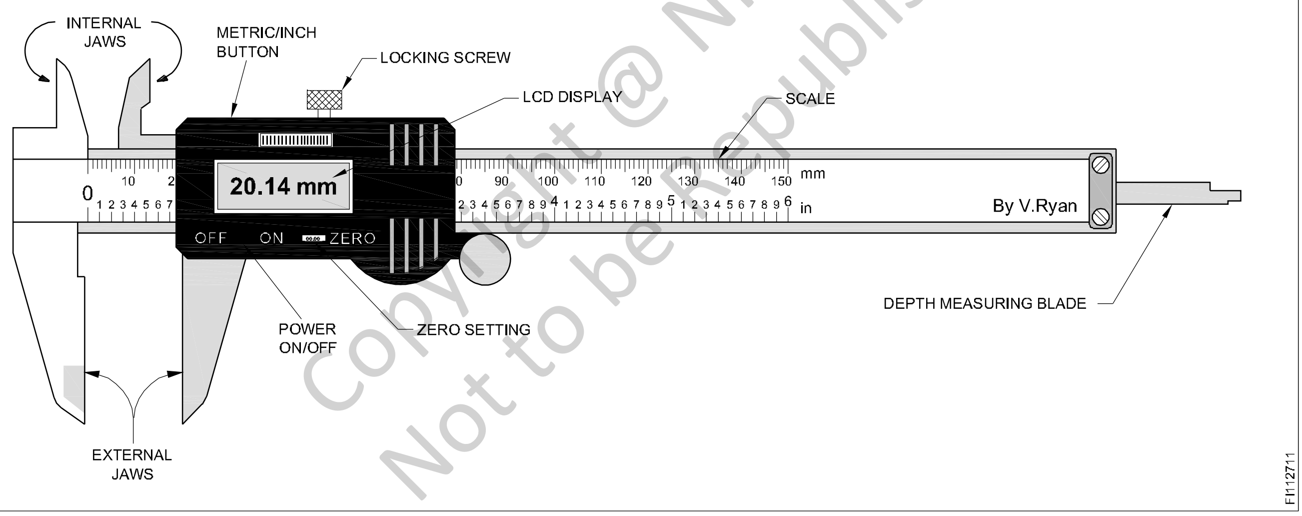
Earlier versions of the type of measuring instrument had to read by looking carefully at the inch or metric scale and there was a need for very good eye sight in order to read the small sliding scale. Manually operated vernier caliper are remain popular because they are much cheaper than the digital version.

The digital caliper requires a small battery whereas the manual version does not need any power source.The digital calipers are easier to use as the measurement is clearly display and also, by pressing inch/mm button the distance can be read as metric or inch.

The display is turned on with the ON/OFF button. before measuring, the zero setting to be done, by bringing the external jaws together until they touch each other and then press the zero button. Now the digital caliper is ready to use.

Always set zero position when turning on the display for the first time.

Fig 1



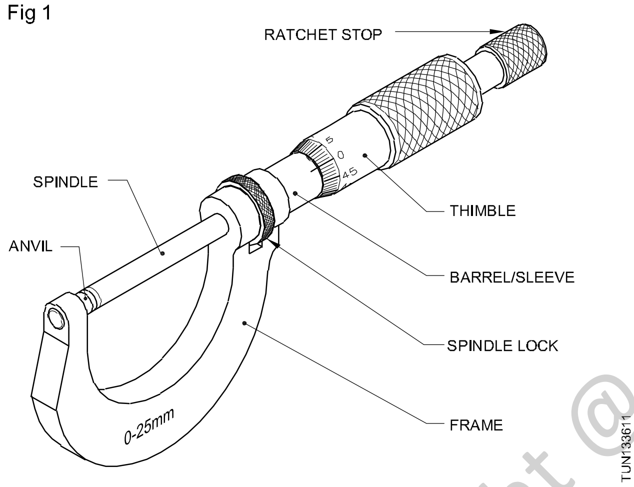
Outside micrometers

Objectives : At the end of this lesson you shall be able to
- **list the parts of an outside micrometer**
- **state the functions of the main parts of an 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. (Fig 1)

Fig 1



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.

Graduations of metric outside micrometer

Objectives : At the end of this lesson you shall be able to
- **state the principle of a micrometer**
- **determine the least count of an outside micrometer.**

Working principle

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.

Graduations (Fig 1)

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.

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.

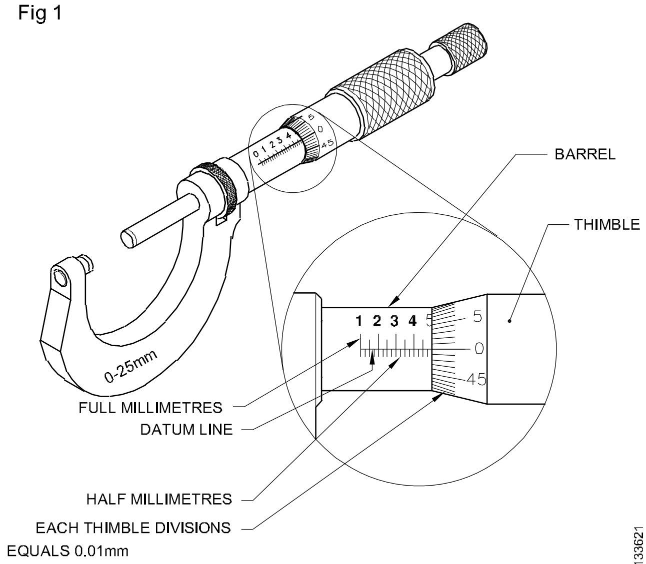
The distance moved by the spindle during one rotation of the thimble is 0.5 mm.

Movement of one division of the thimble = 0.5 x 1/50

= 0.01 mm

Accuracy or least count of a metric outside micrometer is 0.01mm.

Fig 1



OUTSIDE MICROMETER

Reading dimensions with an outside micrometers

Objectives: At the end of this lesson you shall be able to
- **select the required range of a micrometer**
- **read micrometer measurements.**

Ranges of outside micrometer

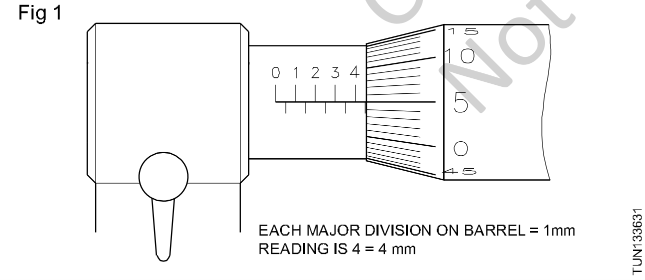
Outside micrometers are available in ranges of 0 to 25 mm, 25 to 50 mm, 50 to 75 mm, 75 to 100 mm, 100 to 125 mm and 125 to 150 mm.

For all ranges of micrometers, the graduations marked on the barrel is only 0-25 mm. (Fig 1)

Method of reading

Read on the barrel scale the number of whole millimeters that are completely visible from the bevel edge of the thimble. It reads 4 mm. (Fig 1)

Fig 1



Add to this any half millimeters that are completely visible from the bevel edge of the thimble.

The figure reads 1/2 = 0.5 mm.(Fig 2)

Add the thimble reading to the two earlier readings.

The figure shows the 5th division of the thimble is coinciding with the index line of the sleeve. Therefore the reading of the thimble is 5x0.01 mm = 0.05 mm. (Fig 3)

Fig 2

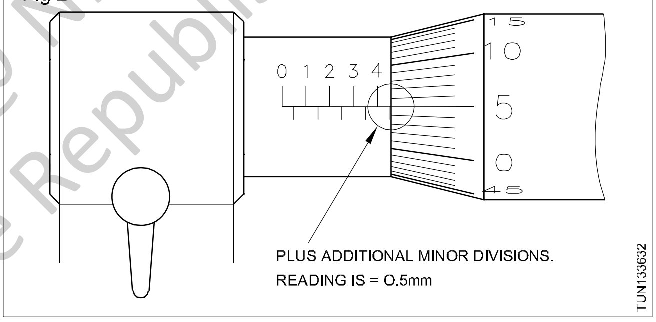
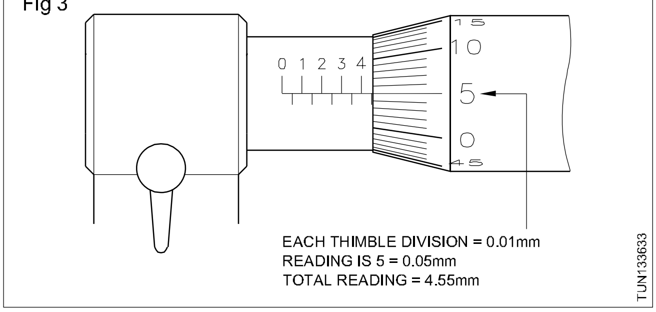


Fig 3



The total reading of the micrometer.

a 4.00 mm

b 0.50 mm

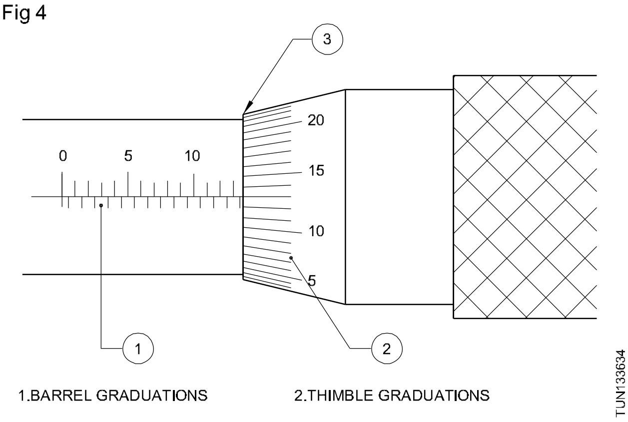
c 0.05 mm

Total reading 4.55 mm (Fig 3)

Reading micrometer measurements

How to read a measurement with an outside micrometer? (Fig 4)

Fig 4



First note the minimum range of the outside micrometer. While measuring with a 50 to 75 mm micrometer, note it as 50 mm.

Then read the barrel graduations. Read the value of the visible lines on the left of the thimble edge.

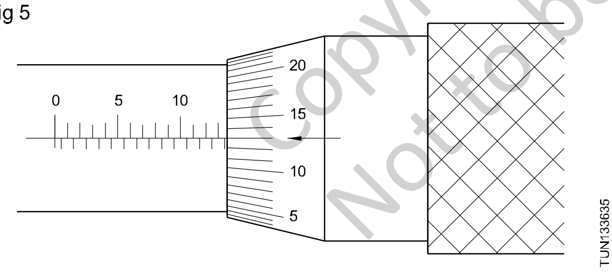
13.00 mm
+ 00.50 mm

13.50 mm

Next read the thimble graduations.

Read the thimble graduations in line with the barrel datum line, 13th div. (Fig 5)

Fig 5



Multiply this value with 0.01 mm (least count).

13 x 0.01 mm = 0.13 mm.

Add

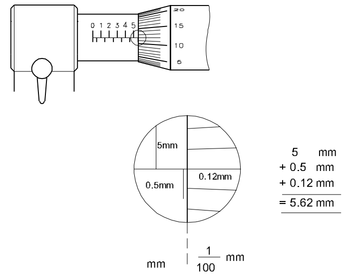
Minimum range	50.00 mm
Barrel reading	13.50 mm
Thimble reading	00.13 mm
Total	63.63 mm

The micrometer reading is 63.63 mm.

Some examples of metric micrometer readings and their solution

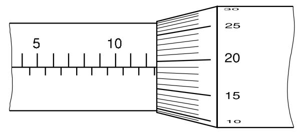
i
5.00 mm
0.50 mm
0.12 mm

Total 5.62 mm



iii
12.00 mm
0.50 mm
0.19 mm

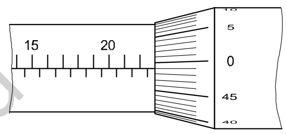
Total 12.69 mm



12.69mm

iiii
23.00 mm
0.50 mm
0.49 mm

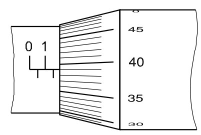
Total 23.99 mm



23.99mm

iv
1.00 mm
0.50 mm
0.39 mm

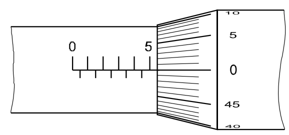
Total 1.89 mm



1.89mm

v
5.00
0.50 mm
0.00 mm

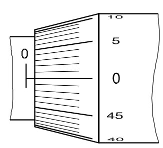
Total 5.50 mm



5.50 mm

vi
0.00 mm
0.50 mm
0.00 mm

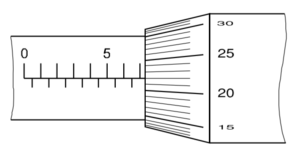
Total 0.50 mm



0.50 mm

vii
7.00 mm
0.00 mm
0.22 mm

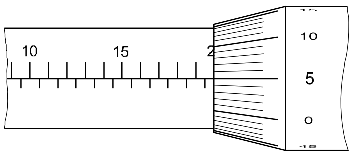
Total 7.22 mm



7.22 mm

viii 19.00 mm
0.50 mm
0.05 mm

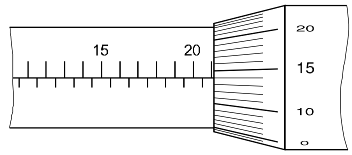
Total 19.55 mm



19.55 mm

x 21.00 mm
0.00 mm
0.14 mm

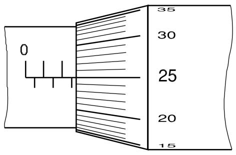
Total 21.14 mm



21.14 mm

ix 2.00 mm
0.50 mm
0.25 mm

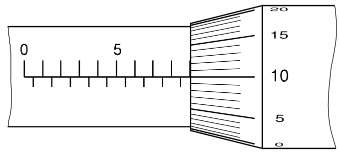
Total 2.75 mm



2.75 mm

xi 9.00 mm
0.00 mm
0.10 mm

Total 9.10 mm



9.10 mm

Error in micrometer

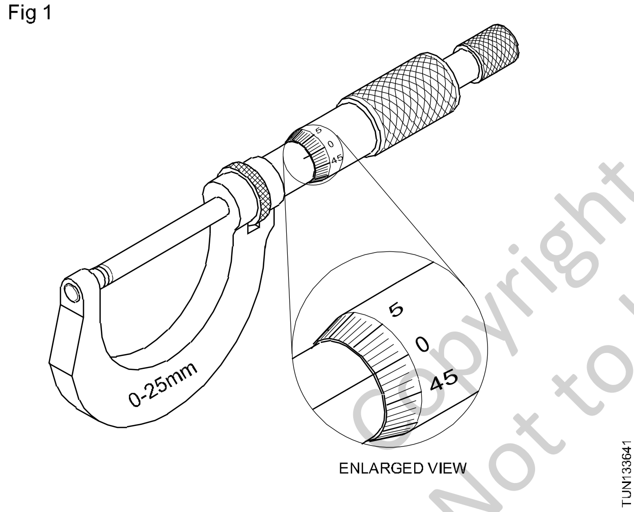
Objective: This shall help you to

- **check outside micrometer for '0' error.**

No zero error

When the measuring faces are in contact if the zero of the thimble should be coincide with the datum line No zero error (Fig 1).

Fig 1



Zero error

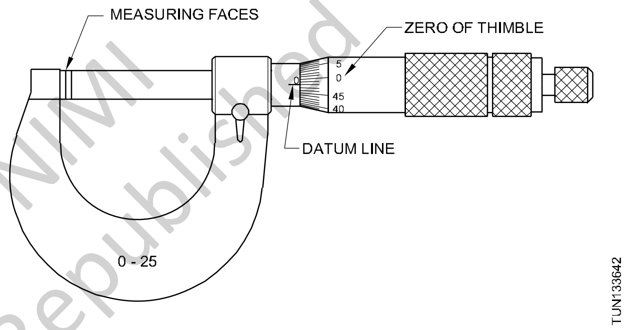
When the measuring faces are in contact, (Fig 2) if the zero of the thimble do not coincide with the datum line (the zero of the thimble will be above or below the datum line) the micrometer is said to be with zero error. There are two types of zero error.

a) Positive error

b) Negative error

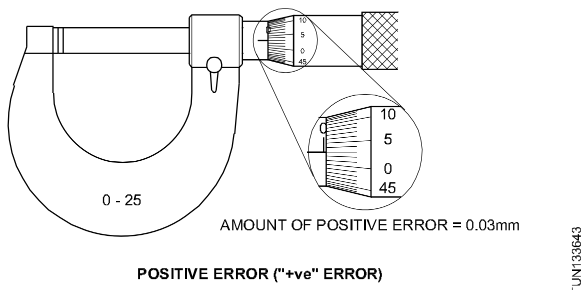
> **All micrometers should be checked for its zero error and the error should be noted if any before using it on checking dimensions.**
>
> **Clean measuring faces with clean cloth before checking for zero error.**

Fig 2



Positive error: When the anvil and spindle faces are in contact in case of a 0-25 mm micrometer or 0-1 micrometer and with a test piece inbetween the measuring faces in case of a higher range micrometer. If the zero of the thimble rest below the datum line of the sleeve the error is called as "Positive". (Fig 3)

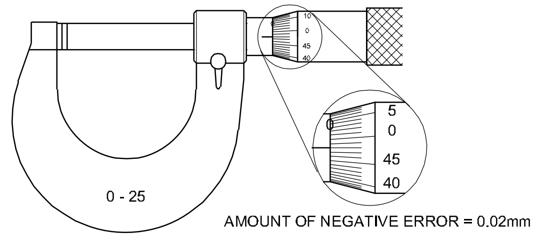
Fig 3



To get the correct reading the amount of error should be substracted from the reading dimension.

Negative error: When the anvil and spindle faces are in contact, if the zero of the thimble passes above the datum line of the sleeve, the error is called as "Negative". (Fig 4)

Fig 4

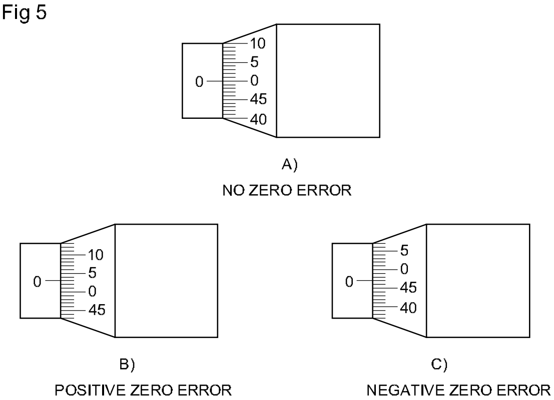


NEGATIVE ERROR ("-ve" ERROR)

To get the correct reading the amount of negative error should be added to the reading dimension.

> **Caution: When you come across with micrometer having "zero error", inform your instructor and get it corrected by him. Do not try yourself to correct at this stage.**

Fig 5



Digital micrometers

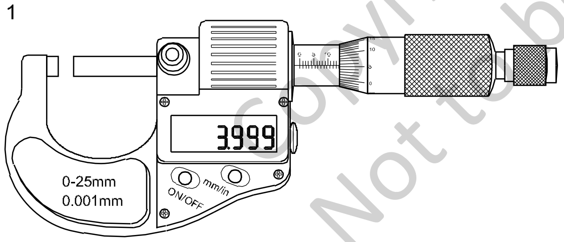
Objectives: At the end of this lesson you shall be able to

- **state the uses of digital micrometer**
- **list the parts of digital micrometer**
- **read the reading from LED display and thimble and barrel**
- **brief the maintenance, maintenance of digital micrometers.**

Digital micrometers is one of the simplest and most widely used measuring equipment in any manufacturing industry. Its simplicity and the versatile nature make Digital micrometers so popular. Different kinds of Digital micrometers available in the market.

Feature of digital micrometers (Fig 1)

Fig 1



FEATURE OF DIGITAL MICROMETERS

- LCD displays measuring data and makes direct read out with resolution of 0.001mm.
- Origin setting mm/inch conversion, swith for absolute and incremental measurement.
- Carbide tipped measuring faces.
- Ratchet ensures invariable measurement and accurate repeatable reading

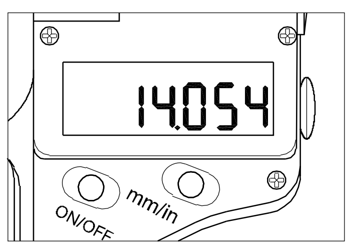
Accuracy of digital micrometers

Digital micrometers provide 10 times more precision and accuracy : 0.00005 inches or 0.001mm resolution, with 0.0001 inches or 0.001mm accuracy.

Reading of the digital micrometer

The digital micrometers are provided with high precision reading with LCD display. The reading is 14.054 mm as shown in Fig 2.

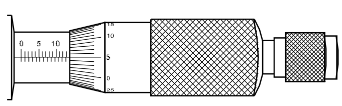
Fig 2



READING OF THE DIGITAL MICROMETERS

Reading also by reading the marks on the sleeve and the thimble. Usually, the reading from the large LCD display for the digital micrometer because the digital reading is more accurate. The reading on the sleeve and the thimble is just for reference. Read the markings on the sleeve and the thimble, firstly, read the point which the thimble stops at it on the right of the sleeve (It is 14mm here, because each line above the centre long line represents 1mm while each line below the centre long line represent 0.5mm) (Fig 3)

Fig 3



Secondly, read the markings on the thimble, It is between 5 and 6, So you need to estimate the reading. (It is 0.055mm for each line here represents 0.001mm). At last, add all the reading up : 14mm + 0.055 mm = 14.055mm. So the total reading is 14.055mm.

Maintenance of a digital micrometers

Never apply voltage (e.g. engraving with an electric pen) on any part of the Digital Micrometers for fear of damaging the circuit.

Press the ON/OFF button to shut the power when the Digital micrometers stands idle; take out the battery if it stands idle for a long time.

As for the battery, abnormal display (digit flashing or even no display) shows a flat battery. Thus you should push the battery cover as the arrow directing and then replace with a new one. Please note that the positive side must face out If the battery bought from market dosen't work well (the power may wear down because of the long-term storage or the battery's automatic discharge and etc.) Please do not hesitate to contact the supplier.

Flashing display shows dead battery. If this is the case please replace the battery at once. No displace shows poor contact of a battery or short circuit of both poles of the battery. Please check and adjust pole flakes and battery insulator cover. In case water enters the battery cover, open the cover immediately and blow the inside of the battery cover at a temperature of no more than 40^{0}C till it gets dry.

Lathe - cutting speed and feed & depth of cut

Objectives : At the end of this lesson you shall be able to
- **distinguish between cutting speed and feed**
- **read and select the recommended cutting speed for different materials from the chart**
- **point out the factors governing the cutting speed**
- **state the factors governing feed.**

Cutting speed (Fig 1)

The speed at which the cutting edge passes over the material, which is expressed in metres per minute is called the cutting speed. When a work of a diameter 'D' is turned in one revolution the length of portion of the work in contact with the tool is π x D. When the work is making 'n' rev/min, the length of the work in contact with the tool is π x D x n. This is converted into metres and is expressed in a formula form as

$$V = \frac{\pi DN}{1000}$$

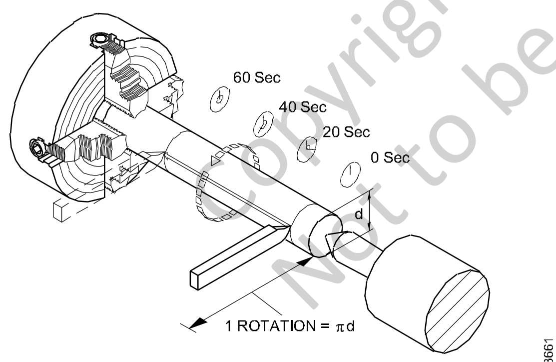
Where V = cutting speed in metre/min

π = 3.14

D = diameter of the work in mm.

N = r.p.m.

Fig 1



CUTTING SPEED FOR TURNING OPERATION

Example

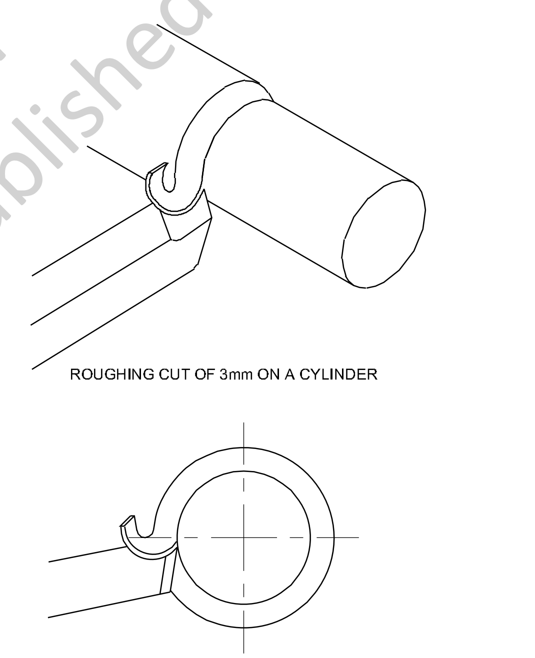
Find out the rpm of the spindle for a 50 mm bar to cut at 25 m/min.

$$V = \frac{\pi DN}{1000} \quad N = \frac{1000V}{\pi D}$$

$$\frac{1000 \times 25}{3.14 \times 50} = \frac{500}{3.14} = 159 \text{ r.p.m}$$

When more material is to be removed in lesser time, a higher cutting speed is needed. This makes the spindle to run faster but the life of the tool will be reduced due to more heat being developed. Recommended cutting speeds are given in a chart form which provides normal tool life under normal working conditions. As far as possible the recommended cutting speeds are to be chosen and the spindle speed calculated before performing the operation. (Fig 2)

Fig 2



DEPTH OF CUT

Factors governing the cutting speed

Finish required

Depth of cut

Tool geometry

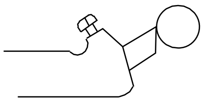
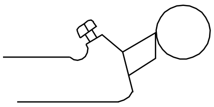
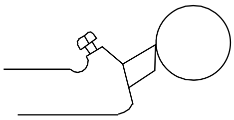
Properties and rigidity of the cutting tool and its mounting

Properties of the workpiece material

Rigidity of the workpiece

Type of cutting fluid used & Rigidity of machine tool

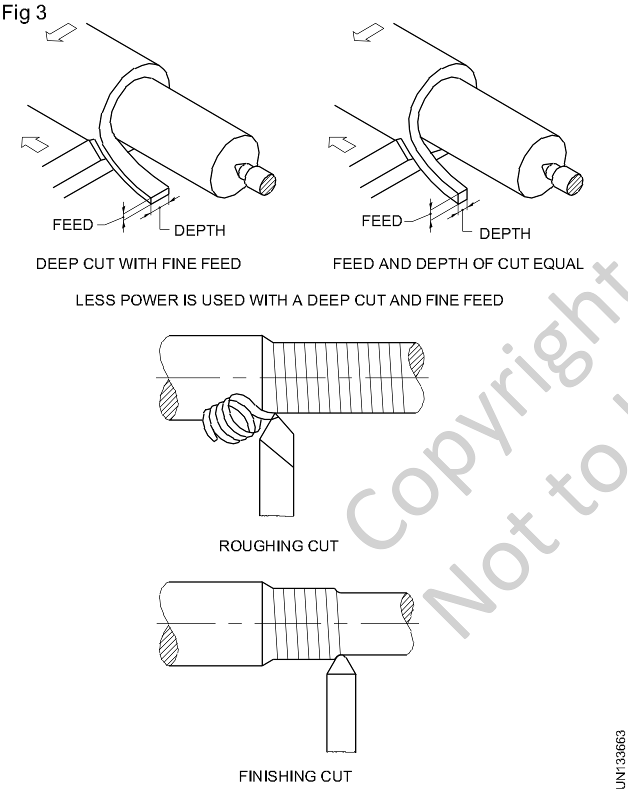
Relationship of r.p.m to the cutting speed on different diameter

Cutting speed 120m/min	Length of metal passing cutting tool in one revolution	Calculated r.p.m of spindle
 Ø25 mm	.... 78.5 mm	1528
 Ø50 mm	.... 157.0 mm	764
 Ø75 mm	.... 235.5 mm	509.5

Feed (Fig 3)

The feed of the tool is the distance it moves along the work for each revolution of the work, and it is expressed in mm/rev.

Fig 3



Factors governing feed

Tool geometry

Surface finish required on the work

Rigidity of the tool

Coolant used.

Depth of cut (Fig 3)

It is defined as the perpendicular distance measured between the machined surface (d) and the unmachined surface (D) expressed in mm.

$$\text{Depth of cut} = \frac{D - d}{2}$$

Rate of metal removal

The volume of metal removal is the volume of chip that is removed from the work in one minute, and is found by multiplying the cutting speed, feed rate and the depth of cut.

Cutting speeds and feeds for H.S.S. tools are given in Table 1

Table 1

Material being turned	**Feed**	**Cutting speed**
Aluminium	0.2 - 1.00	70 - 100
Brass (alpha) - ductile	0.2 - 1.00	50 - 80
Brass (free cutting)	0.2 - 1.5	70 - 100
Bronze (phosphor)	0.2 - 1.00	35 - 70
Cast iron (grey)	0.15 - 0.7	25 - 40
Copper	0.2 - 1.00	35 - 70
Steel (mild)	0.2 - 1.00	35 - 50
Steel (medium-carbon)	0.15 - 0.7	30 - 35
Steel (alloy high tensile)	0.08 - 0.3	5 - 10
Thermosetting plastics	0.2 - 1.00	35 - 50

Note

For super HSS tools the feeds would remain the same, but cutting speeds could be increased by 15% to 20%

A lower speed range is suitable for heavy, rough cuts.

A higher speed range is suitable for light, finishing cuts.

The feed is selected to suit the finish required and the rate of metal removal.

When carbide tools are used, 3 to 4 times higher cutting speed than that of the H.S.S. tools may be chosen.

Calculation involving cutting speed, feeds

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

- **determine the spindle speed for turning jobs of different materials of different diameters with different tool materials**
- **determine the turning time with the given data.**

The selection of the spindle speed is one of the factors which decides the efficiency of cutting. It depends on the size of the job, material of the job and material of the cutting tool. The formula to determine cutting speed is.

$$= \frac{\pi \times D \times N}{1000} \text{ metre/min. where D is in mm.}$$

$$N = \frac{CS \times 1000}{\pi \times D}$$

To determine the spindle speed (N)

Example 1

Calculate the spindle speed to turn a MS rod of ø40 mm. Using HSS tool data in the above problem, since the material is mild steel and tool is HSS, the recommended cutting speed from the chart is 30m/min.

ø = 40 mm

$$N = \frac{CS \times 1000}{\pi \times D}$$

$$= \frac{30 \times 1000}{\frac{22}{7} \times 40}$$

$$= \frac{30 \times 1000 \times 7}{22 \times 40}$$

$$= \frac{30 \times 25 \times 7}{22}$$

= 238.6 r.p.m.

The spindle speed should be set nearest to the calculated r.p.m., on the lower side.

Example 2

Determine the spindle speed to be set for a hard cast iron round rod of ø 40 mm using a HSS tool.

Data: The cutting speed for hard cast iron from the chart is 15 m/min.

ø = 40 mm

$$N = \frac{CS \times 1000}{\pi \times D}$$

$$= \frac{15 \times 1000}{\frac{22}{7} \times 40}$$

$$= \frac{15 \times 1000 \times 7}{22 \times 40}$$

$$= \frac{15 \times 25 \times 7}{22}$$

= 119.3 r.p.m.

The spindle speed should be set nearest to the calculated r.p.m., on the lower side.

Example 3

Calculate the spindle speed to turn a ø40 mm MS rod using a cemented carbide tool.

Data: The cutting speed recommended for-turning mild steel using a carbide tool is 92 mtr/minute.

ø of job = 40 mm

$$N = \frac{CS \times 1000}{\pi \times D}$$

$$= \frac{92 \times 1000}{\frac{22}{7} \times 40}$$

$$= \frac{92 \times 1000 \times 7}{22 \times 40}$$

$$= \frac{92 \times 25 \times 7}{22}$$

= 731.8 r.p.m.

The spindle speed should be set to the nearest calculate r.p.m.

Turning time calculation

The time factor is very important to decide the manufac turing of the component as well as to fix the incentives to the operator. If the spindle speed, feed and length of the cut are known, the time can be determined for a given cut.If the feed is 'f' and length of cut is 'l', then the total number if revolutions the job has to make for a cut is l/f. If N is the rpm, the time required for a cut is found by

$$\text{Time to turn} = \frac{\text{Length of cut} \times \text{No.of cuts}}{\text{Feed} \times \text{r.p.m}}$$

$$T = \frac{l \times n}{f \times N}$$

where 'n' is the number of cuts and 'N' is the r.p.m.

Example 1

A mild steel of ø 40 mm and 100 mm length has to be turned to ø 30 mm in one cut for full length using a HSS tool with a feed rate of 0.2 mm/rev. Determine the turning time.

$$\text{Turning time} = \frac{l \times n}{f \times N}$$

The r.p.m. for the above is calculatedHand found out as 238.6 r.p.m.

l = 100mm

f = 0.2 mm

n = 1

N = 238.6 r.p.m.

$$\text{Time} = \frac{100 \times 1}{0.2 \times 238.6}$$

$$= \frac{100 \times 10}{2 \times 238.6}$$

$$= \frac{500}{238.6}$$

= 2.09 minutes

2 minute 5.4 seconds.

Different types of micrometer

Objectives : At the end of this lesson you shall be able to
- **identify and name the different types of micrometers other than regular micrometers**
- **state the specific use of each micrometer.**

In addition to regular micrometers, there are several other types of micrometers, with the same fundamental principle, but specifically designed to meet the various special applications, such as external, internal, depth measurement etc.

Types of micrometers other than regular

Screw thread micrometer

Tube micrometer

Digital micrometer

Depth micrometer

Flange micrometer

Ball micrometer

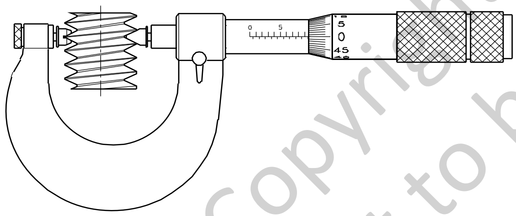
Stick micrometer

External micrometer with interchangeable anvils

Keyway depth micrometer

Screw thread micrometer (Fig 1)

Fig 1



A screw thread micrometer is similar to an outside micrometer except that the spindle is pointed to fit between 60° V threads, and the anvil is shaped to fit over 60° V thread. It is used to measure the pitch diameter of the thread. Screw thread micrometers are available in many sizes depending on the pitch of the thread to be measured.

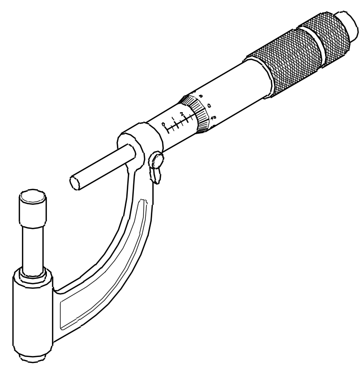
Tube micrometer (Fig 2)

A tube micrometer is specially designed to measure the thickness of the material of piping, tubing and and other parts of similar shapes.

Digital micrometer

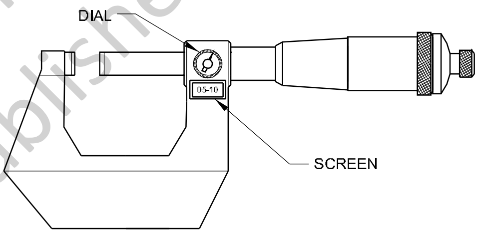
This type of micrometer has got a dial on the frame of the micrometer and an illuminated screen below it. The dial pointer has an internal connection with the micrometer screw for measuring. The graduations on the sleeve and thimble are the same as on a regular micrometer. This micrometer is used to measure the dimensions similar to those measured by the outside micrometers, and the reading can be noted. (Fig 3)

Fig 2



TUBE MICROMETER

Fig 3

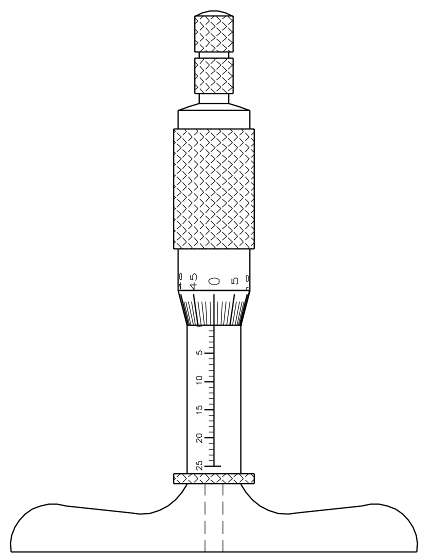


DIGITAL MICROMETER

The advantage of this micrometer is, the readings are seen on the screen or the dial directly, without any diffi-culty. We need not look on the sleeve or the thimble scale coincidence. This avoids errors in reading and saves time. A layman can also read the measurement directly.

Depth micrometer (Fig 4)

Fig 4

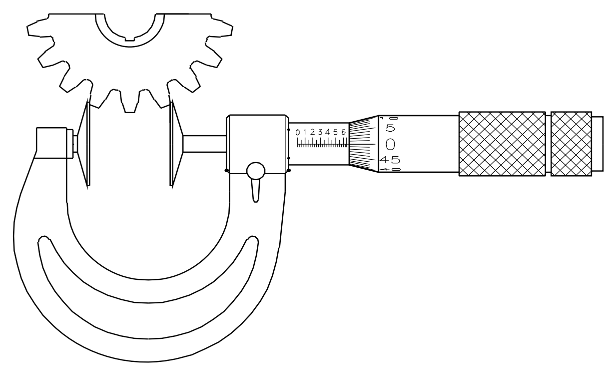


DEPTH MICROMETER

A depth micrometer is designed to measure accurately the depth of grooves, bores, counterbores, recesses and holes. The graduations are read in the same manner as is done in the case of regular micrometers. Larger ranges of depth can be measured by inserting an extension rod through the top of the micrometer. The graduations are in the reversed direction to those of an o/s micrometer.

Flange micrometer (Fig 5)

Fig 5

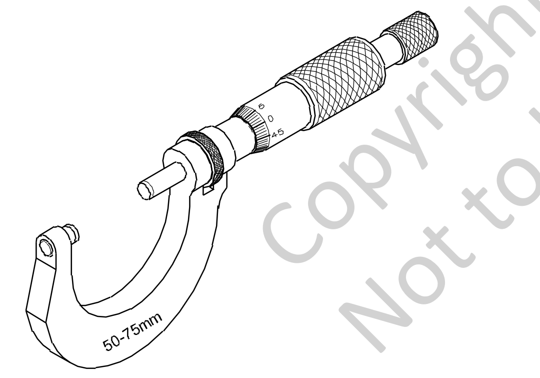


FLANGE MICROMETER

A flange micrometer is similar to a regular micrometer and is equipped with two flanges in the place of the anvil and spindle. This is used to measure chordal thickness of the gear teeth and the thickness of the fins of an engine and the collar thickness of the job.

Ball micrometer (Fig 6)

Fig 6



In this form of micrometer, hemispherical balls are fitted at the anvil and spindle. Measurement is similar to that in a regular micrometer. It is used to measure a sphere where the point of contact comes in between.

Stick micrometer

Stick micrometers are designed for the measurement of longer internal lengths.

This comprises of:

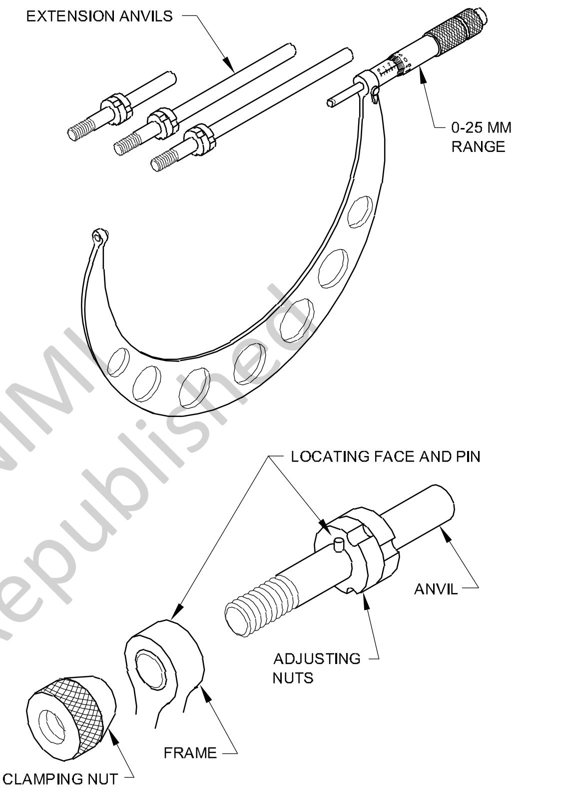
- a 150 mm or 300 mm micrometer unit, fitted with a micrometer of 25 mm range and having rounded terminal faces
- a series of extension rods, which together with the micrometer unit, permits a continuous range of measurement up to the maximum length required.

Secured joints are used for joining the end piece, extension rod and the measuring unit. The screw unit generally has threads of 0.5 mm pitch. The extension rod is generally hollow and has a minimum external diameter of 14 mm.

In this type of micrometer, there should be sufficient play between the external and internal threads of the joint to permit the abutment forces of the various parts of the micrometer to butt together solidly.

External micrometer with interchangeable anvils (Fig 7)

Fig 7



It is nothing but an external micrometer. The advantage in this micrometer is the range of the micrometer can be increased by merely changing the different anvils.

A set of replaceable anvils is supplied in a box and the size of the anvil is marked on each anvil. Depending upon the size of the job, the anvil size can be changed, and reading can be taken. Thus it is an economy micrometer, i.e. in one micrometer itself, long ranges can be accommodated. To fix the anvils to the frame, a guide is provided and locked by a nut.

Keyway depth micrometer

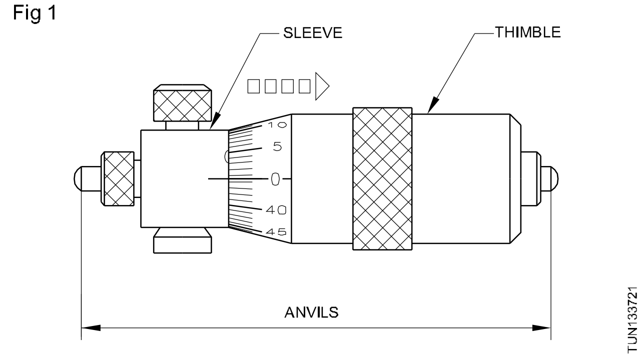
It is similar to a depth micrometer except that the frame has 120° inclined butting surfaces to rest on the circumference on a cylindrical job. It is used for measuring depth of keyways on a cylindrical shaft. While measuring the depth of the keyway, first take the measurement on a cylindrical job opposite to the keyway; then take the measurement of the keyway depth, subtract the initial measurement from the final measurement to know the exact depth of the keyway.

Inside micrometer - metric

Objectives : At the end of this lesson you shall be able to
- **name the parts of an inside micrometer**
- **determine the reading of the bore or hole**
- **determine the reading with a spacing collar & extension rods**
- **determine the distance between internal parallel surfaces.**

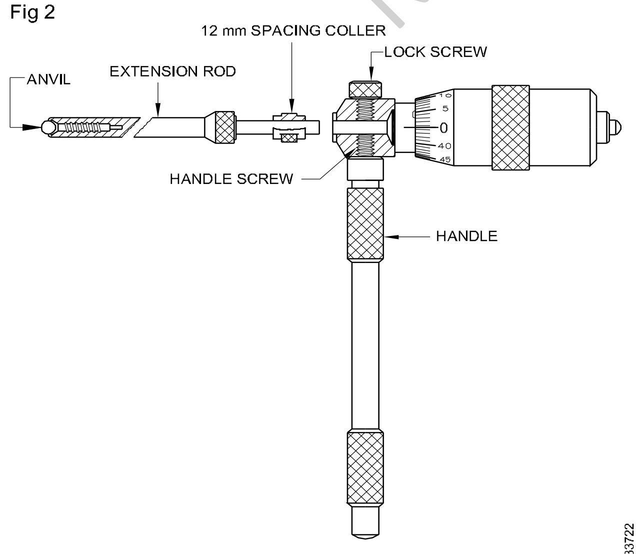
The inside micrometer is similar to an ordinary outside micrometer but without the 'U' frame. (Fig 1) The measurement is taken over the contact points. As the thimble opens or closes, the contact points get opened or closed. The inside micrometer consists of a sleeve, thimble, anvils, a spacing collar and extension rods. It is also equipped with a handle to measure deep bores. The least count of the instrument is also 0.01 mm

Fig 1



The inside micrometer is equipped with a 12mm spacing collar and 4 extension rods for measuring holes of ranges. 50-75mm, 75-100 mm, 100-125mm and 125-150mm. The sleeve is marked with the main scale and the thimble with the thimble scale. The barrel has a limited adjustment of 13mm. when the inside micrometer is closed (when zero of thimble coincides with the zero of the barrel), it is capable of reading the minimum dimension of 25mm. In addition to this, it is possible to read up to 38mm with the thimble opening to the extreme right. In order to read further higher ranges, a standard spacing collar of 12mm width is to be added. This facilitates the micrometer to read a minimum range of 50mm (Fig 2).

Fig 2



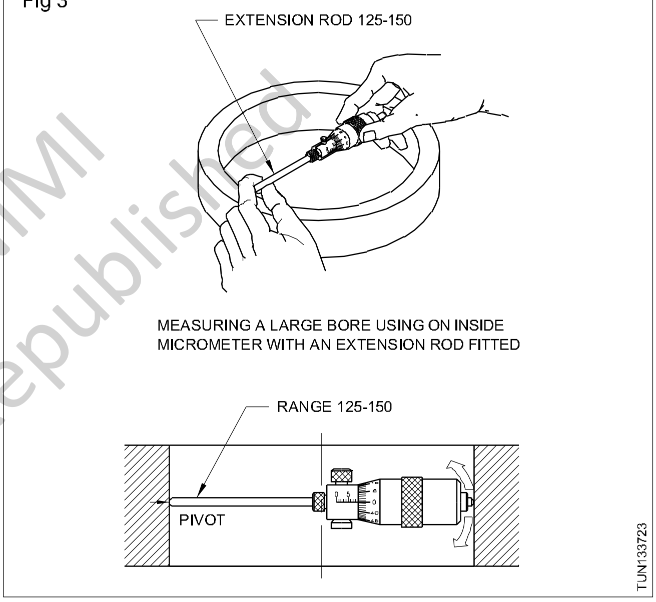
INSIDE MICROMETER

Similarly, each extension rod has to be used without the collar for measuring a minimum range up to 13mm variation and with the collar for a maximum range of measurements. a clamping screw is also provided to clamp the extension rod firmly.

Determining the size of a bore or hole

Fig 3 shows an inside micrometer with a spacing collar and extension rod of 125-150mm range. The size of the bore is 125mm + 12mm + barrel reading + thimble reading which is equal to 125 + 12 + 1.5 + 0.00 = 138.50mm.

Fig 3



Determining the distance between internal parallel surfaces

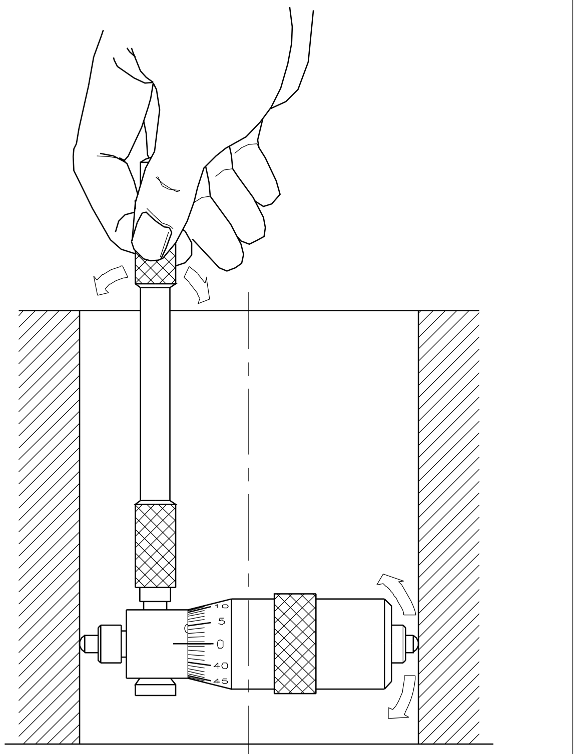
While checking parallelism between two surfaces of a deep bore, a handle must be used along with the inside micrometer. The figure shows the inside micrometer with a handle. In order to ascertain the parallelism., a minimum of two readings has to be taken, i.e. one at the top surface of the bore. If there is no difference in the two readings, we may take it for granted that the surfaces are perfectly parallel. Any variation in the reading shows the bore has an error between the two surfaces. (Fig 4)

Three point internal micrometer (Fig 5)

A three-point internal micrometer is used for a direct measurement of an internal diameter accurately and efficiently. It is also used to measure the diameter of a deep hole, the end of a blind hole, internal recess etc.

The instrument is checked for its zero error with a master ring gauge. (Fig 6)

Fig 4



USING AN EXTENDED HANDLE WHEN MEASURING THE BORE OF A SLEEVE BEARING

Fig 5

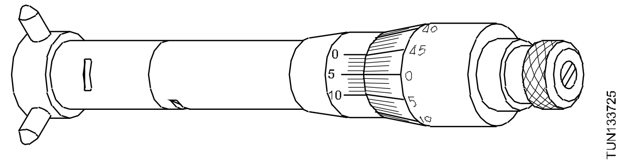
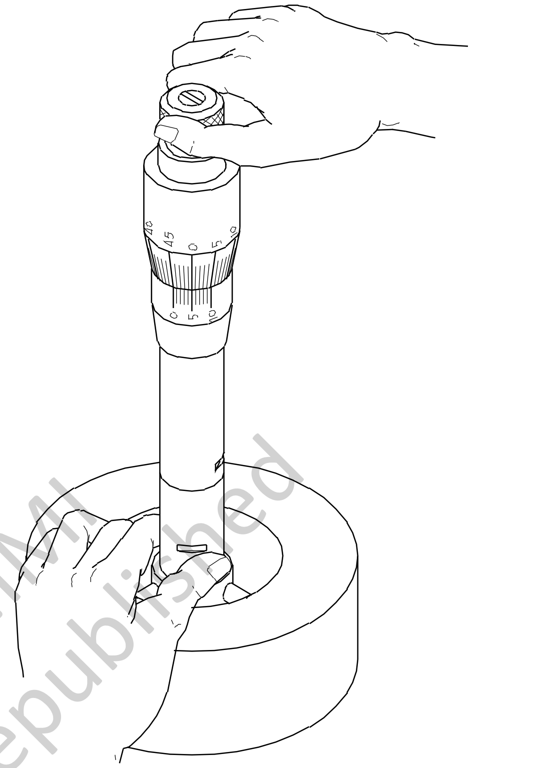


Fig 6



Three-point internal micrometer

Objectives : At the end of this lesson you shall be able to
- **state the uses of a three-point internal micrometer**
- **identify the parts of a three-point micrometer**
- **state the features of a three-point micrometer.**

The three-point internal micrometer (Fig 1) is useful for :

- measuring the diameters of through and blind holes
- checking cylindricity and roundness of bores.

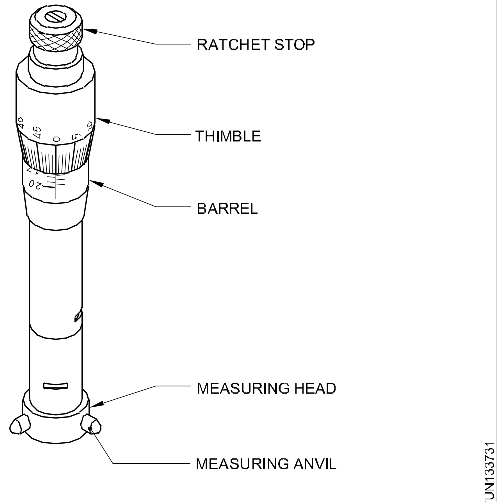
The commonly used three-point internal micrometers have a least count of .005mm

Parts

- The measuring head (consisting of three measuring anvils)
- Ratchet stop
- Thimble
- Barrel

This micrometer has a cone spindle which advances when the thimble is rotated clockwise. The movement of the cone spindle makes the measuring anvils to move forward and backward uniformly. The three measuring anvils facilitate self-alignment of the instrument within the bore.

Fig 1

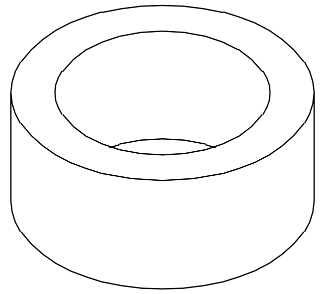


Three-point internal micrometers are available in sets. Each set consists of 3 or 4 micrometers. The measuring range of each of them will be 10mm.

The ratchet stop permits uniform pressure between the anvils and the work surfaces being measured.

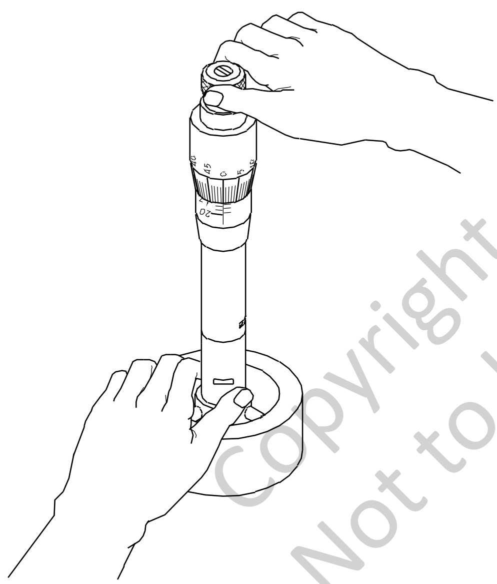
These micrometers are provided with one or more zero setting rings. (Fig 2)

Fig 2



Before taking measurement, the zero setting has to be checked using the setting ring. (Fig 3)

Fig 3



The position of the anvil can be reset by loosening the barrel using a screw driver provided for this purpose.

Depending on the depth of the bore the length of the micrometer can be varied using the extension rod. (Fig 4) A set of spanners is provided for assembling and disassembling the extension rod. (Fig 5)

The instruments are available in various sizes and forms for measuring different sizes.

They are also available in analogue or digital readouts.

Fig 4

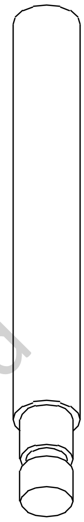
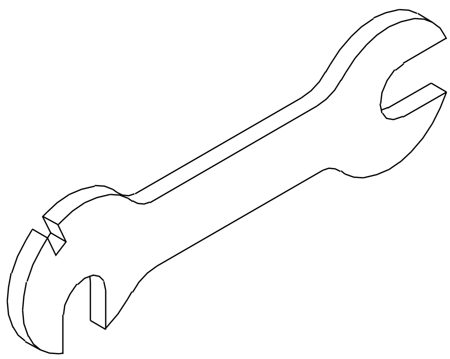


Fig 5



Sources of measuring errors

Objectives : At the end of this lesson you shall be able to
- **state what is meant by measuring errors**
- **name the different types of measuring errors**
- **identify each of the measuring errors.**

Measuring errors occur each time when we measure a workpiece. We must, therefore, always allow for a certain inaccuracy when we measure a workpiece. The degree of this inaccuracy depends on the skill of the person measuring it and the inaccuracy of the measuring instrument.

Measuring errors can be grouped as follows.

- Systematic errors
- Random errors
- Geometrical errors
- Contact errors
- Gauge and instrument errors
- Elastic deformation
- Parallel errors
- Observation errors
- Cosine errors
- Temperature errors

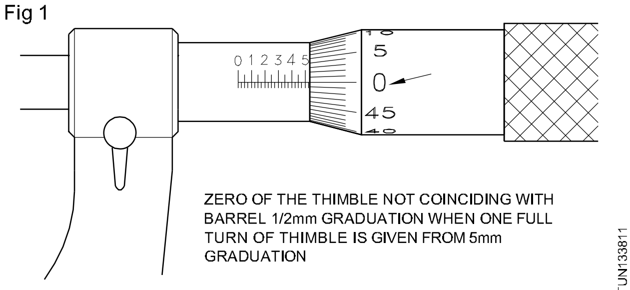
Systematic errors

Measuring errors which are due to the measuring instrument are known as systematic errors. The systematic errors can be subdivided into:

- known systematic errors
- unknown systematic errors.

The known systematic errors are those which always influence the measuring result to the same extent and in the same direction (+ or -); for example, a subdividing error for a scale as shown here. The value to be read off here can then be corrected. (Fig 1)

Fig 1



The unknown systematic errors give different values in different directions (+ and -) in different measurements. An example of this type of error is errors due to friction changes in the measuring instrument.

The result of all the unknown systematic errors is referred to as the degree of inaccuracy of the measuring device.

Random or accidental errors

Random errors are caused by external conditions, such as differences in temperature, air humidity, dirt and vibrations and also the human factor such as viewing errors and fatigue.

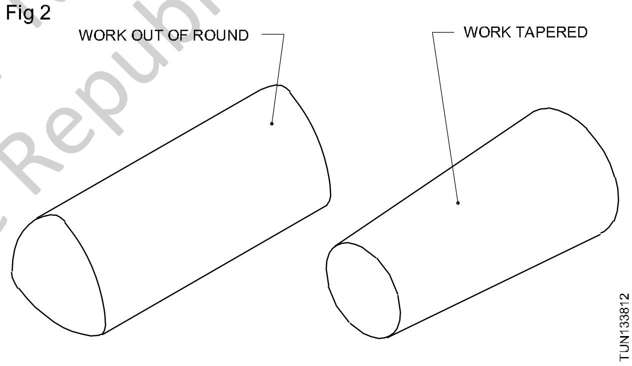
Geometric errors

Geometric errors can be subdivided into:

- macro-geometrical errors
- micro-geometrical errors.

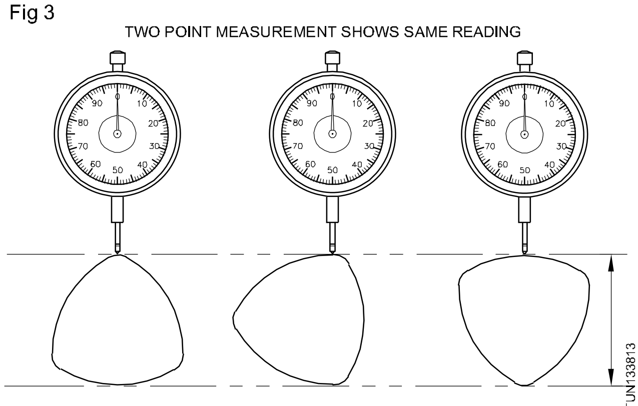
Macro-geometrical errors occur when the workpiece measured does not correspond to the theoretical form indicated in the drawing. For example, when a cylinder is tapered or out of round as shown in Fig 2, it results in a macro-geometrical error.

Fig 2



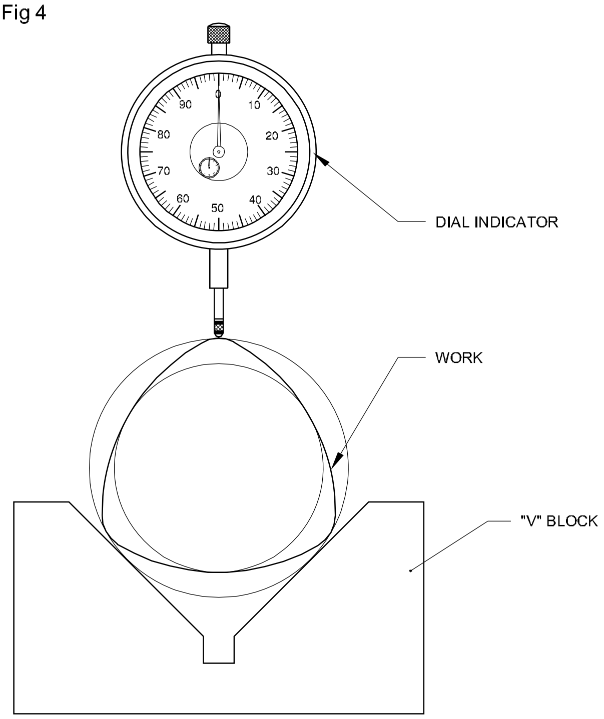
This type of error cannot be detected with the two point measurement as shown in Fig 3.

Fig 3



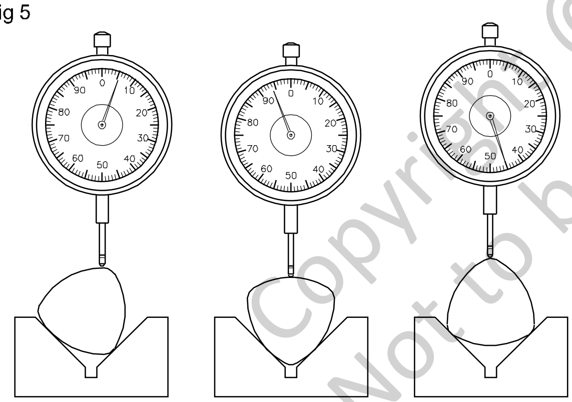
By placing the shaft on a 'V' block (three point measurement), this defect can be immediately noticed. (Figs 4 and 5)

Fig 4



WHEN WORK ROTATED DIFFERENT DIAL READINGS WILL BE READ

Fig 5



THREE POINT MEASUREMENT SHOWS DIFFERRNT DIAL READINGS

This error can also occur when measuring holes.

Micro-geometrical errors are due to surface roughness. In the case of a surface with considerable profile depth, the measuring tip could drop down in a profile recess, thereby giving a faulty reading.(Fig 6)

Contact errors

Impurities between the measuring tip and the workpiece being measured can often cause measuring errors. In order to eliminate the contact errors (considered quite serious), always keep the measuring instruments clean.

Gauge and instrument errors

In the case of the vernier caliper, the measurement is parallel but not in line with the scale. (See the distance 's' on the illustration). A play between the movable jaw and the main scale can, in this case, produce an error which could have a considerable effect on the result. (Fig 7)

Fig 6

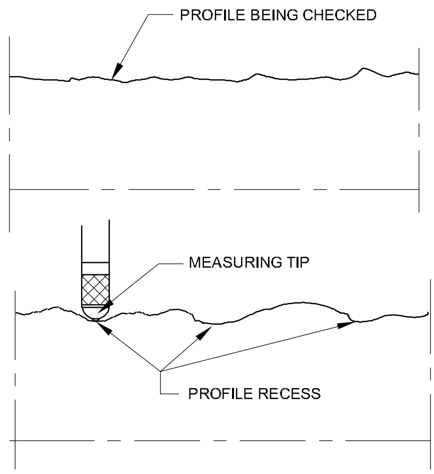
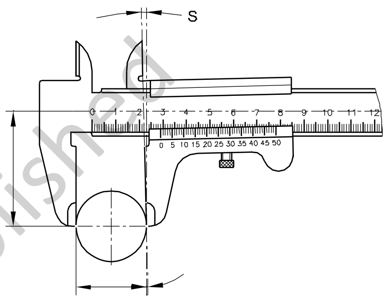
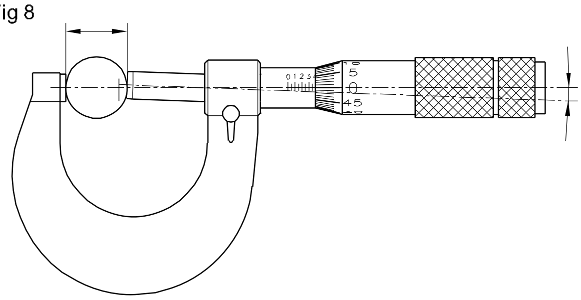


Fig 7



In the case of a micrometer an angular error is negligible but a parallel error will occur. Other errors that come under this heading are errors due to changes in friction, and backlash in measuring instruments. (Fig 8)

Fig 8



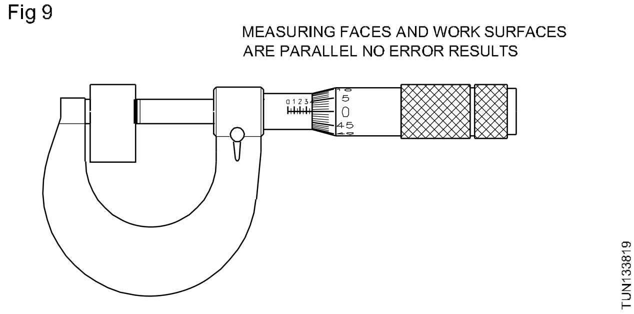
Elastic deformation

In order to keep the elastic deformation within reasonable limits, the indicator stands, measuring clamps and measuring fixtures must be robustly constructed. By using a small and constant measuring force, this error can also be brought to a minimum. Eg. the ratchet drive provided in micrometers.

Parallel errors (Fig 9)

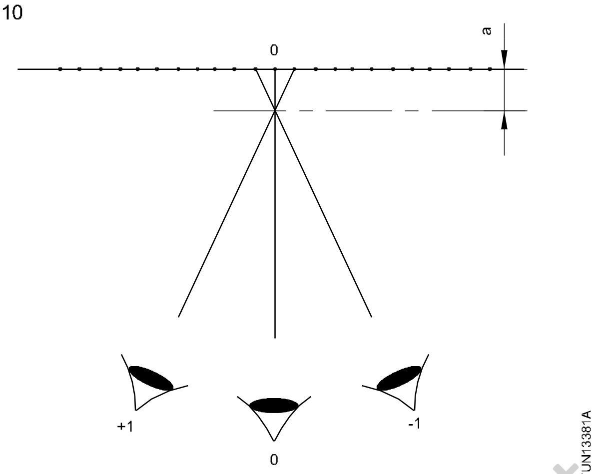
If measurement is being carried out between two flat measuring surfaces, these must be parallel to each other. If the measuring workpiece surfaces are not parallel to each other, parallel errors will result. By using a spherical measuring tip against a flat surface to be measured, parallel errors can be avoided.

Fig 9



Observation errors (Fig 10)

Fig 10



Parallax errors occur in connection with the reading of scales and instruments with dial indicators. The error depends on the fact that the pointer has a certain distance 'a' from the scale. If viewed at from one side instead of from straight ahead as you should do, the pointer appears to show a larger or smaller reading.

Temperature errors

The change in temperature can cause major measuring errors. For this reason 20°C has been set as the reference temperature for measurements.

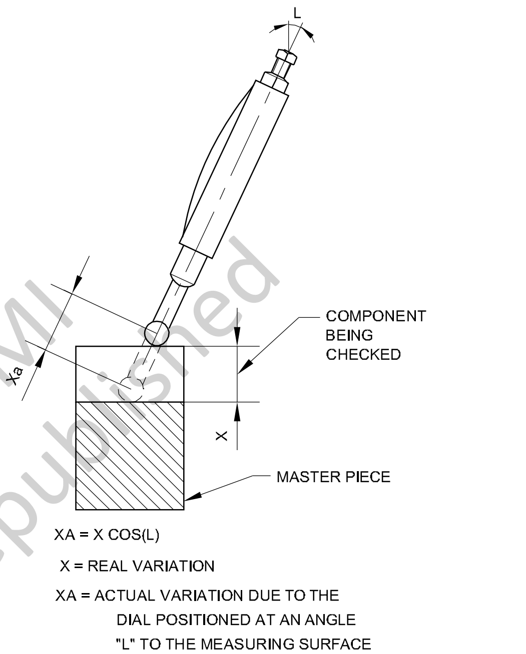
Cosine errors (Fig 11)

A cosine error occurs when the plunger/lever of the measuring instrument is not parallel with the workpiece being measured.

It may be noted that the movement of the dial indicator hand depends on the movement of the plunger or lever.

An inclination of the plunger, as shown in the figure, would need additional movement of the plunger for a distance. X is the deviation of the component perpendicular to the surface of the work, and naturally the dial indicator will show a reading of Xa. (Xa is the plunger movement.)

Fig 11



Drills - different parts

Objectives : At the end of this lesson you shall be able to
- state what is drilling
- state the necessity of drilling
- list the types of drills used
- name the parts of a twist drill
- list the defects in a drilled hole
- state the causes and the remedies for the defects.

Drilling

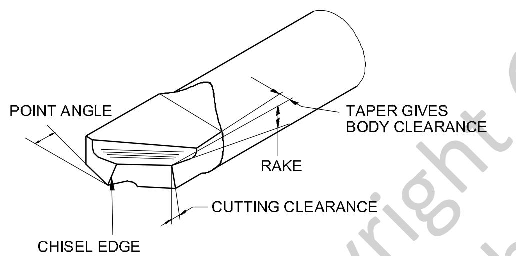
Drilling is the production of cylindrical holes of definite diameters in workpieces by using a multi-point cutting tool called a 'drill'. It is the first operation done internally for any further operation.

Types of drills and their specific uses

Flat drill (Fig 1)

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.

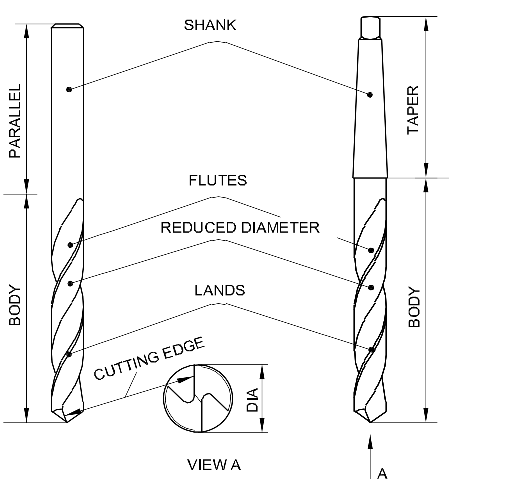
Fig 1



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. Twist drills are available in standard sizes. Parallel shank twist drills are available below 13mm size. (Fig 2)

Fig 2

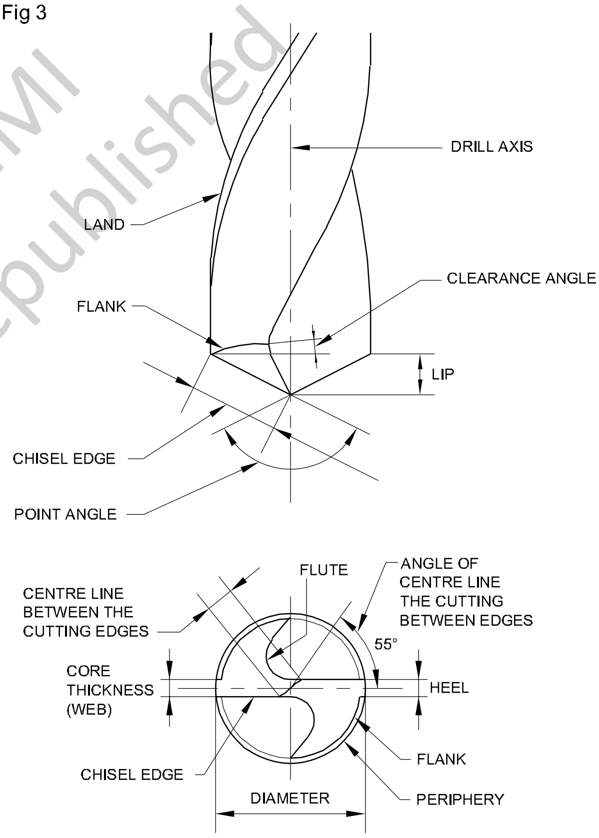


Parts of a twist drill

Drills are made from high speed steel. The spiral flutes are machined at an angle of 271/2° 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. (Fig 3)

Fig 3



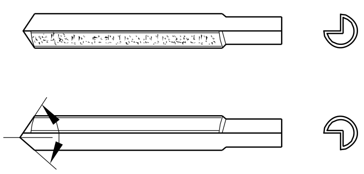
The portions left between the flutes are called 'lands'. The size of a drill is determined and governed by the diameter over the lands.

The point angle is the cutting angle, and for general purpose work, it is 118°. The clearance angle 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. (Fig 4)

Fig 4



DEEP HOLE DRILL

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. (Fig 5a)

A slow helix drill is used on materials like brass, gun-metal, phosphor-bronze and plastics. (Fig 5b)

A quick helix drill is used for copper, aluminium and other soft metals. (Fig 5c)

Fig 5a

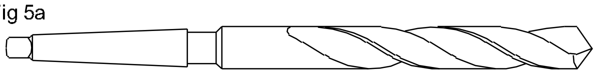
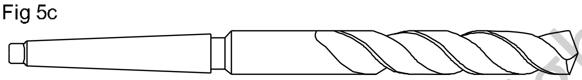


Fig 5b

Fig 5c



Quick helix drill should never be used on brass as it will 'dig in' and the workpiece may be thrown from the machine table.

Parallel shank drills can be held only in drill chucks. Taper shank twist drills are mounted directly in the tailstock barrel or fitted to a sleeve and mounted. The tang in the taper shank twist drill provides a positive drive. When inserting a taper shank twist drill in a socket or sleeve, tap the sleeve with a hide mallet. To remove the drill from the socket, a drift is used.

Factors governing drilling operations

The three factors governing drilling operations are:

- cutting speed
- feed pressure
- cooling method.

Cutting speed for drilling

The cutting speed for drilling is the peripheral speed of the drill, and it is stated in metres per minute. The cutting speed depends upon the machinability of the work material. When the cutting speed for drilling a material is determined, the revolutions for which the lathe has to be set during drilling is calculated by the formula.

$$V = \frac{\pi \times D \times N}{1000}$$

Feed

The rate at which the drill advances into the material for each revolution of the drill is known as the feed rate and it is expressed in mm/rev. The feed rate selection also depends upon the machinability of the metal being drilled:

Drill grinding

Any one of the following indicates the sign that the drill needs re-sharpening.

- A need for high feed pressure to make the drill to cut and advance.
- Chattering or screaming of the drill when pressure is applied.

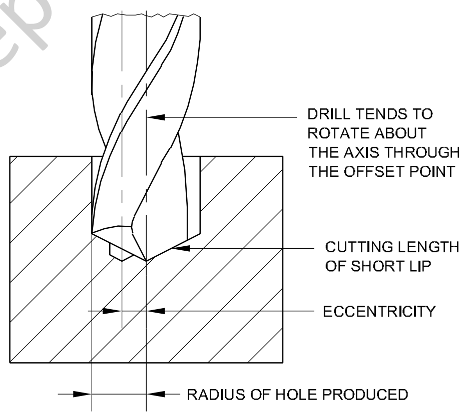
It is recommended that a drill grinding jig is to be used for re-sharpening purposes as it is almost impossible to grind the drills to the correct angles by off-hand grinding. But for general purpose drilling, off- hand grinding may also be done, taking care to avoid the following faults.

Grinding faults

Faulty grinding is indicated by the following.

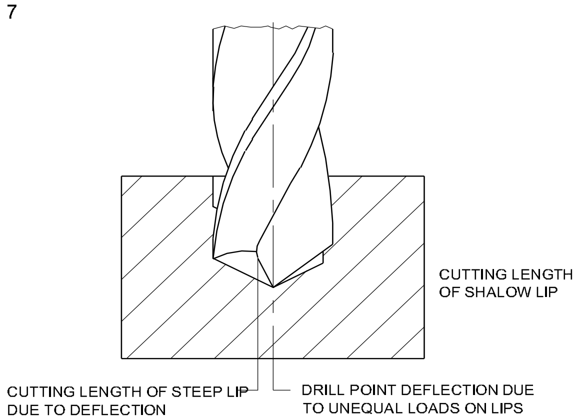
The two cutting edges are of unequal length. This fault causes two cuttings of unequal thickness, or one cutting being ejected and an oversize hole results. (Figs 6 and 7)

Fig 6



ACTION OF DRILL GROUND WITH CUTTING EDGES OF UNEQUAL LENGTH

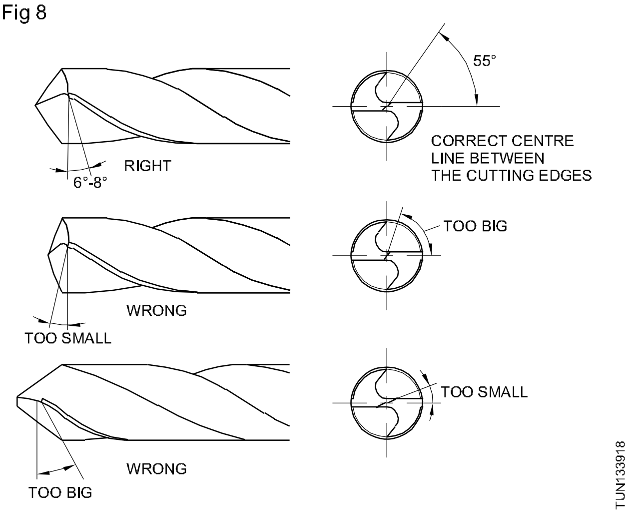
Fig 7



ACTION OF DRILL GROUND WITH CUTTING EDGES EQUAL BUT UNEQUAL ANGLE

Excessive clearance angle ground. This fault will cause the cutting edges to chip off and break. This in turn, will cause the drill to dig into the workpiece. (Fig 8)

Fig 8



Insufficient clearance angles. The drill rubs rather than cuts. When a drill gets badly worn out, it cuts poorly and the three signs of a badly worn out drill are :

blunt cutting edges'at the point of the drill

- too much feeding pressure to make the drill to cut
- work and drill getting heated up.

It is essential to provide a bigger point angle of the drill for drilling hard metals.

Recommended helix point angles for drilling different : Work materials

(For guidance only)

Material of the workpiece	Helix angle angle	Point angle
Steel, alloyed and unalloyed cast steel, cast iron, malleable iron	28°	118°
White cast iron	28°	150°
Brass, bronze	15°	118° to 140°
Bakellite	40°	118° to 140°

Pilot hole drilling

For producing large size holes by drilling, it is always advantageous to drill with smaller drills and finally use the drill of the required size. This operation is known as pilot drilling.

The steps to finish a required size of a drilled hole are shown in Fig 9.

Cutting fluids for drilling

The use of an appropriate cutting fluid will always give a better surface finish; it permits the use of a higher cutting speed, and extends the tool life.

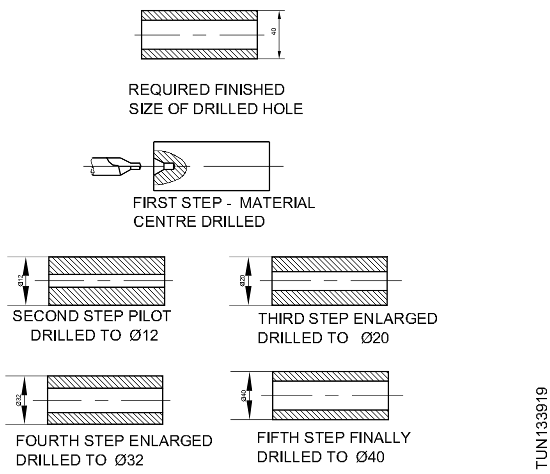
The cutting fluids generally used for drilling operation are the same that are used for other lathe operations.

Soluble oil is the most commonly used cutting fluid.

Recommended cutting fluids for drilling different metals

- Aluminium and its alloys - dry or kerosene.
- Copper - soluble oil.
- Brass - dry or soluble oil.
- Cast iron- dry or cooled with compressed air.
- Chilled cast iron - soluble oil.
- Mild steel - soluble oil, sulphurised oil.
- Alloy steels - soluble oil, sulphurised oil.

Fig 9



Drill angles

Objectives : At the end of this lesson you shall be able to
- **state what is drilling**
- **state the necessity of drilling**
- **name the types of drills used**
- **name the parts of a twist drill**
- **list out the defects in a drilled hole**
- **state the causes and the remedies for the defects.**

Like all cutting tools the drills are provided with certain angles for efficiency in drilling.

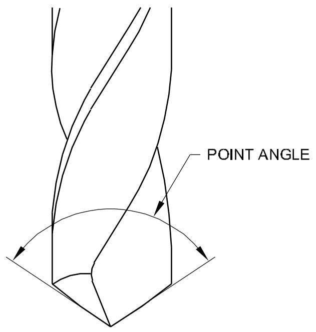
Angles

There are different angles for different purposes. They are listed below.

Point angle, Helix angle, Rake angle, Clearance angle and Chisel edge angle.

Point angle/Cutting angle (Fig 1)

Fig 1



The point angle of a general purpose (standard) drill is 118°. This is the angle between the cutting edges (lips). The angle varies according to the hardness of the material to be drilled.

Helix angle (Figs 2, 3 and 4)

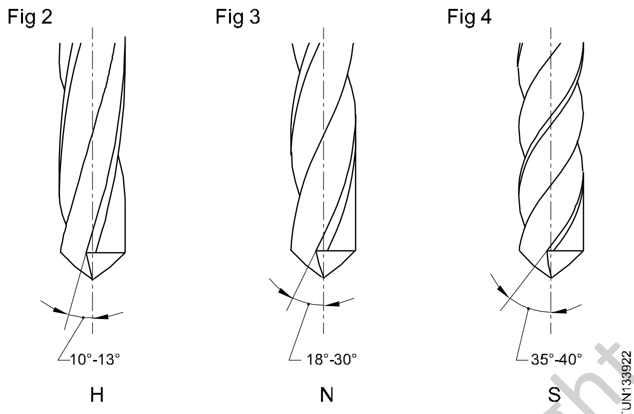
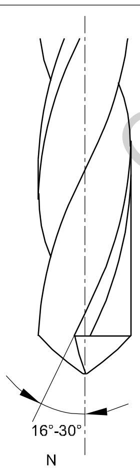


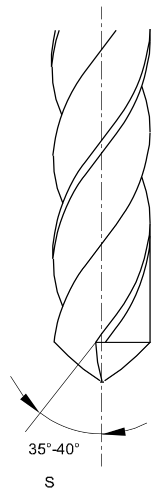
Fig 3



Twist drills are made with different helix angles/The helix angle determines the rake angle at the cutting edge of the twist drill.

The helix angles vary according to the material being drilled. According to Indian Standard, three types of drills are used for drilling various materials.

Fig 4



Type N = for normal low carbon steel.

Type H = for hard and tenaceous materials.

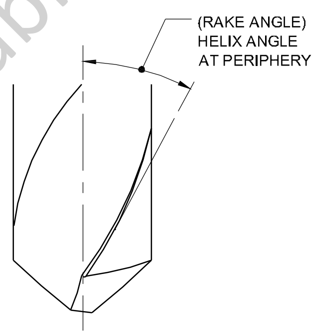
Type S = for soft and tough materials.

The type of drill used for general purpose drilling work type N.

Rake angle (Fig 5)

Rake angle is the angle of flute (Helix angle).

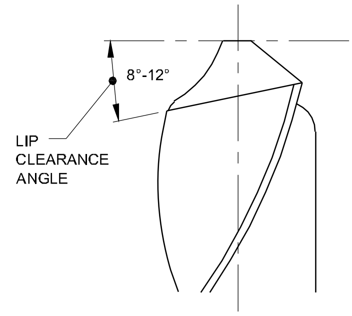
Fig 5



Clearance angle (Fig 6)

Clearance angle is to prevent the friction of the land behind the cutting edge. This will help in the penetration of the cutting edges into the material. If the clearance angle is too much, the cutting edges will be weak, if it is too small, the drill will not cut.

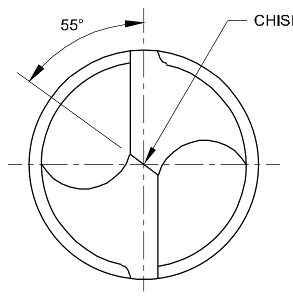
Fig 6



Chisel edge angle/Web angle (Fig 7)

This is the angle between the chisel edge and the cutting lip.

Fig 7



Designation of drills

Twist drills are designated by the

- diameter
- tool type
- material

Example

A twist drill of 9.50 mm dia., of tool type 'H' for right hand cutting and made from HSS is designated as

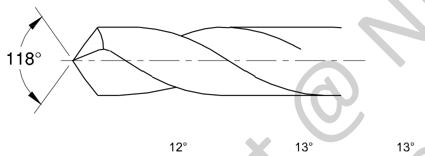
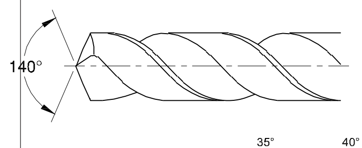
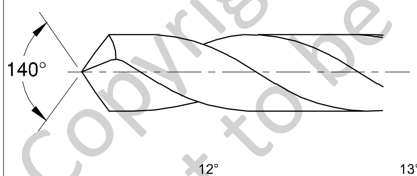
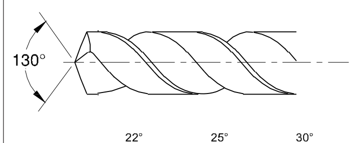
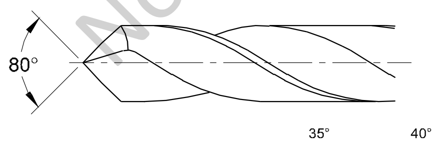
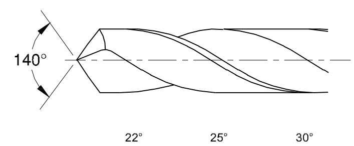
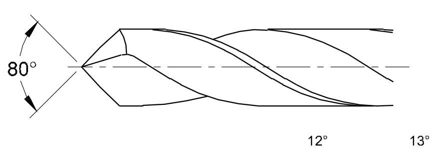
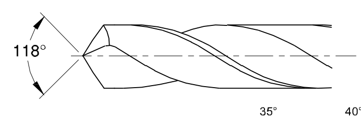
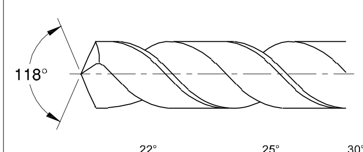
Twist drill 9.50 - H - IS5101 - HS

- 9.50 — **Diameter of drill**
- IS5101 — **IS NO.**
- H — **Tool type**
- HS — **Material**

> **NOTE: If the tool is not indicated in the designation, it should be taken as Type 'N' tool.**

Drills for different materials

Recommeded drills

Material to be drilled	Point angle / Helix angle d=3.2.5, 5-10, 10	Material to be drilled	Point angle / Helix d=3.5 mm, 5 mm
Steel and cast steel up to 70 kgf/mm^2 strength Gray cast iron Malleable cast iron Brass German silver, nickel		Copper (up to 30 mm drill diameter) Al - alloy, forming Curly chips Celluloid	
Brass, Cuzn 40		Austenitic steels Magnesium alloys	
Steel, and cast steel 70... 120 Kgf/mm^2		Moulded steels (with thickness S>d)	
Stainless steel Copper (drill diameter more than 30 mm) Al-alloy, forming short borken chips		Moulded plastics, with thickness s>d Laminated plastics Hard rubber (ebonite) Marble, state, coal	
		Zinc alloys	

Cutting speed and RPM

Objectives : At the end of this lesson you shall be able to
- define cutting speed
- state the factors for determining the cutting speed
- differentiate between cutting speed and r.p.m.
- determine r.p.m. spindle speed
- select r.p.m. for drill sizes from tables.

For a drill to give satisfactory performance, it must operate at the correct cutting speed and feed.

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 table. Based on the cutting speed recommended, the r.p.m., at which a drill has to be driven, is determined.

Materials being drilled for HSS	Cutting speed(m/min)
Aluminium	70-100
Brass	35-50
Bronze(phosphor)	20-35
Cast iron (grey)	25-40
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

Calculating r.p.m.

$$v = \frac{n \times d \times \pi}{1000} \text{ m/min}$$

$$n = \frac{v \times 1000}{d \times \pi} \text{ r.p.m.}$$

n - r.p.m.

v - Cutting speed in m/min.

d - diameter of the drill in mm

$\pi = 3.14$

Example

Calculate the r.p.m. for a high speed steel drill Ø 24 mm to cut mild steel.

The cutting speed for MS is taken as 30 m/min. from the table.

$$n = \frac{1000 \times 30}{3.14 \times 24} = 398 \text{ r.p.m.}$$

It is always preferable to set the spindle speed to the nearest available lower range. The selected spindle speed is 300 r.p.m.

The r.p.m. will differ according to the diameter of drills. The cutting speed being the same, larger diameter drills will have lesser r.p.m. and smaller diameter drills will have higher r.p.m.

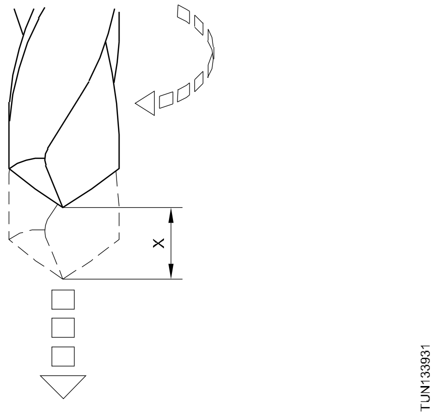
The recommended cutting speeds are achieved only by actual experiments.

Feed in drilling

Objectives : At the end of this lesson you shall be able to
- state what is meant by feed
- state the factors that contribute to an efficient feed rate.

Feed is the distance (X) a drill advances into the work in one complete rotation. (Fig 1)

Fig 1



Feed is expressed in hundredths of a millimetre.

Example - 0.040mm.

The rate of feed is dependent upon a number of factors.

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

Factors like rigidity of the machine, holding of 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.

The table for the feed rate given here is based on the average feed values suggested by the different manufacturers of drills. (Table 1)

Table 1

Drill diameter	Rate of feed
(mm) H.S.S.	(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 -15.1	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

Too coarse a feed may result in damage to the cutting edges or breakage of the drill.

Too slow a rate of feed will not bring improvement in surface finish but may cause excessive wear of the tool point, and lead to chattering of the drill.

For optimum results in the feed rate while drilling, it is necessary to ensure the drill cutting edges are sharp. Use the correct type of cutting fluid.

Boring tools

Objectives : At the end of this lesson you shall be able to
- **identify and name the different types of boaring tools**
- **list out the advantages of the different boring tools.**

Boring is the process of enlarging and truing an existing drilled or core hole with a single point cutting tool.

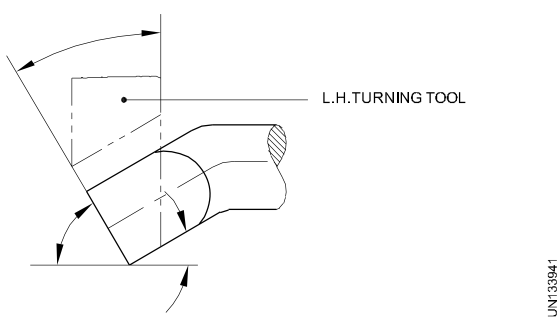
Necessity of boring a hole

- To enlarge a drilled hole larger than the drill size as drills are available in standard sizes only.
- To obtain concentricity of the hole.
- To maintain accuracy of the hole.
- To obtain better surface finish.
- To remove the error formed by drilling, and to facilitate the reaming operation.

Boring tools and holders

Boring is an internal operation performed on the drilled or cored holes. The cutting edge of a boring tool is ground similar to the left hand plain turning tool. But the operation being performed is from right to left. (Fig 1)

Fig 1



Parts of a rough boring tool (Figs 1,2 & 3)

Fig 2

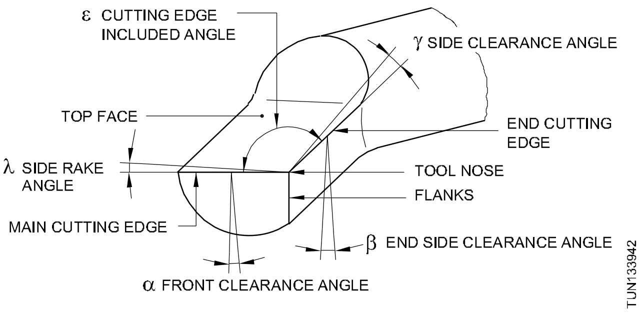
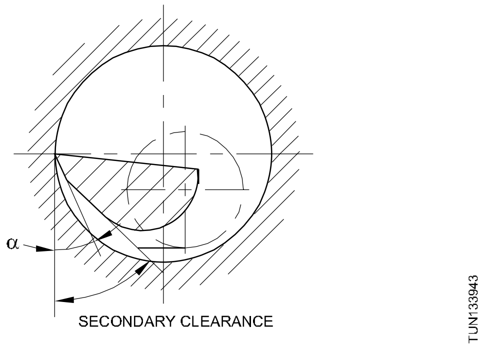


Fig 3

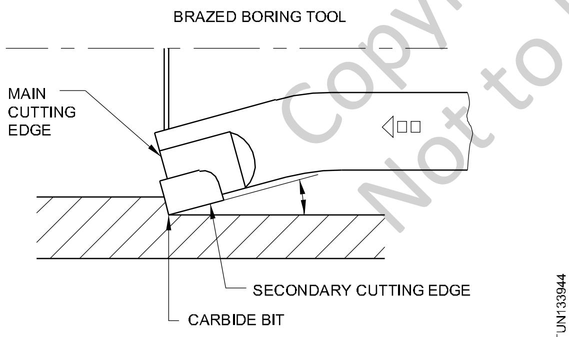


Types of boring tools

The following are the different types of boring tools.

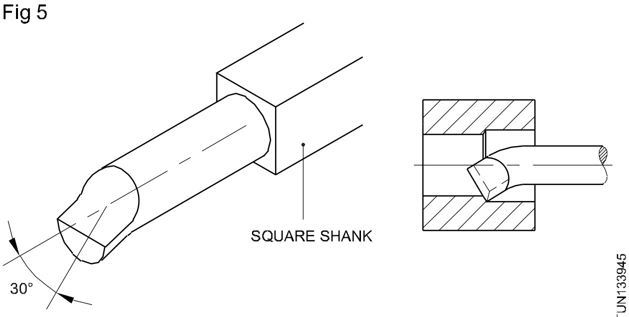
- Solid forged tools
- Boring bars with bits
- Brazed tools (Fig.4)
- Throw-away bits inserted in special holders.

Fig 4



Solid forged tools (Fig 5)

Fig 5

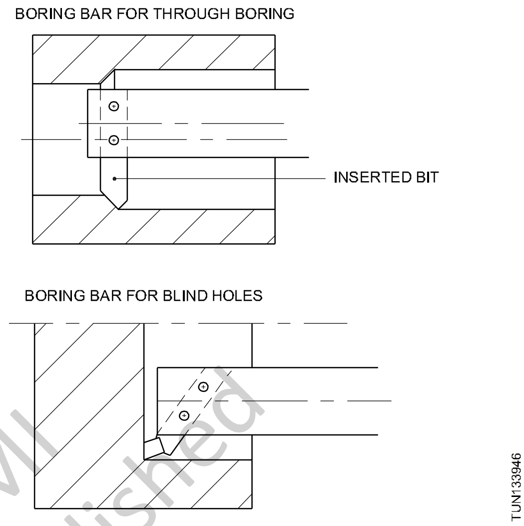


The solid forged boring tool is generally made of high speed steel, with the end forged and ground to resemble a left hand turning tool. They are light duty tools and are used on small diameter holes. They are held in special tool holders which are mounted in the tool post.

Occasionally tungsten carbide or high speed steel tips are brazed to low carbon bars, for economy.

Boring bars with inserted bit (Fig 6)

Fig 6



The boring bar tool-holder is mounted in the tool post and is used for heavier cuts than those for the forged boring tool.

The square tool bits are set at angles of 30°, 45° or 90° in the broached holes in the bar.

The boring bars may be plain type or end cap type. The cutting tool of the plain type is held in position by a set screw. The cutting tool of the end-cap type is held in position by the wedging action of a hardened plug.

The round or square section tool bits may be inserted in boring bars, the size depending on the diameter of the bar.

The tool bit may be square to the axis of the bar for plain boring or at an angle for facing shoulder, or threading up to a shoulder.

The bar is held in a split or 'V' block holder.

The advantages of different boring tools

Solid boring tools

Available with square and round shank.

Enables to mount on the tool post easily.

Re-grinding is easy.

As the tool is integral, alignment is easy.

Can be easily forged to the required shape and angle.

Boring bars and inserted bits

Used for heavy duty boring operation.

Used for deep boring operation.

Tool changing is faster, thereby re-sharpening time is avoided.

Cost is less because the boring bar is made out of low carbon steel.

Boring tools can be set square to the axis of the boring bar or at an angle very quickly.

Counter sinking

Objectives: At the end of this lesson you shall be able to
- **state what is countersinking**
- **list the purpose of countersinking**
- **state the angles of countersinking for the different applications**
- **name the different types of countersinks**
- **distinguish between Type A and Type B countersink holes.**

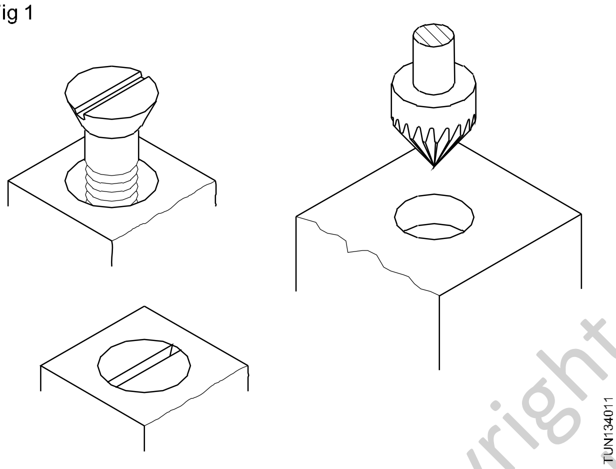
What is countersinking?

Countersinking is an operation of beveling the end of a drilled hole. The tool used is called a countersink.

Countersinking is carried out for the following purposes,

to provide a recess for the head of a countersink screw, so that it is flush with the surface after fixing. (Fig 1)

Fig 1



to deburr a hole after drilling

for accommodating countersink rivet heads

to chamfer the ends of holes for thread cutting and other machining processes.

Angles for countersinking

Countersinks are available in different angles for different uses.

75° countersink riveting

80° countersink self tapping screws

90° countersink head screws and deburring

120° chamfering ends of holes to be threaded or other machine processes.

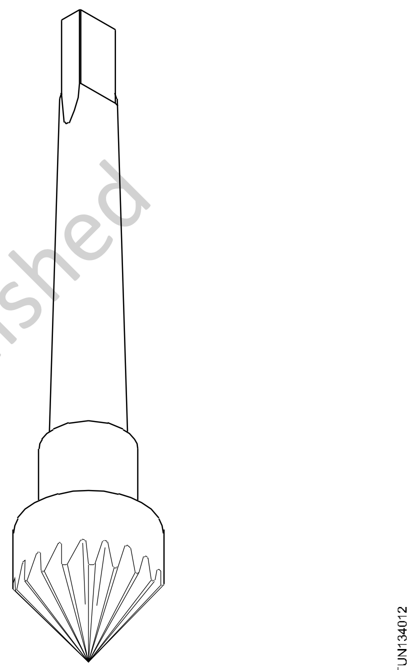
Countersinks

Countersinks of different types are available.

The commonly used countersinks have multiple cutting edges and are available in taper shank and straight shank. (Fig 2)

For countersinking small diameter holes special counter-sinks with two or one flute are available. This will reduce the vibration while cutting.

Fig 2



Countersinks with pilot (Fig 3)

For precision countersinking, needed for machine tool assembling and after machining process, countersinks with pilots are used.

They are particularly useful for heavy duty work.

The pilot is provided at the end for guiding the countersink concentric to the hole.

Countersinks with pilots are available with interchange able and solid pilots.

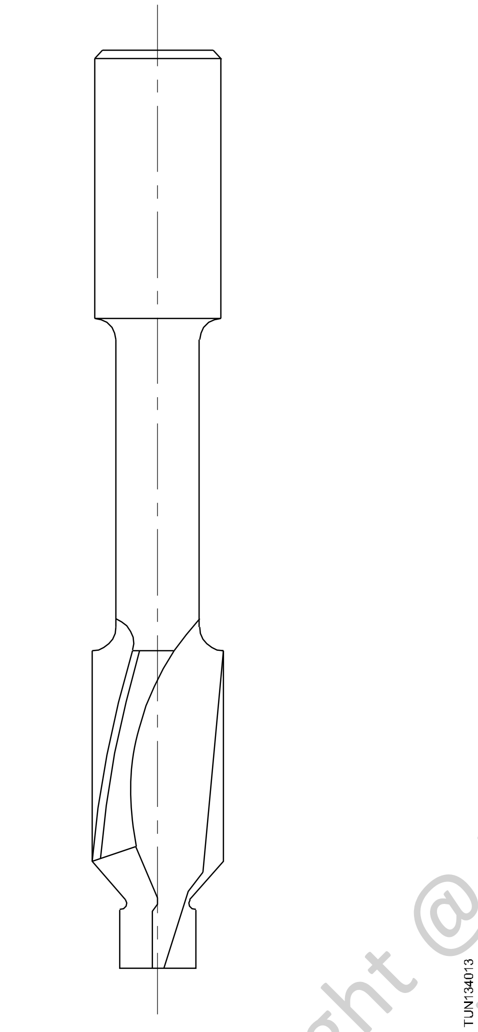
Countersink hole sizes

The countersink holes according to Indian Standard IS 3406 (Part 1) 1986 are of four types: Type A, Type B, Type C and Type E.

Type A is suitable for slotted countersink head screws, cross recessed and slotted raised countersink head screws.

These screws are available in two grades i.e. medium and fine.

Fig 3



The dimensions of various features of the Type ‘A’ countersink holes, and the method of designation are given in Table 1.

Type ‘B’ countersink holes are suitable for countersink head screws with hexagon socket.

The dimensions of the various features and the method of designation are given in Table II.

Type ‘C’ countersink holes are suitable for slotted raised countersink (oval) head tapping screws and for slotted countersink (flat) head tapping screws.

The dimension of the various features and the method of designation are given in Table III.

Type ‘E’ countersinks are used for slotted countersink bolts used for steel structures.

The dimensions of the various features and the method of designation are given in Table IV.

Methods of Representing countersink holes in drawings

Countersink hole sizes are identified by code designation or using dimension. IS details are given in Table 1 toTable IV

TABLE I

Dimensions and designation of countersink - Type A according to IS 3406 (Part 1) 1986

Fig 4

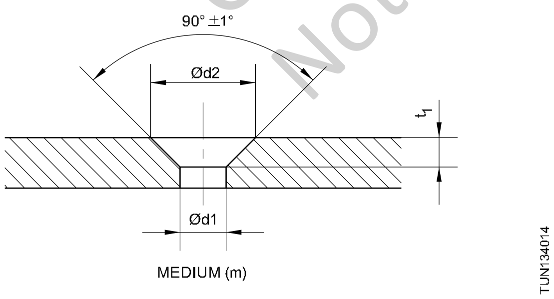
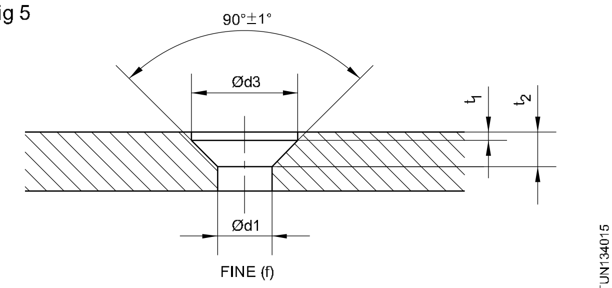


Fig 5



For Norminal Size		1	1.2	(1.4)	1.6	(1.8)	2	2.5	3	3.5	4	(4.5)
Medium	d_1 H13	1.2	1.4	1.6	1.8	2.1	2.4	2.9	3.4	3.9	4.5	5
Series	d_2 H13	2.4	2.8	3.3	3.7	4.1	4.6	5.7	6.5	7.6	8.6	9.5
(m)	t_1^{3}	0.6	0.7	0.8	0.9	1	1.1	1.4	1.6	1.9	2.1	2.3
Fine	d_1 H12	1.1	1.3	1.5	1.7	2	2.2	2.7	3.2	3.7	4.3	4.8
Series	d_3 H12	2	2.5	2.8	3.3	3.8	4.3	5	6	7	8	9
(f)	t_1^{3}	0.7	0.8	0.9	1	1.2	1.2	1.5	1.7	2	2.2	2.4
	t_2 + 0.1 0	0.2	0.15	0.15	0.2	0.2	0.15	0.35	0.25	0.3	0.3	0.3

TABLE I (Contd)

Designation : A countersink Type A with clearance hole of fine (f) series and having nominal size 10 shall be designated as - Countersink A f 10 - IS : 3406.

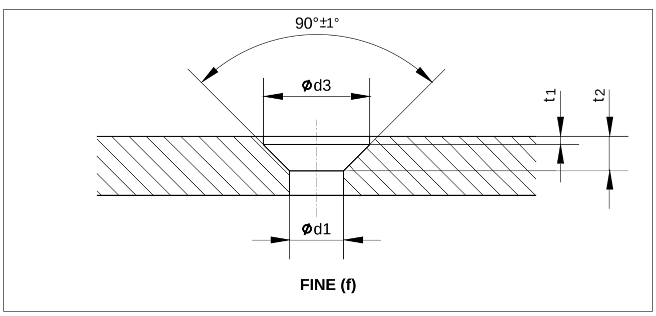
For Norminal Size		5	6	8	10	12	(14)	16	(18)	20
Medium	d_1 H13	5.5	6.6	9	11	13.5	15.5	17.5	20	22
Series	d_2 H13	10.4	12.4	16.4	20.4	23.9	26.9	31.9	36.4	40.4
(m)	t_1^{3}	2.5	2.9	3.7	4.7	5.2	5.7	7.2	8.2	9.2
Fine	d_1 H12	5.5	6.4	8.4	10.5	13	15	17	19	21
Series	d_3 H12	10	11.5	15	19	23	26	30	34	37
(f)	t_1^{3}	2.6	3	4	5	5.7	6.2	7.7	8.7	9.7
	t_2 + 0.1 0	0.2	0.45	0.7	0.2	0.7	0.7	1.2	1.2	1.7

Note 1 : Size shown in brackets are of second preference.

Note 2 : Clearance hold d_1 according to medium and fine series of IS : 1821 'Dimensions for clearance clearance holes for bolts and screws (second revision)'

TABLE II

Dimensions and designation of countersink - Type B according to IS 3406 (Part 1) 1986



For Norminal Size		3	4	5	6	8	10	12	(14)	16	(18)	20	22 24
Medium	d_1 H12	4.3	5.3	6.4	8.4	10.5	13	15	17	19	21	23	25
Series	d_2 H12	6.3	8.3	10.4	12.4	16.5	20.5	25	28	31	34	37	48.2
52 (f)	t_1^3		1.7	2.4	2.9	3.3	4.4	5.5	6.5	7	7.5	8	8.513.1
14	t_2 + 0.1												
	0	0.2		0.3		0.4			0.5				1

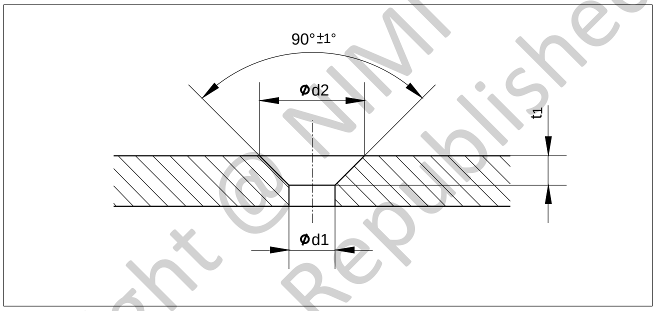
Note 1 : Sizes shown in brackets are of second perference.

Note 2 : Clearance hole d_1 accodring to medium and fine series of IS : 1821 - 1982.

Designation : A countersink Type B with clearance hole of fine (f) series and having nominal size 10 shall be designated as - Countersink B f 10 - IS : 3406.

TABLE III

Dimensions and designation of countersink - Type C according to IS 3406 (Part 1) 1986



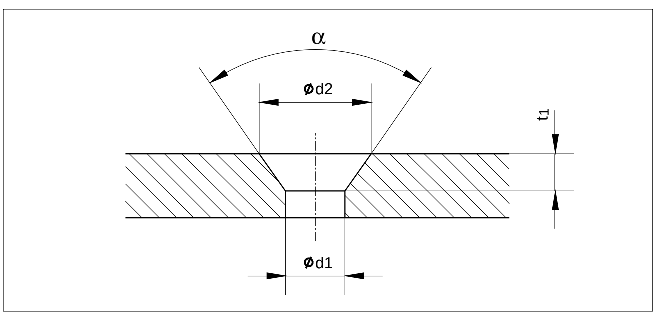
For Screw Size No.	(0)	(1)	2	(3)	4	(5)	6	(7)	8	10	(12)	14	(16)
d_1 H12	1.6	2	2.4	2.8	3.1	3.5	3.7	4.2	4.5	5.1	5.8	6.7	8.4
d_1 H12	3.1	3.8	4.6	5.2	5.9	6.6	7.2	8.1	8.7	10.1	11.4	13.2	16.6
t_1^3	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	3	3.4	3.9	4.9

Note : Size given in brackets are of second perference.

Designation : A countersink Type C for screw size 2 shall be designated as - Countersink C 2 - IS : 3406.

TABLE IV

Dimensions and designation of countersink - Type E according to IS 3406 (Part 1) 1986



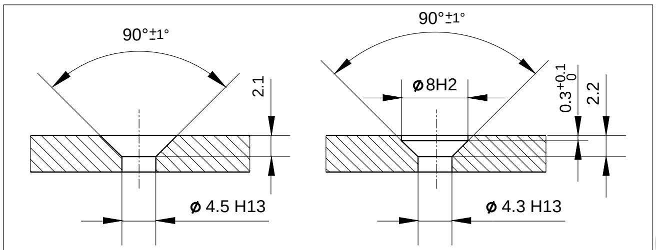
For Screw Size No.	10	12	16	20	22	24
d_1 H12	10.5	13	17	21	23	25
d_2 H12	19	24	31	34	37	40
t_1 [3]	5.5	7	9	11.5	12	13
	75°			60°		
Note : Clearance hold d_1 according to fine series of IS : 1821 - 1982						

Designation : A countersink Type C for screw size 2 shall be designated as - Countersink C 2 - IS : 3406.

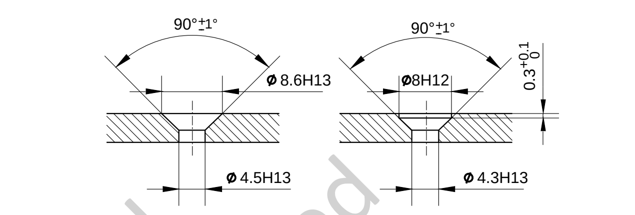
Use of code designation

Use of dimension

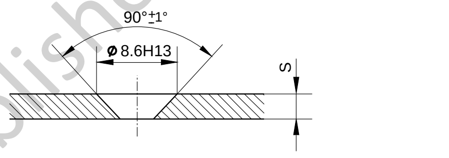
The dimension of the countersink can be expressed by diameter of the countersink and the depth of the countersink.



WHEN INDICATING THE DEPTH OF COUNTERSINK



WHEN INDICATING THE DIAMETER OF COUNTERSINK



IN THE CASE OF COMPONENTS WITH: S ≤ t1

Counterboring and spot facing

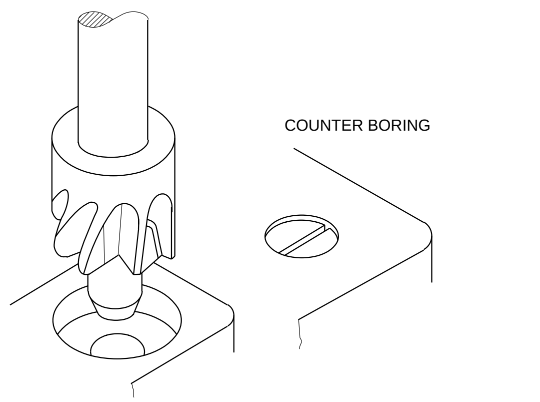
Objectives: At the end of this lesson you shall be able to

- **differentiate counterboring and spot facing**
- **state the types of counterbores and their uses**
- **determine the correct counterbore sizes for different holes.**

Counterboring

Counterboring is an operation of enlarging a hole to a even depth to house heads of socket heads or cap screws with the help of a counterbore tool. (Fig 1)

Fig 1



Counterbore (Tool)

The tool used for counterboring is called a counterbore. (Fig 2). Counterbores will have two or more cutting edges.

At the cutting end, a pilot is provided to guide the tool concentric to the previously drilled hole. The pilot also helps to avoid chattering while counterboring. (Fig 3)

Counterbores are available with solid pilots or with interchangeable pilots. The interchangeable pilot provides flexibility of counterboring on different diameters of holes.

Spot facing

Spot facing is a machining operation for producing a flat seat for bolt head, washer or nut at the opening of a drilled hole. The tool is called a spot facer or a spot facing tool. Spot facing is similar to counterboring, except that it is can be used for spot facing as well. (Fig 4)

Fig 2

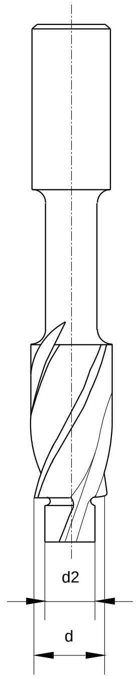


Fig 3

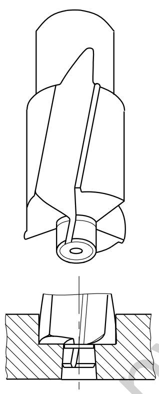
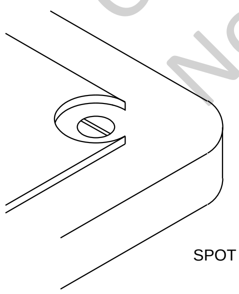
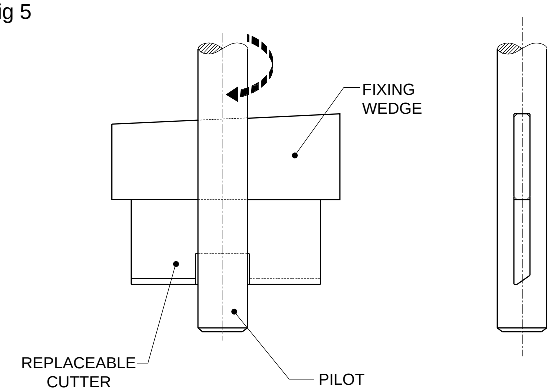


Fig 4



Spot facing is also done by fly cutters by end-cutting action. The cutter blade is inserted in the slot of the holder, which can be mounted on to the spindle. (Fig 5)

Fig 5



Counterbore sizes and specification

Counterbore sizes are standardised for each diameter of screws as per BIS.

There are two main types of counterbores. Type H and Type K.

The type H counterbores are used for assemblies with slotted cheese head, slotted pan head and cross recessed pan head screws. The type K counterbores are used in assemblies with hexagonal socket head cap-screws.

For fitting different types of washers the counterbore standards are different in Type H and Type K.

The clearance hole d1 are of two different grades i.e. medium (m) and fine (f) and are finished to H13 and H12 dimensions.

The table given below is a portion from I S 3406 (Part 2) 1986. This gives dimensions for Type H and Type K counterbores.

Counterbore and Clearance Hole Sizes for Different Sizes of Screws.

Letter and number drills

Objectives: At the end of this lesson you shall be able to
- **state the range of drill sizes in number and letter drill series**
- **determine the number and letter drills for given diameters referring to the chart**
- **state the core drill.**

Generally drills are manufactured to standard sizes in the metric system. These drills are available in specified steps. The drills, which are not covered under the above category, are manufactured in number and letter drills. These drills are used where odd sizes of holes are to be drilled.

Letter drills

The letter drill series consists of drill sizes from 'A' to 'Z'. The letter 'A' drill is the smallest with 5.944 mm diameter, and the letter 'Z' is the largest, with a 10.490 mm diameter. (Table 1)

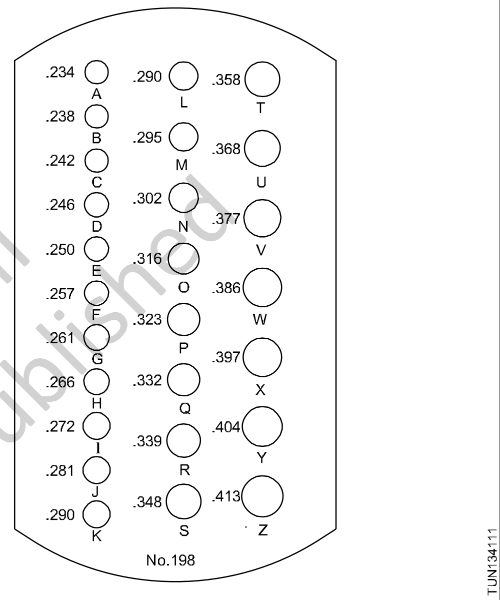
TABLE 1

Letter drill sizes

Letter	Diameter	
	Inches	mm
A	.234	5.944
B	.238	6.045
C	.242	6.147
D	.246	6.248
E	.250	6.35
F	.257	6.528
G	.261	6.629
H	.266	6.756
I	.272	6.909
J	.277	7.036
K	.281	7.137
L	.290	7.366
M	.295	7.493
N	.302	7.671
O	.316	8.026
P	.323	8.204
Q	.332	8.433
R	.339	8.611
S	.348	8.839
T	.358	9.093
U	.368	9.347
V	.377	9.576
W	.386	9.804
X	.397	10.084
Y	.404	10.262
Z	.413	10.490

In the number drill and the letter drill series, the correct diameter of the drill is gauged with the help of the respective drill gauges. 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. (Fig 1)

Fig 1



Number drills

The number drill series consists of drills numbered from 1 to 80. The No.1 drill is the largest, with 5.791 mm diameter, and the No.80 drill is the smallest, with 0.35 mm diameter. (Table 2) There is no uniform variation in the drill diameters from number to number. To find the correct diameter of a number drill, refer to a drill Size Chart or a Handbook. Number drill series are also known as 'wire gauge' series.

TABLE 2

Number drill sizes

No.	Diameter	
	Inches	mm
1	.228	5.791
2	.221	5.613
3	.213	5.410
4	.209	5.309
5	.2055	5.220
6	.204	5.182

Number drill sizes (contd)

No.	Diameter	
	Inches	mm
7	.201	5.105
8	.199	5.055
9	.196	4.978
10	.1935	4.915
11	.191	4.851
12	.189	4.801
13	.185	4.699
14	.182	4.623
15	.180	4.572
16	.177	4.496
17	.173	4.394
18	.1695	4.305
19	.166	4.216
20	.161	4.089
21	.159	4.039
22	.157	3.988
23	.154	3.912
24	.152	3.861
25	.1495	3.797
26	.147	3.734
27	.144	3.658
28	.1405	3.569
29	.136	3.454
30	.1285	3.264
31	.120	3.048
32	.116	2.946
33	.113	2.870
34	.111	2.819
35	.110	2.794
36	.1065	2.705
37	.104	2.642
38	.1015	2.578
39	.0995	2.527
40	.098	2.489
41	.096	2.438
42	.0935	2.375
43	.089	2.261
44	.086	2.184

Number drill sizes (contd)

No	Diameter	
	Inches	mm
45	.082	2.083
46	.081	2.057
47	.0785	1.994
48	.076	1.930
49	.073	1.854
50	.070	1.778
51	.067	1.702
52	.0635	1.613
53	.0595	1.511
54	.055	1.395
55	.052	1.321
56	.0465	1.181
57	.043	1.092
58	.042	1.067
59	0.41	1.041
60	.040	1.016
61	0.0390	1.00
62	0.0380	0.98
63	0.0370	0.95
64	0.0360	0.92
65	0.0350	0.90
66	0.033	0.85
67	0.032	0.82
68	0.031	0.79
69	0.0292	0.75
70	0.0280	0.70
71	0.0260	0.65
72	0.0240	0.65
73	0.0240	0.60
74	0.0225	0.58
75	0.0210	0.52
76	0.0200	0.50
77	0.0180	0.45
78	0.0160	0.40
79	0.0145	0.38
80	0.0135	0.35

Core drill

A core drill is a specifically designed to remove a cylinder of material, much like a hole saw. The material left inside the drill bit is referred to as the core. The earliest core drills were those used by the ancient egyptians, invented in 3000 BC. core drills are used for many applications, either where the core needs to be preserved, or where drilling can be done more rapidly since much less material needs to be removed than with a standard bit. This is the reason that diamond-tipped core drills are commonly used in construction to create holes for pipes, manholes and other large-diameter penetrations in concrete or stone. Core drills are used frequently in mineral exploration where the coring may be several hundred to several thousand feet in length. The core samples are recovered and examined by geologists for mineral percentage and stratigraphic contact points. This gives exploration companies the information necessary to begin or abandon mining operations in a particular area. Before the start of world war two, Branner Newsom, a California mining engineer, invented a core drill that could take out large diameter cores up to 16 feet in length for mining shafts. This type of core drill is longer in use as modern drill technology allows standard drilling to accomplish the same at a much cheaper cost.

Fig 2

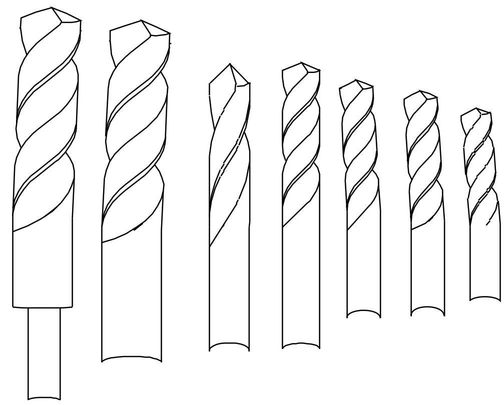
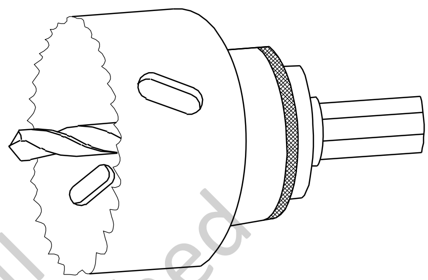


Fig 3



Reamers

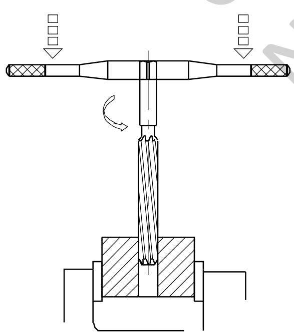
Objectives : At the end of this lesson you shall be able to
- state the use of reamers
- state the advantages of reaming
- distinguish between hand and machine reaming
- name the elements of a reamer and state their functions.

What is a reamer?

A reamer is a multi-point cutting tool used for enlarging by finishing previously drilled holes to accurate sizes.(Fig 1)

Advantages of 'reaming'

Fig 1



Reaming produces

- high quality surface finish
- dimensional accuracy to close limits.

Also small holes which cannot be finished by other processes can be finished.

Classification of reamers

Reamers are classified as hand reamers and machine reamers. (Figs 2 and 3)

Fig 2

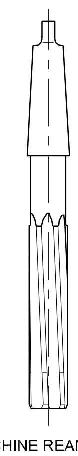
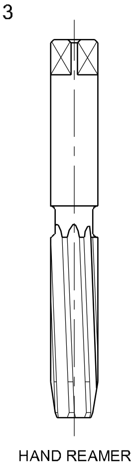


Fig 3



Reaming by using hand reamers is done manually for which great skill is needed.

Machine reamers are fitted on spindles of machine tools and rotated for reaming.

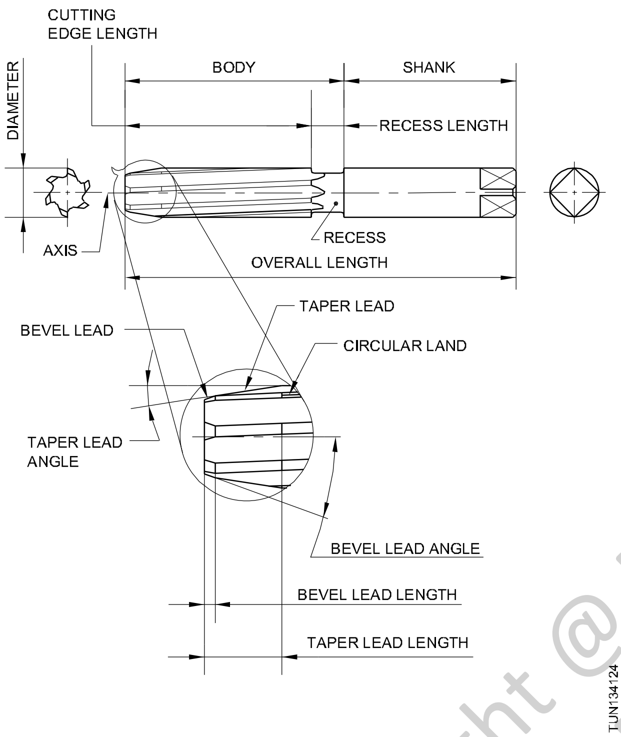
Machine reamers are provided with morse taper shanks for holding on machine spindles.

Hand reamers have straight shanks with 'square' at the end, for holding with tap wrenches. (Figs 2 & 3)

Parts of a hand reamer

The parts of a hand reamer are listed hereunder. Refer to Fig 4.

Fig 4



Axis

The longitudinal centre line of the reamer.

Body

The portion of the reamer extending from the entering end of the reamer to the commencement.

Recess

The portion of the body which is reduced in diameter below the cutting edges, pilot or guide diameters.

Shank

The portion of the reamer which is held and driven. It can be parallel or tapered.

Circular land

The cylindrically ground surface adjacent to the cutting edge on the leading edge of the land.

Bevel lead

The bevel lead cutting portion at the entering end of the reamer cutting its way into the hold. It is not provided with a circular land.

Taper lead

The tapered cutting portion at the entering end to facilitate cutting and finishing of the hole. It is not provided with a circular land.

Bevel lead angle

The angle formed by the cutting edges of the bevel lead and the reamer axis.

Taper lead angle

The angle formed by the cutting edges of the taper and the reamer axis.

Terms relating to cutting geometry flutes

The grooves in the body of the reamer to provide cutting edges, to permit the removal of chips, and to allow the cutting fluid to reach the cutting edges. (Fig 5)

Heel

The edge formed by the intersection of the surface left by the provision of a secondary clearance and the flute. (Fig 5)

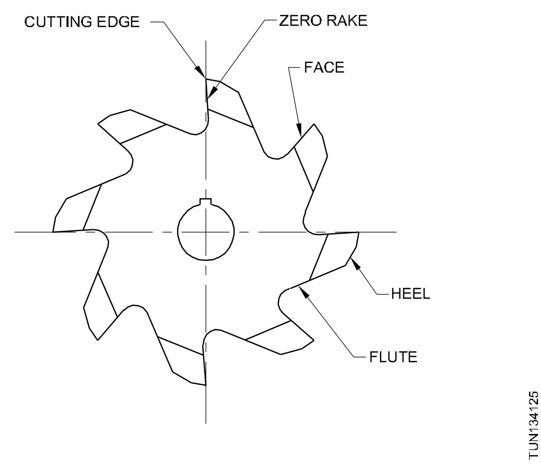
Cutting edge

The edge formed by the intersection of the face and the circular land or the surface left by the provision of primary clearance. (Fig 5)

Face

The portion of the flute surface adjacent to the cutting edge on which the chip impinges as it is cut from the work. (Fig 5)

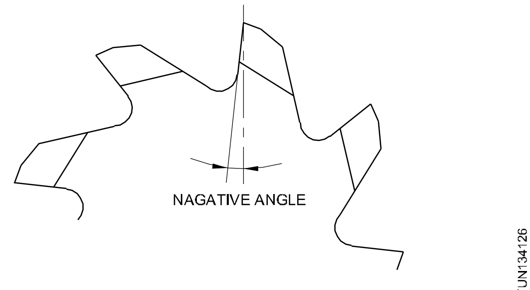
Fig 5



Rake angles

The angles in a diametral plane formed by the face and a radial line from the cutting edge. (Fig 6)

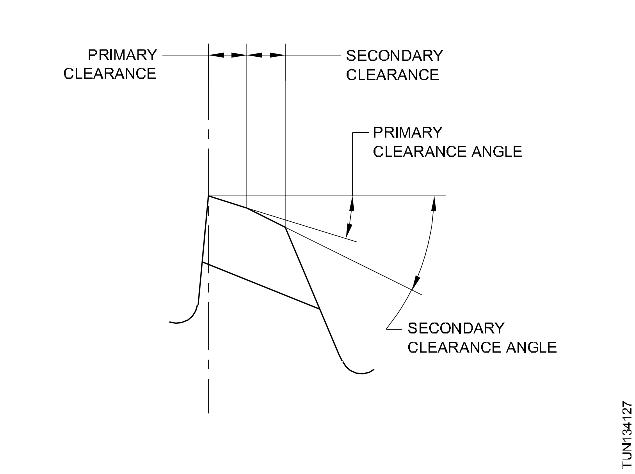
Fig 6



Clearance angle

The angles formed by the primary or secondary clearances and the tangent to the periphery of the reamer at the cutting edge. They are called primary clearance angle and secondary clearance angle respectively. (Fig 7)

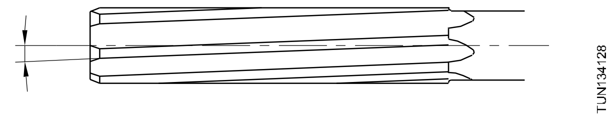
Fig 7



Helix angle

The angle between the edge and the reamer axis. (Fig 8)

Fig 8

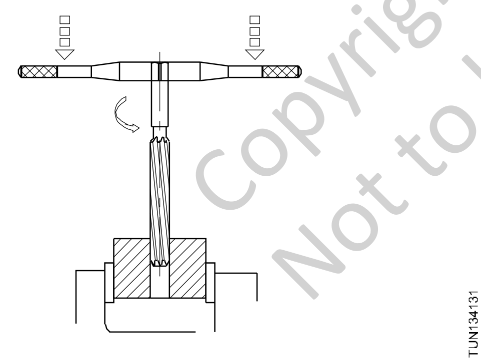


Hand reamers

Objectives : At the end of this lesson you shall be able to
- **state the general features of hand reamers**
- **identify the types of hand reamers**
- **distinguish between the uses of straight fluted and helical fluted reamers**
- **name the materials from which reamers are made and specify reamers.**

General features of hand reamers (Fig 1)

Fig 1



Hand reamers are used to ream holes manually using tap wrenches.

These reamers have a long taper lead.(Fig 2) This allows to start the reamer straight and in alignment with the hole being reamed.

Most hand reamers are for right hand cutting.

Helical fluted hand reamers have left hand helix. The left hand helix will produce smooth cutting action and finish.

Most reamers, machine or hand, have uneven spacing of teeth. This feature of reamers helps to reduce chattering while reaming. (Fig 3)

Fig 2

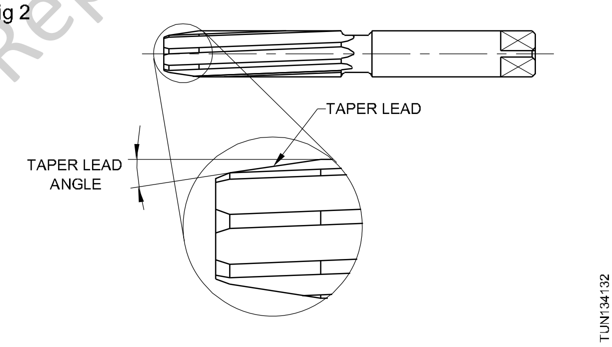
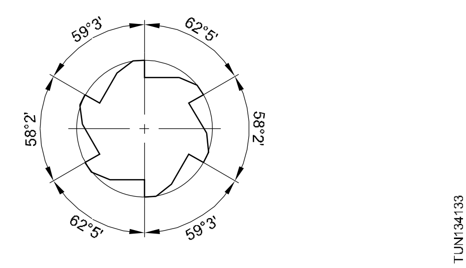


Fig 3



Types, features and functions

Hand reamers with different features are available for meeting different reaming conditions. The commonly used types are listed here under.

Parallel hand reamer with parallel shank (Fig 4)

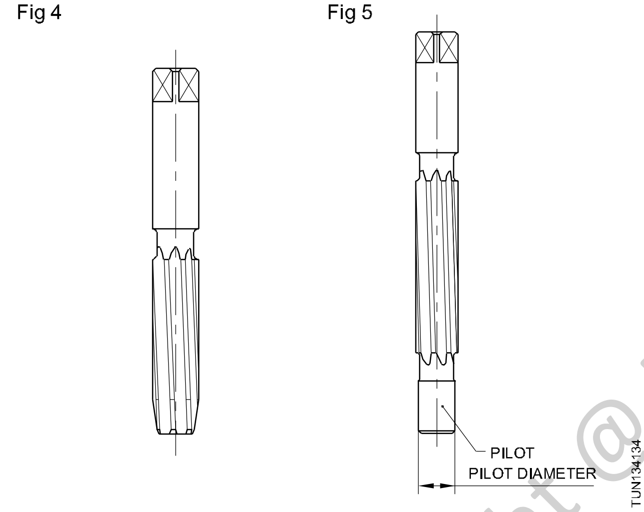
A reamer which has virtually parallel cutting edges with taper and bevel lead. The body of the reamer is integral with a shank. The shank has the nominal diameter of the cutting edges. One end of the shank is square shaped for tuning it with a tap wrench. Parallel reamers are available with straight and helical flutes. This is the commonly used hand reamer for reaming holes with parallel sides.

Reamers commonly used in workshop produce H8 holes.

Hand reamer with pilot (Fig 5)

For this type of reamer, a portion of the body is cylindrically ground to form a pilot at the entering end. The pilot keeps the reamer concentric with the hole being reamed.(Fig 3)

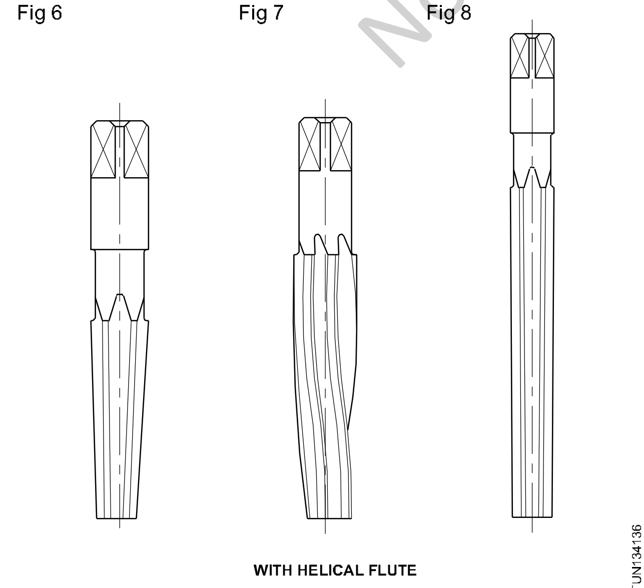
Fig 4 Fig 5



Socket reamer with parallel shank (Figs 6 and 7)

This reamer has tapered cutting edges to suit metric morse tapers. The shank is integral with the body, and is square shaped for driving. The flutes are either straight or helical. The socket reamer is used for reaming internal morse tapered holes.

Fig 6 Fig 7 Fig 8

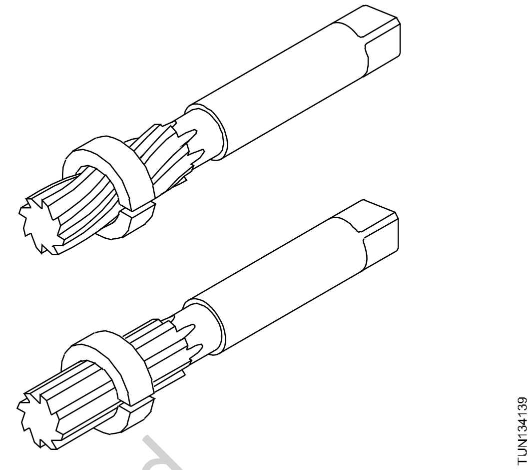


Taper pin hand reamer (Fig 8)

This reamer has tapered cutting edges for reaming taper holes to suit taper pins. A taper pin reamer is made with a taper pin of 1 in 50. These reamers are available with straight or helical flutes.

Use of straight and helical fluted reamers (Fig 9)

Fig 9



Straight fluted reamers are useful for general reaming work. Helical fluted reamers are particularly suitable for reaming holes with keyway grooves or special lines cut into them. The helical flutes will bridge the gap and reduce binding and chattering.

Material of hand reamers

When the reamers are made as a one-piece construction, high speed steel is used. When they are made as two-piece construction then the cutting portion is made of high speed steel while the shank portion is made of carbon steel. They are butt-welded together before manufacturing.

Specifications of a reamer

To specify a reamer the following data is to be given.

- Type
- Flute
- Shank end
- Size

Example

Hand reamer, straight flute, parallel shank of Ø 20 mm.

Drill size for reaming

Objectives : At the end of this lesson you shall be able to
- **determine the hole size for reaming.**

For reaming with a hand or a machine reamer, the hole drilled should be smaller than the reamer size.

The drilled hole should have sufficient metal for finishing with the reamer. Excessive metal will impose a strain on the cutting edge of the reamer and damage it.

Calculating drill size for reamer

A method generally practised in workshop is by applying the following formula.

Drill size = Reamed size – (Undersize + Oversize)

Finished size

Finished size is the diameter of the reamer.

Undersize

Undersize is the recommended reduction in size for different ranges of drill diameter. (See Table 1)

TABLE 1

Undersizes for reaming

Diameter of ready reamed hole (mm)	Undersize of rough bored hole (mm)
under 5	0.1.....0.2
5......20	0.2.....0.3
21....50	0.3.....0.5
over 50	0.5.....1

Oversize

It is generally considered that a twist drill will make a hole larger than its diameter. The oversize for calculation purposes is taken as 0.05 mm - for all diameters of drills. For light metals the undersize will be chosen 50% larger.

Example

A hole is to be reamed on mild steel with a 10 mm reamer. What will be the diameter of the drill for drilling the hole before reaming?

Drill size = Reamed size – (Undersize + Oversize)

(Reamed size)	=	10 mm
Undersize as per table	=	0.2 mm
Oversize	=	0.05 mm
Drill size	=	10 mm – 0.25 mm
	=	9.75 mm

Determine the drill hole sizes for the following reamers:

i 15 mm

ii 4 mm

iii 40 mm

iv 19 mm.

Answer

i __________

ii __________

iii __________

iv __________

Note

> **If the reamed hole is undersize, the cause is that the reamer is worn out.**

Always inspect the condition of the reamer before commencing reaming.

For obtaining good surface finish

> **Use a coolant while reaming. Remove metal chips from the reamer frequently. Advance the reamer slowly into the work.**

Defects in reaming - Causes and remedies

Reamed hole undersize

If a worn out reamer is used, it may result in the reamed hole being undersize. Do not use such reamers.

Always inspect the condition of the reamer before using.

Surface finish rough

The causes may be any one of the following or a combination thereof.

- Incorrect application
- Swarf accumulated in reamer flutes
- Inadequate flow of coolant
- Feed rate too fast

While reaming apply a steady and slow feed-rate.

Ensure a copious supply of the coolant.

Do not turn the reamer in the reverse direction.

Coolant and lubricant

Objectives : At the end of this lesson you shall be able to
- state what is cutting fluid
- state the function of cutting fluids & their advantages
- state the properties of a good cutting fluid
- list the different types of cutting fluids
- select appropriate cutting fluids for different materials.

Cutting fluids and compounds are the substances used for efficient cutting while cutting operations take place.

Functions

The functions of cutting fluids are:

- to cool the tool as well as the workpiece
- to reduce the friction between the chip and the tool face by lubricating
- to prevent the chip from getting welded to the tool cutting edge
- to flush away the chips
- to prevent corrosion of the work and the machine.

Advantages

As the cutting fluid cools the tool, the tool will retain its hardness for a longer period; so the tool life is more.

Because of the lubricating function, the friction is reduced and the heat generated is less. A higher cutting speed can be selected.

As the coolant avoids the welding action of the chip to the tool-cutting edge, the built up edge is not formed. The tool is kept sharp and a good surface finish is obtained.

As the chips ar flushed away the cutting zone will be neat.

The machine or job will not get rusted because the coolant prevents corrosion.

Properties of a good cutting fluid

A good cutting fluid should be sufficiently viscous.

At cutting temperature, the coolant should not catch fire.

It should have a low evaporation rate.

It should not corrode the workpiece or machine.

It must be stable and should not foam or fume.

It should not create any skin problems to the operator.

Should not give off bad smell or cause itching etc. which are likely to irritate the operator, thus reducing his efficiency.

Should be transparent.

Types of cutting fluids

The following are the common cutting fluids.

- Straight mineral oil
- Chemical solution (synthetic fluids)
- Compounded or blended oil
- Fatty oils
- Soluble oil (Emulsified oil-suds)

Straight mineral oil

Straight mineral oils are the coolants which can be used undiluted. Use of straight mineral oil as a coolants has the following disadvantages.

It gives off a cloud of smoke.

It has little effect as a cutting fluid.

Hence straight mineral oils are poor coolants. But kerosene which is a straight mineral oil is widely used as a coolant for machining aluminium and its alloys.

Chemical solution (Synthetic oil)

These consist of carefully chosen chemicals in dilute solution with water. They possess a good flushing and a good cooling action, and are non-corrosive and non-clogging. Hence they are widely used for grinding and sawing. They do not cause infection and skin trouble. They are artificially coloured.

Compounded or blended oil

These oils are used in automatic lathes. These oils are much cheaper and have more fluidity than fatty oil.

Fatty oil

Lard oil and vegetable oil are fatty oils. They are used on heavy duty machines with less cutting speed. They are also used on bench-works for cutting threads by taps and dies.

Soluble oil (Emulsified oil)

Water is the cheapest coolant but it is not suitable because it causes rust to ferrous metals. An oil called soluble oil is added to water which gets a non-corrosive effect with water in the ratio of about 1:20. It dissolves in water giving a white milky solution. Soluble oil is an oil blend mixed with an emulsifier.

Other ingredients are mixed with the oil to give better protection against corrosion, and help in the prevention of skin irritations.

Soluble oil is generally used as a cutting fluid for centre lathes, drilling, milling and sawing.

Soft soap and caustic soda serve as emulsifying agents.

A chart showing coolants for different metals is given below.

Recommended Cutting Fluids for Various Metals and Different Operations

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

Methods of applying lubricant

Objectives : At the end of this lesson you shall be able to
- name the different methods of lubrication
- state the gravity feed methods of applying lubrication
- state the splash methods of applying lubrication
- name the different types of lubricators
- distinguish between the different methods of lubrication.

The following methods are used for efficient lubrication

- Gravity feed method
- Force feed method
- Splash method

Gravity feed method

There are numerous ways of employing this principle, varying from the simple oil hole to the more elaborate wick and glass-sided drip feed lubricators in which the flow of the oil may be controlled and observed through the glass. A selection of these lubricators is shown in Fig 1.

Fig 1

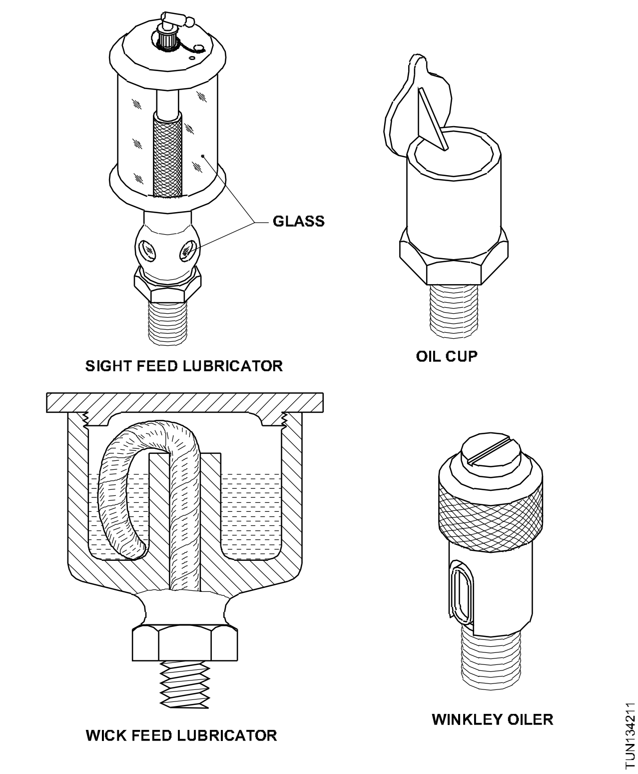
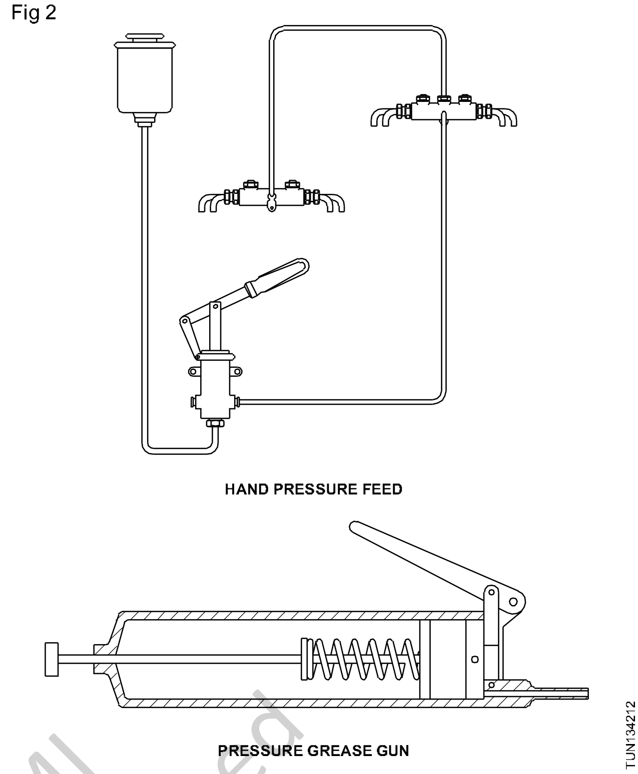


Fig 2

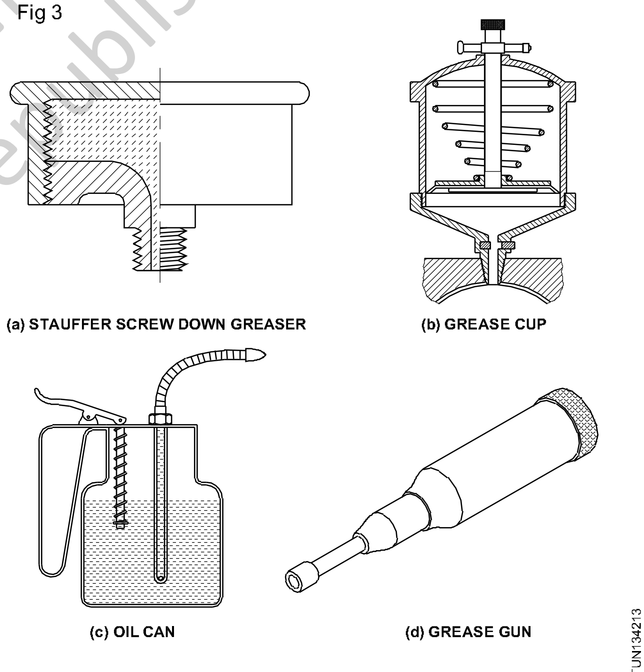


Force (Pressure) feed method

There are various systems of lubrication employing a pressure feed to the lubricant, and the most important of such systems may be classified roughly into the following.

- Continuous feed of oil under pressure to each bearing concerned. In this method an oil pump driven by the machine delivers oil to the bearings and back to a sump from which it is drawn by the pump.
- Pressure feed by hand pump in which a charge of oil is delivered to each bearing at intervals (once or twice a day) by the machine operator. (Fig 2)
- Oil or grease gun method. The oil hole leading to each bearing is fitted with a nipple and by pressing the nose of the gun against this the lubricant is forced into the bearing. (Figs 3a, b, c & d)

Fig 3



Splash method

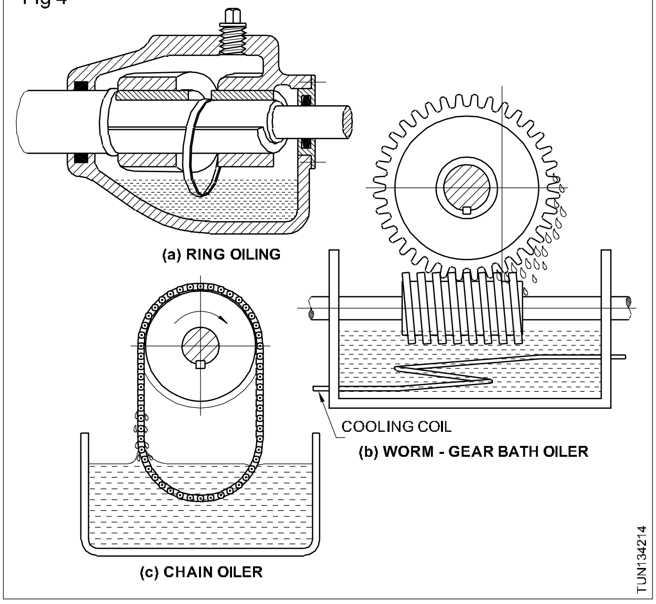
In this method the shaft, or something attached to it, actually dips into the oil and a stream of lubricant is continually splashed round the parts requiring lubrication. This method is employed for the gears and bearings inside all gear drives, the lower parts of the gears actually dipping in the oil. (Figs 4a, b and c)

A common method of employing splash lubrication is known as 'ring oiling.'

Handling and Care:-

1. Stored in clean and dry location
2. Storage temperature should remain moderate at all times.
3. Lubricants in storage should be located away from all types of Industrial contamination including dust and humidity.
4. Brings must be kept tight at all times and drum covers should be used when ever drums are stored in the up right position.
5. Lubricants are stored in the horizontal position on proper storage racks allowing the containers to be rotate and used on as first - in first out basis.
6. Eliminate confusion with proper labeling.
7. Be sure that the proper transfer equipment and procedure are employed for that specific lubricants.

Fig 4



Lathe mandrels

Objectives : At the end of this lesson you shall be able to
- **define a mandrel**
- **state the constructional features of a solid mandrel**
- **identify and name the different types of mandrels**
- **enumerate the uses of different mandrels.**

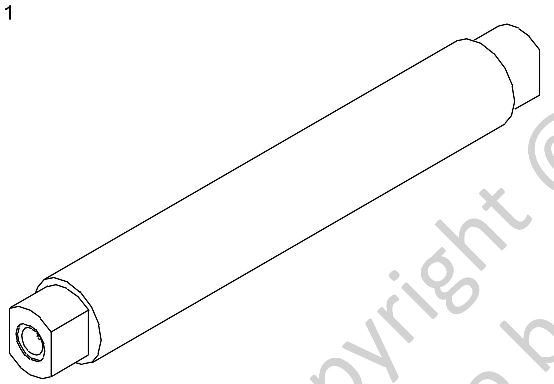
Types of mandrels and their uses

Sometimes it is necessary to machine the outer surfaces of cylindrical works accurately in relation to a hole concentric that has been previously bored in the centre of the work. In such cases the work is mounted on a device known as a mandrel.

Mandrel (Fig 1)

Lathe mandrels are devices used to hold the job for machining on lathes. They are mainly used for machining outside diameters with reference to bores which have been duly finished by either reaming or boring on a lathe.

Fig 1

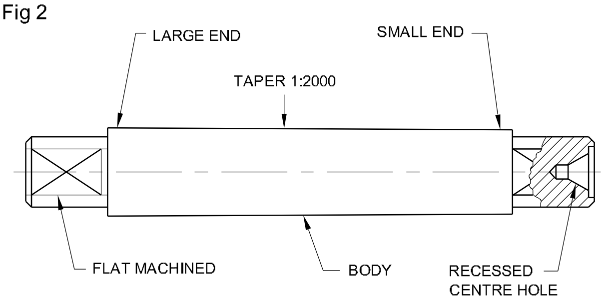


MANDREL

Constructional features of a solid mandrel (Fig 2)

The standard solid mandrel is generally made of tool steel which has been hardened and ground to a specific size and is ground with a taper of 1:2000.

Fig 2



DETAILS OF THE STANDARD SOLID MANDREL

It is pressed or driven into a bored or reamed hole in a workpiece so that it can be mounted on a lathe. The ends of the mandrel are machined smaller than the body and and are provided with a flat for the clamping screw of the lathe carrier. This preserves accuracy and prevents damage to the mandrel when the lathe carrier is clamped on.

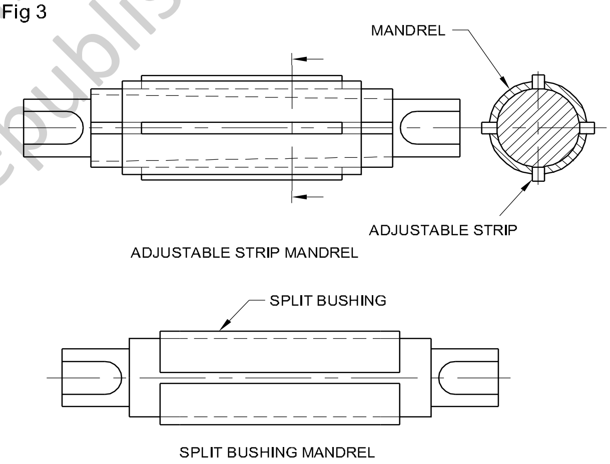
The centres made in these mandrels are 'B' type i.e. protected centres. In such centres the working portion is deep and does not get damaged while handling.

Types of mandrels

- Expansion mandrel
- Gang mandrel
- Stepped mandrel
- Screw or threaded mandrel
- Taper shank mandrel
- Cone mandrel

Expansion mandrel (Fig 3)

Fig 3



EXPANSION MANDRELS

The two most common types of expansion mandrels are:

- split bushing mandrel
- adjustable strip mandrel.

Split bushing mandrel

A split bushing mandrel consists of a solid tapered mandrel, and a split bushing, which expands when forced on to the mandrel. The range of application of each solid mandrel is greatly increased by fitting any number of different sized bushings. As a result only a few mandrels are required.

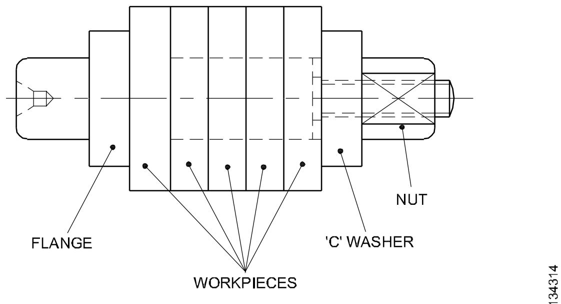
Adjustable strip mandrel

The adjustable strip mandrel consists of a cylindrical body with four tapered grooves cut along its length, and a sleeve, which is slotted to correspond with the tapered grooves. Four strips are fitted in the slots.

When the body is driven in,the strips are forced out by the tapering grooves and expanded radially. Sets of different sized strips greatly increase the range of each mandrel. This type of mandrel is not suitable for thin walled work, since the force applied by the strips may distort the workpiece.

Gang mandrel (Fig 4)

Fig 4



GANG MANDREL

A gang mandrel consists of a parallel body with a flange at one end and a threaded portion at the other end. The internal diameters of workpieces are larger than the mandrel body diameters by not more than 0.025 mm. A number of pieces can be mounted and held securely when the nut is tightened against the 'U' washer. The nut should not be over-tightened, otherwise inaccuracies will result.

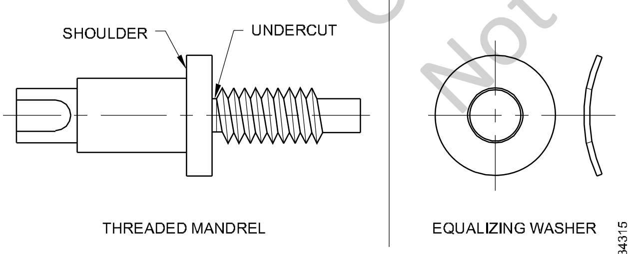
A gang mandrel is especially useful when machining operations have to be performed on a number of thin pieces which might easily be distorted, if held by any other method.

Stepped mandrel

The stepped mandrel is manufactured in order to reduce the number of mandrels. It differs from the plain mandrel in the fact that a number of steps are provided on it. Its use saves time in holding various bored works.

Screw or threaded mandrel (Fig 5)

Fig 5



THREADED MANDREL

A threaded mandrel is used when it is necessary to hold and machine workpieces having a threaded hole.

This mandrel has a threaded portion which corresponds to the internal thread of the work to be machined. An undercut at the shoulders ensures the work to fit snugly (tightly) against the flat shoulder.

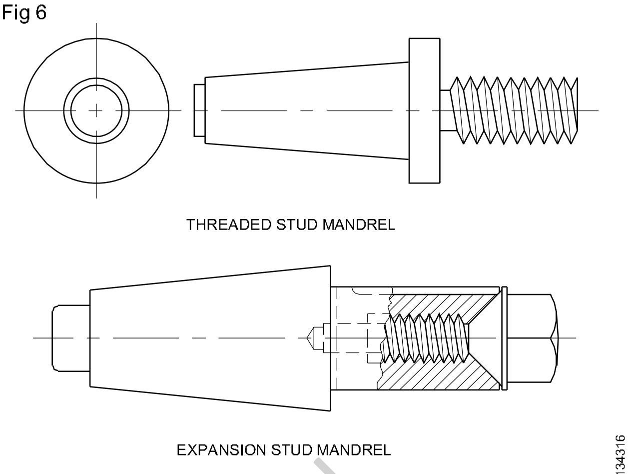
Taper shank mandrel (Fig 6)

Taper shank mandrels are not used between lathe centres. They are fitted to the internal taper of the headstock spindle. The extending portion can be machined to suit the workpiece to be turned. Taper shank mandrels are generally used to hold small workpieces.

Two common types of taper shank mandrels are:

- expansion stud mandrel
- threaded stud mandrel.

Fig 6



TAPER SHANK MANDRELS

Expansion stud mandrel

The expansion stud mandrel is slotted and has an internal thread. When a tapered screw is tightened, the outside diameter of the stud expands against the inside of the workpiece. This type of mandrel is useful when machining a number of similar parts whose internal diameters vary slightly.

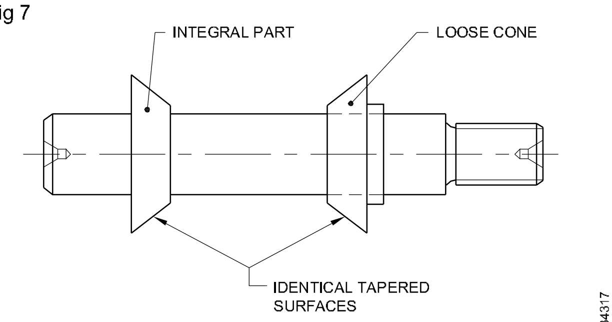
Threaded stud mandrel

The threaded stud mandrel has a projecting portion which is threaded to suit the internal thread of the work to be machined. This type of mandrel is useful for holding workpieces which have blind holes.

Cone mandrel (Fig 7)

A cone mandrel is a solid mandrel. It has a portion taper turned with a steep taper and integral with the body. One end of the mandrel is threaded. A loose cone slides over the plain turned portion of the body of the mandrel. It has the same steep taper as that of the tapered integral part. A job of large bore, can be held between these two tapers and tightly secured by means of nut, washer and spacing collars.

Fig 7



CONE MANDREL

The Indian standard system of limits & fits

Objectives : At the end of this lesson you shall be able to
- **state what is mass production and interchangeable manufacture**
- **state the necessity of the limits system**
- **name the different standard systems of limits and fits accepted and adopted internationally.**

Mass production

When identical components are manufactured in large quantities it is stated that they are mass produced. These identical components should fulfil:

- dimensional accuracy
- degree of surface finish
- interchangeability.
- Standardization

Mass production has the advantage of interchangeable manufacture of components machined by different operators on different machine tools under different environments that can be assembled without any rectification with their mating parts. This avoids selective assembly which is time consuming.

Necessity of limit system

It is practically impossible to machine components to an exact size, due to the varying skills of the operators, the condition of the machine tools, the quality of the cutting tools and the accuracy of the precision instrument used. Hence some permissible deviations to the exact size are accepted and given, and the operator is expected to produce the components within the limits, which, even though not necessarily equal to the exact size, will not affect the functioning of the components. This necessitates the introduction of the limit system.

Internationally accepted systems of limits and fits

- British Standard System of Limits and Fits (B.S.).
- International Standard Organization System of Limits and Fits. (I.S.O.)
- Bureau of Indian Standard System of Limits and Fits (B.I.S.)

Apart from the above most commonly used limit systems, various countries follow their own standards to manufacture components for some of their industries.

Advantages of the limit system

- Interchangeability is assured.
- Not necessary to employ highly skilled operators.
- Not necessary to use conventional measuring instruments.
- Time for the manufacture of components will be comparatively less.

Definition of terms under B.I.S.

Objectives : At the end of this lesson you shall be able to
- **define the terms involved in the B.I.S. system of limits**
- **state the terms under BIS system of limits and fits**
- **define each term under the BIS system of limits and fits.**

The B.I.S. standard system of limits and fits is followed by the industries in our country as the standard. It is adopted from the I.S.O. and B.S. standards with modifications to suit our conditions and requirements. For the purpose of B.I.S. standard, the following definitions and symbols are followed.

Size

It is a number expressed in a particular unit in the measurement of length.

Basic size

It is the size based on which the dimensional deviations are given. (Fig 1)

Maximum limit of size

It is the greater of the two limit sizes..(Fig 2) (Table 1)

Minimum limit of size

it is the smaller of the two limits of size. (Fig 2).(Table 1)

Actual size

It is the size of the component by actual measurement after it is manufactured, it should lie between the two limits of size if the component is to be accepted.

Limits of size

These are the extreme permissible sizes within which the operator is expected to make the component. (Fig 2) (Maximum and minimum limits)

Fig 1

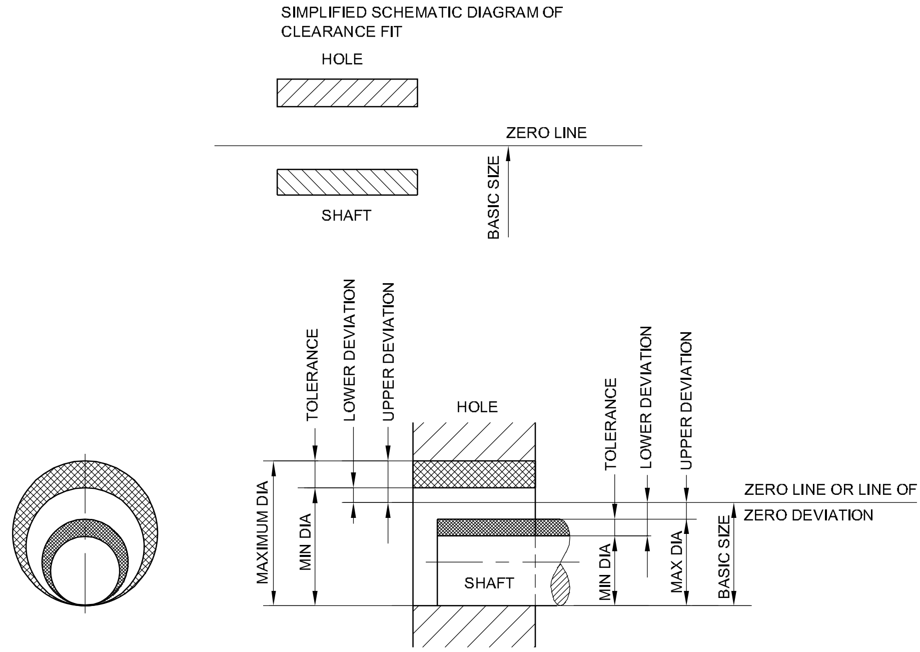
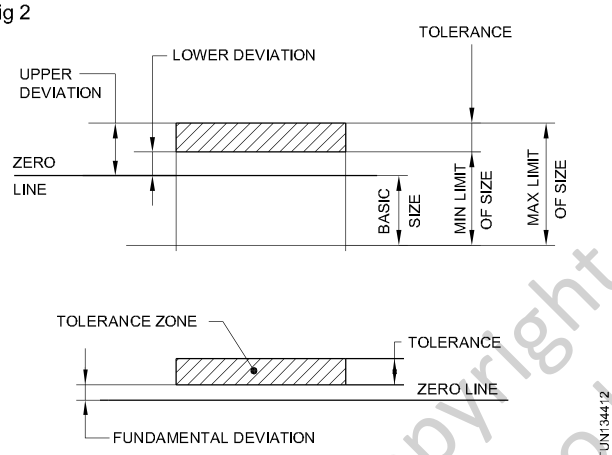


Fig 2



Hole

In the BIS system of limits & fits, all internal features of a component including those which are not cylindrical are designated as * hole'. (Fig 3)

Shaft

In the BIS system of limits & fits, all external features of a component including those which are not cylindrical are designated as shaft. (Fig 3)

Fig 3

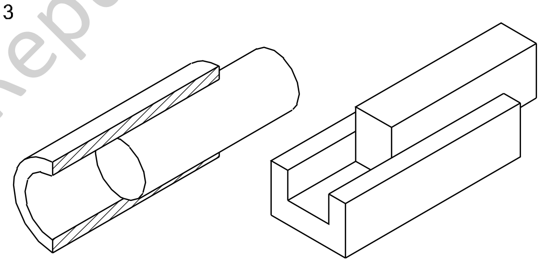


TABLE 1 (Examples)

Sl. No.	Size of Components	Upper Deviation	Lower Deviation	Max-Limit of Size	Min-Limit of Size
1	$20.00^{+0.008}_{-0.005}$	+0.008	- 0.005	20.008	19.995
2	$20.00^{+0.028}_{+0.007}$	+0.028	+0.007	20.028	20.007
3	$20.00^{-0.012}_{-0.021}$	-0.012	-0.021	19.988	19.979

Deviation

It is the algebraic difference between a size, to its corresponding basic size. It may be positive, negative or zero. (Fig 2)

Upper deviation

It is the algebraic difference between the maximum limit of size and its corresponding basic size. (Fig 2) (Table 1)

Lower deviation

It is the algebraic difference between the minimum limit of size and its corresponding basic size. (Fig 2) (Table 1)

> **Upper deviation is the deviation which gives the maximum limit of size. Lower deviation is the deviation which gives the minimum limit of size.**

Actual deviation

It is the algebraic difference between the actual size and its corresponding basic size. (Fig 2)

Tolerance

It is the difference between the maximum limit of size and the minimum limit of size. It is always positive and is expressed only as a number without a sign. (Fig 2)

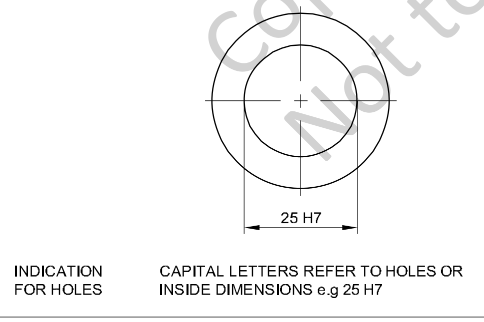
Zero line

In graphical representation of the above terms, the zero line represents the basic size. This line is also called as the line of zero deviation. (Figs 1 and 2).

Fundamental deviation

There are 25 fundamental deviations in the BIS system represented by letter symbols (capital letters for holes and small letters for shafts), i.e for holes - ABCD....Z excluding I,L,O,Q & W. (Fig 4)

Fig 4



In addition to the above, four sets of letters JS, ZA, ZB & ZC are included. For fine mechanisms CD, EF and FG are added. (Ref.IS:919 Part II -1979)

For shafts, the same 25 letter symbols but in small letters are used. (Fig 5)

The position of tolerance zone with respect to the zero line is shown in Figs 6 and 7.

Fig 5

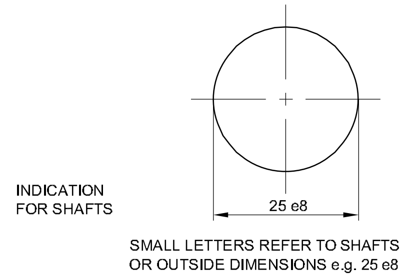


Fig 6

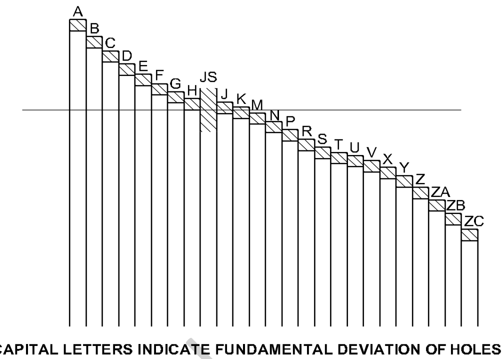
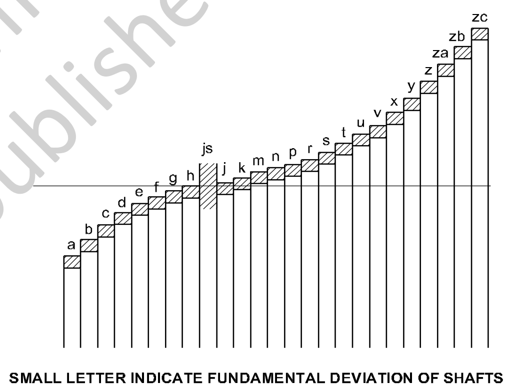


Fig 7

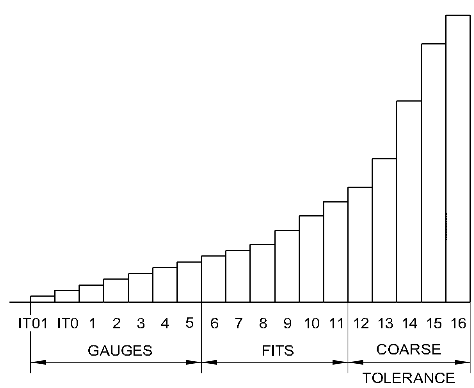


Fundamental tolerance

This is also called as 'grade of tolerance'. In the Indian Standard System, there are 18 grades of tolerances represented by number symbols, both for hole and shaft, denoted as IT01, IT0, IT1....to IT16. (Fig 8) A high number gives a large tolerance zone.

> **The grade of tolerance refers to the accuracy of manufacture.**

Fig 8



In a standard chart, the upper and lower deviations for each combination of fundamental deviation and fundamental tolerance are indicated for sizes ranging up to 500 mm. (Refer to IS 919)

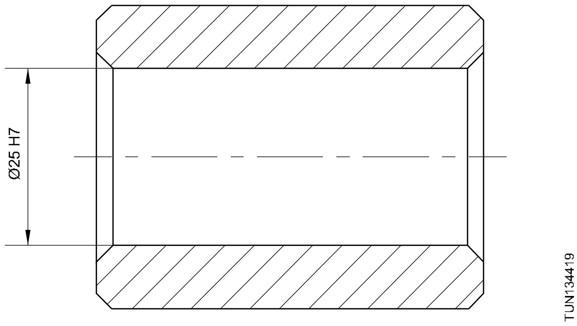
Toleranced size

This includes the basic size, the fundamental deviation and the grade of tolerance.

Example

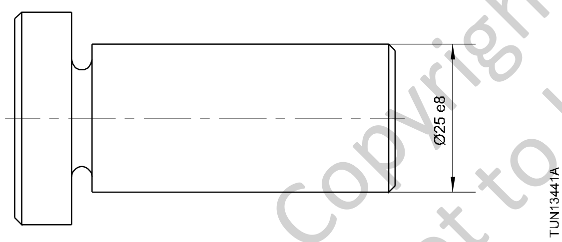
25 H7 - toleranced size of a hole whose basic size is 25. The fundamental deviation is represented by the letter symbol H and the grade of tolerance is represented by the number symbol 7. (Fig 9)

Fig 9



25 e8 - is the toleranced size of a shaft whose basic size is 25. The fundamental deviation is represented by the letter symbol 'e' and the grade of tolerance is represented by the number 8. (Fig 10)

Fig 10



A very wide range of selection can be made by the combination of the 25 fundamental deviations and 18 grades of tolerances.

Example

In figure 13, a hole is shown as 25 ± 0.2 which means that 25 mm is the basic dimension and ± 0.2 is the deviation.

As pointed out earlier, the permissible variation from the basic dimension is called 'DEVIATION'.

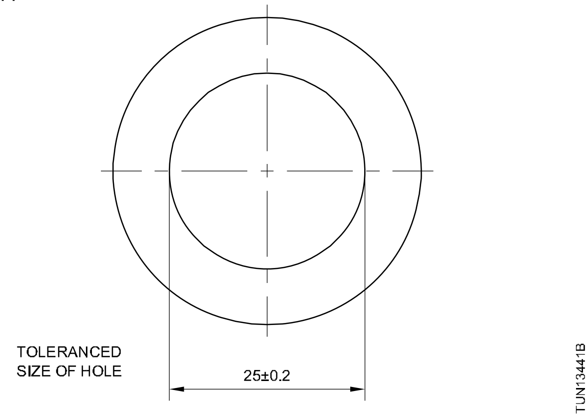
The deviation is mostly given on the drawing with the dimensions.

In the example 25 ± 0.2, ± 0.2 is the deviation of the hole of 25 mm, diameter. (Fig 11) This means that the hole is of acceptable size if its dimension is between.

25 + 0.2 = 25.2 mm

or 25 - 0.2 = 24.8 mm.

Fig 11



25.2 mm is known as the maximum limit. (Fig 12)

24.8 mm is known as the minimum limit. (Fig 13)

Fig 12

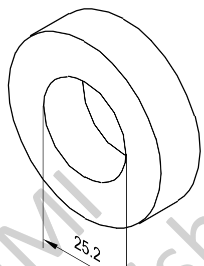
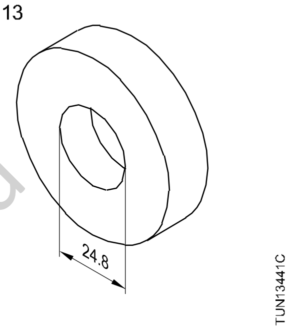
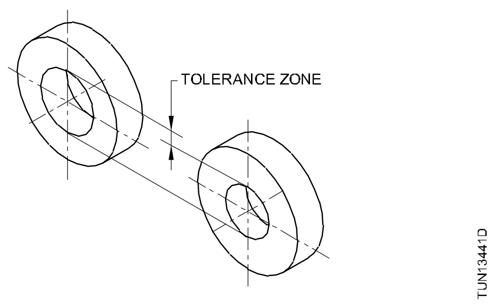


Fig 13



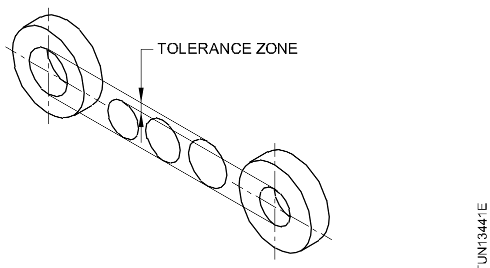
The difference between the maximum and minimum limits is the TOLERANCE. Tolerance here is 0.4 mm (Fig 14)

Fig 14



All dimensions of the hole within the tolerance zone are of acceptable size as in Fig 15.

Fig 15

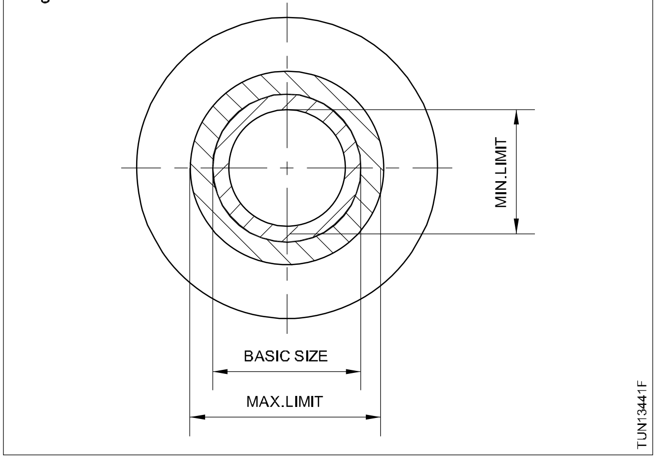


As per BIS 919, while dimensioning the components as a drawing convention, the deviations are expressed as tolerances.

Unilateral & bilateral system

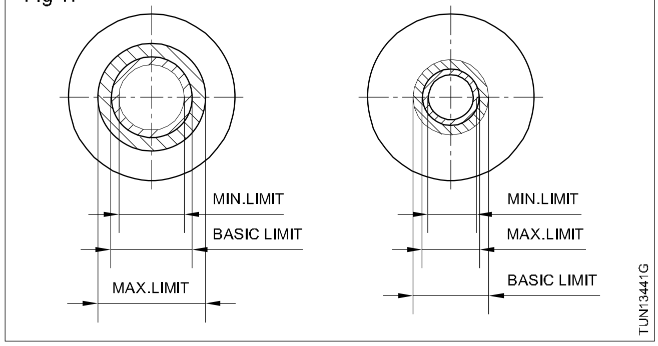
When the deviations given for a particular combination of the symbols are positive and negative so as to give the maximum limit more than the basic size and the minimum limit less than the basic size, then we call it bilateral tolerancing. (Fig 16) If the deviations have only positive

Fig 16



or negative values and have both the maximum limit and minimum limit more than the basic size or less than the basic size respectively, then it is called unilateral tolerancing. (Fig 17)

Fig 17



Fits and their classification as per the indian standard

Objectives : At the end of this lesson you shall be able to
- **define 'Fit as per the indian standard**
- **list out the terms used in limits and fits as per the indian standard**
- **state examples for each class of fit**
- **interpret the graphical representation of different classes of fits.**

Fit

It is the relationship that exists between two mating parts, a hole and a shaft, with respect to their dimensional differences before assembly.

Expression of a fit

A fit is expressed by writing the basic size of the fit first, (the basic size which is common to both the hole and the shaft,) followed by the symbol for the hole, and by the symbol for the shaft.

Example

30 H7/g6 or 30 H7 - g6 or 30 H7/g6

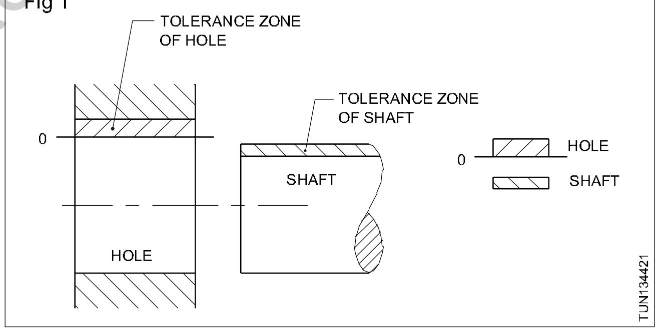
Clearance

In a fit the clearance is the different between the size of the hole and the size of the shaft which is always positive.

Clearance fit

It is a fit which always provides clearance. Here the tolerance zone of the hole will be above the tolerance zone of the shaft. (Fig 1)

Fig 1



Example 20 H7/g6

With the fit given, we can find the deviations from the chart.

For a hole 20 H7 we find in the table + 21.

These numbers indicate the deviations in microns. (1 micrometre = 0.001 mm)

The limits of the hole are 20 + 0.021 = 20.021 mm and 20.000 + 0 = 20.000mm. (Fig 2)

For a shaft 20 g6 we find in the table - 7
- 20.

So the limits of the shaft are 20-0.007 =19.993 mm and 20 - 0.020 =19.980mm.(Fig 3)

Fig 2

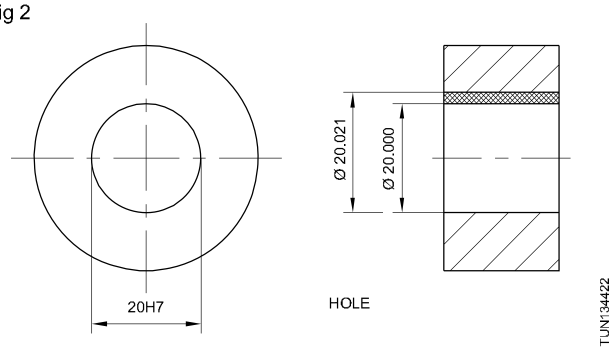
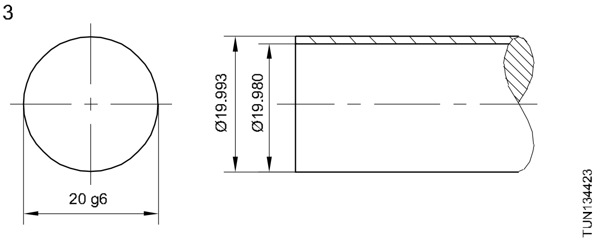


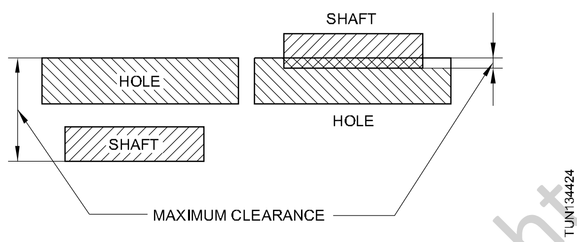
Fig 3



Maximum clearance

In a. clearance fit or transition fit, it is the difference between the maximum hole and minimum shaft. (Fig 4)

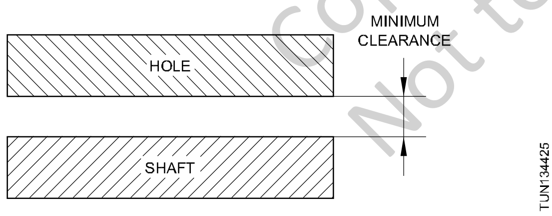
Fig 4



Minimum Clearance

In a clearance fit, it is the difference between the minimum hole and the maximum shaft. (Fig 5)

Fig 5

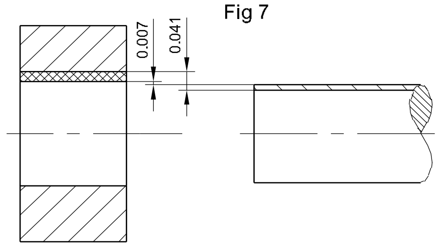


The minimum clearance is 20.000 -19.993 = 0.007mm. (Fig 6)

The maximum clearance is 20.021 -19.980 = 0.041 mm. (Fig 7)

Fig 6

Fig 7



There is always a clearance between the hole and the shaft. This is the clearance fit.

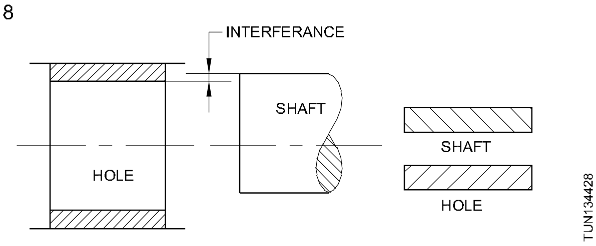
Interference

It is the difference between the size of the hole and the shaft before assembly, and this is negative. In this case, the shaft is always larger than the hole size.

Interference Fit

It is a fit which always provides interference. Here the tolerance zone of the hole will be below the tolerance zone of the shaft. (Fig 8)

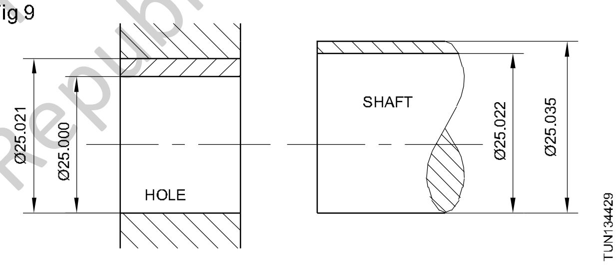
Fig 8



Example Fit 25H7/p6 (Fig 9)

The limits of hole are 25.000 and 25.021 mm and the limits of the shaft 25.022 and 25.035 mm. The shaft is always bigger than the hole. This is an interference fit.

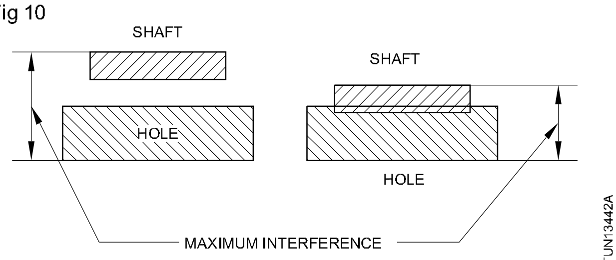
Fig 9



Maximum interference

In an interference fit or transition fit, it is the algebraic difference between the minimum hole and the maximum shaft. (Fig 10)

Fig 10

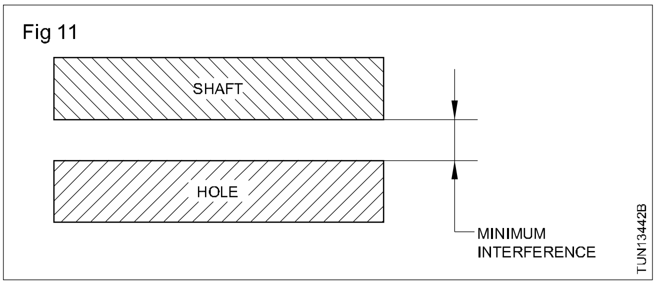


Minimum interference

In an interference fit, it is the algebraic difference between the maximum hole and the minimum shaft. (Fig 11)

In the example shown in figure 9

The maximum interference is = 25.035 - 25.000



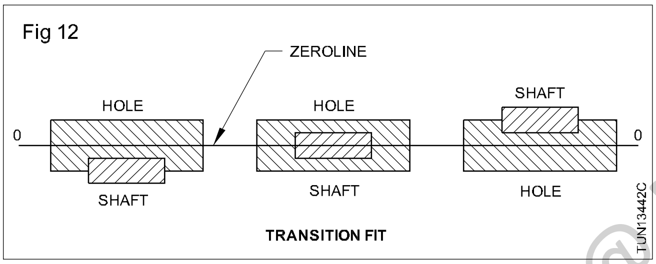
= 0.035

The minimum interference is = 25.022 - 25.021

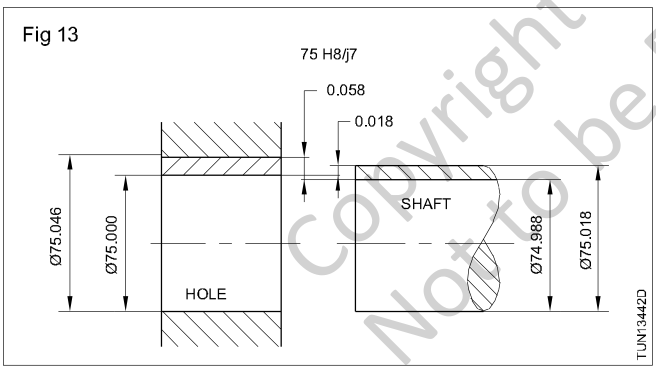
= 0.001

Transition fit

It is a fit which may sometimes provide clearance, and sometimes interference. When this class of fit is represented graphically, the tolerance zones of the hole and shaft will overlap each other. (Fig 12)



Example Fit 75 H8/j7 (Fig 13)



The limits of the hole are 75.000 and 75.046 mm and those of the shaft are 75.018 and 74.988 mm.

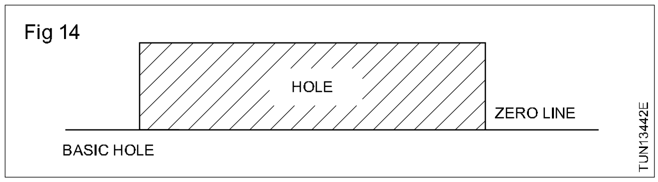
Maximum Clearance = 75.046 - 74.988 = 0.058 mm.

If the hole is 75.000 and the shaft 75.018 mm, the shaft is 0.018 mm, bigger than the hole. This results in interference. This is a transition fit because it can result in a clearance fit or an interference fit.

Hole basis system

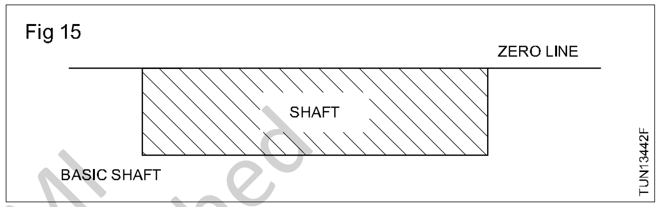
In a standard system of limits and fits, where the size of the hole is kept constant and the size of the shaft is varied to get the different class of fits, then it is known as the hole basis system.

The fundamental deviation symbol 'H' is chosen for the holes, when the hole basis system is followed. This is because the lower deviation of the hole 'H' is zero. It is known as "basic hole'. (Fig 14)



Shaft basis system

In a standard system of limits and fits, where the size of the shaft is kept constant and the variations are given to the hole for obtaining different class of fits, then it is known as shaft basis. The fundamental deviation symbol 'h' is chosen for the shaft when the shaft basis is followed. This is because the upper deviation of the shaft "h" is zero. It is known as basic shaft'. (Fig 15)



The hole basis system is followed mostly. This is be-cause, depending upon the class of fit, it will be always easier to alter the size of the shaft because it is external, but it is difficult to do minor alterations to a hole. Moreover the hole can be produced by using standard toolings.

The three classes of fits, both under hole basis and shaft basis, are illustrated in Fig 16 & 17.

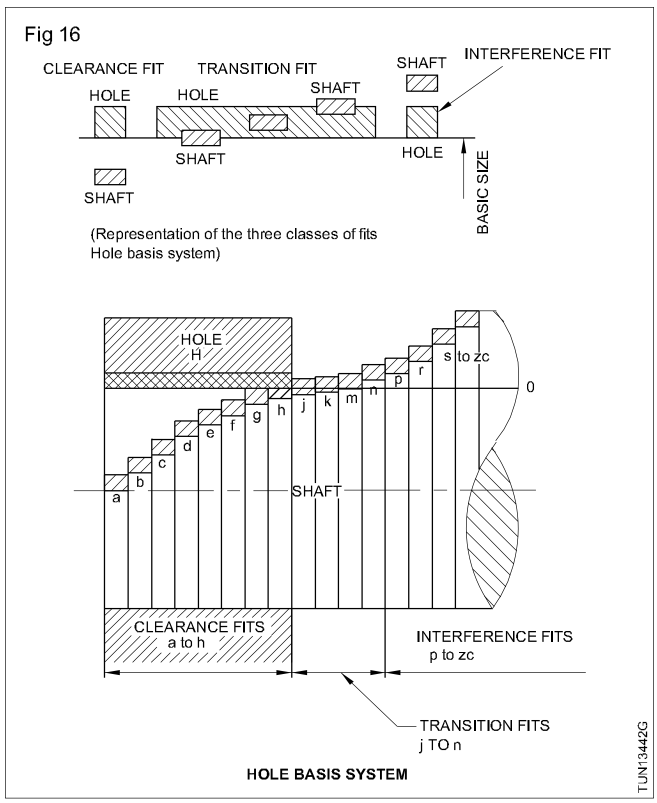
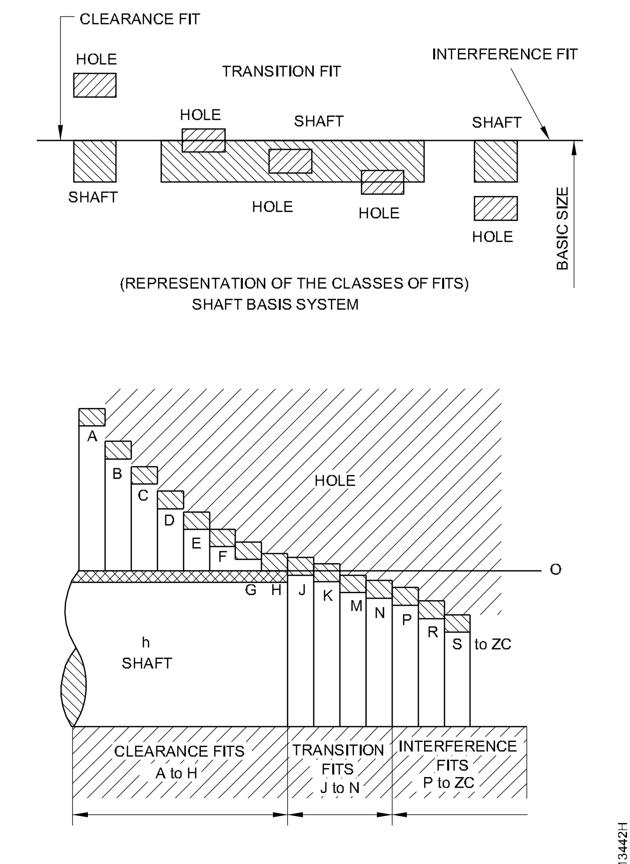


Fig 17

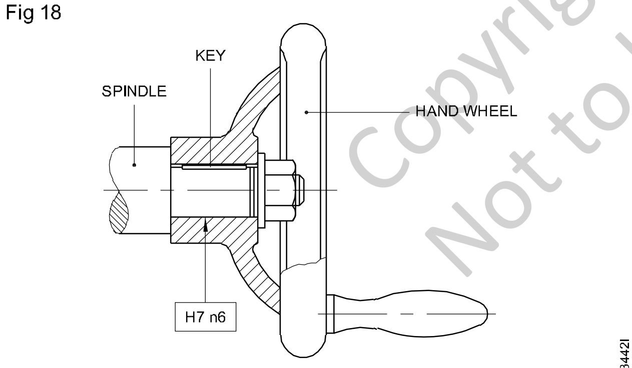


SHAFT BASIS SYSTEM

Hole basis tolerance applications

The hand wheel is fitted to the end of the spindle and held in place by a self-locking nut and washer. (Fig 18)

Fig 18

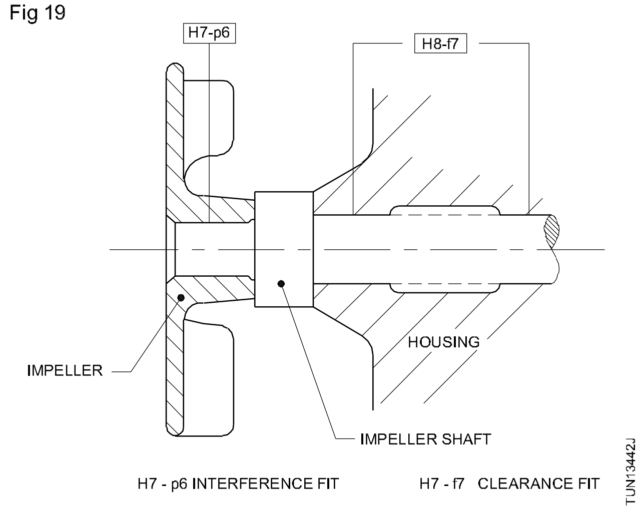


H7 - n6 TRANSITION FIT

A light alloy pump impeller is shown pressed on to steel shaft which runs on two bearings. (Fig 19)

The main bore is shown produced to an H7 limit and it is used to provide support and location for the free end of the boring bar, not directly but through the medium of a pilot bush. Such a bush is made of brass or phosphor bronze. The outside diameter of the busih is made to g6 limits to provide for a close running location fit, and the bore to H8 limits to fit on an j7 bar end to give a normal running fit. Such a machining operation would take place at a slow speed. The fit of the blade tool in its bar slot can be treated in the same way. (Fig 20)

Fig 19



H7 - p6 INTERFERENCE FIT H7 - f7 CLEARANCE FIT

Fig 20

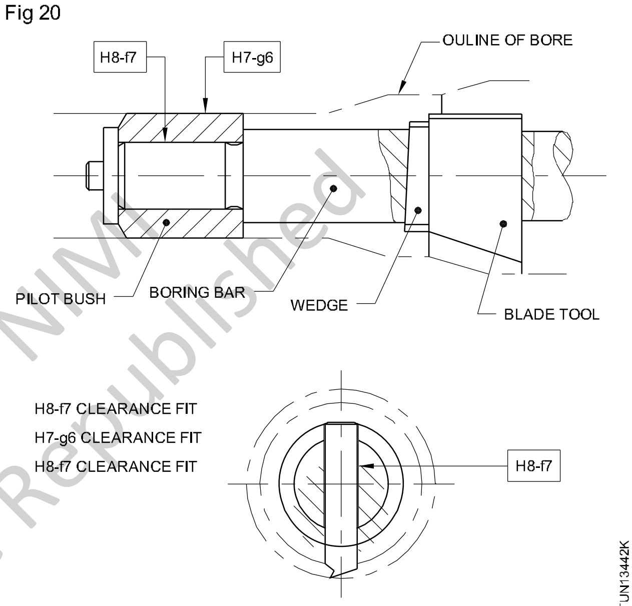
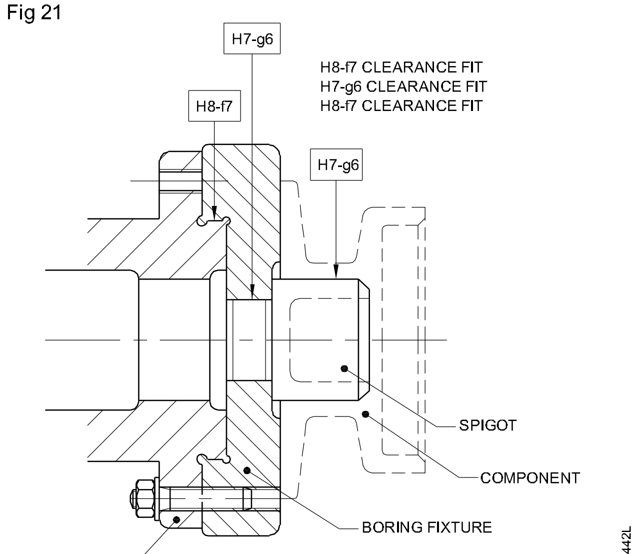


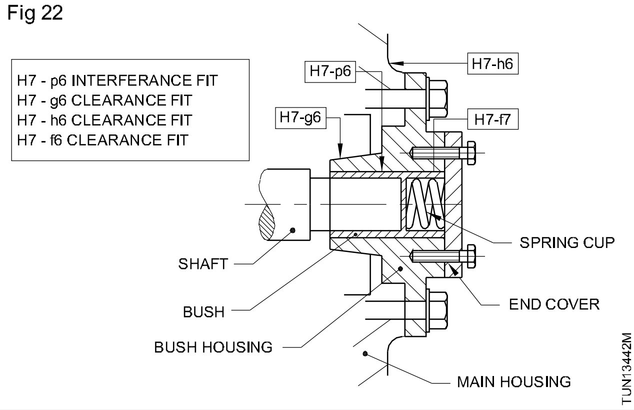
Figure 21 illustrates a flanged spindle nose of a turret lathe with a boring fixture attached. For simplicity in this example, the clamps holding the component to the fixture have been omitted.

Fig 21



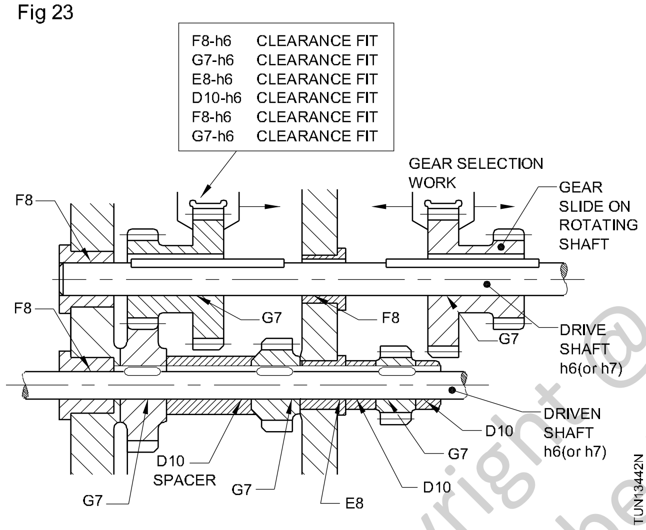
The detail shows the end mounting of the crank shaft of a reciprocating type of compressor. (Fig 22)

Fig 22



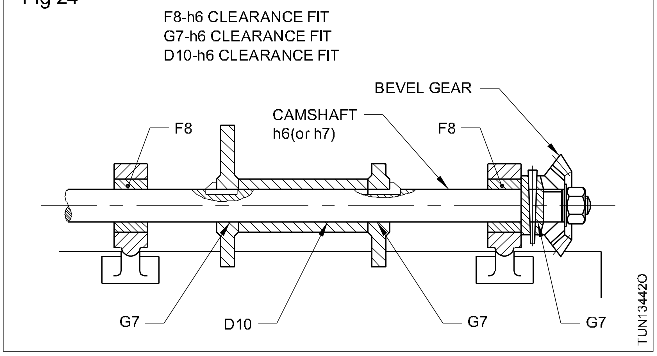
This (Fig 23) details a sectional view of a part of a gearbox in which the upper gears rotate with the drive shaft.

Fig 23



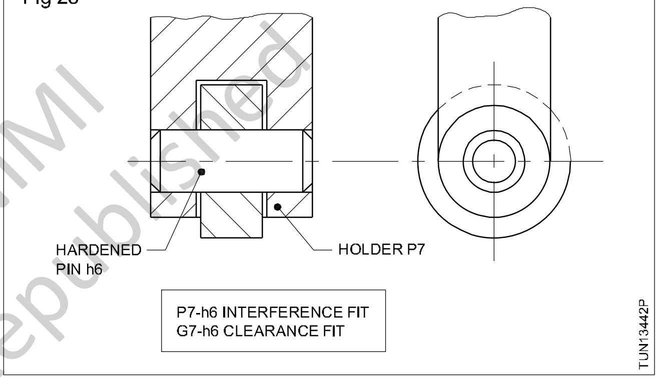
This (Fig 24) illustrates a diagram of a bevel gear driven camshaft, which is supported in two bearing bushes housed in brackets attached to a machine bed.

Fig 24



This (Fig 25) shows a hardened steel roller fitted into a soft steel holder. The roller must be free to rotate on the hardened steel pin which does not itself rotate.

Fig 25



Further classification of fits their applications and service conditions

Fit designation	Classification	Typical applications and service conditions
Clearance H11 - c11	Extra loose running it	Where large clearance is required and where dirty conditions or corrosion are problems. Ex. Agricultural and steel mill pulleys.
Clearance H9 - d10	Loose running fit	Large bearings or pulley and parts requiring ease of assembly.
Clearance H9 - e9	Easy running fit	For smaller applications where a fairly large clearance can be permitted, and where there is more than one bearing on a shaft : Ex. Camshafts, selection shafts in gearboxes, rocker shafts.
Clearance H8 - f7	Normal running fit	Generally used in medium and light engineering for easily produced quality fits as required on gearbox shaft bearings, gears on fixed shafts, guide bushes.
Clearance H7 - g6	Close running fit or location	Although called a running fit, the very small clearance makes it unsuitable for continuous running and should be used only for intermittent or light loadings. May be used for spigot locators.
Clearance H7 - h6	Precision slide fit or	Although there is zero fundamental deviation, in practice there is very small clearance enabling this fit to be used on non-running combinations, such as, precision sliding and jig location fits.

Fit designation	Classification	Typical applications and service conditions
Transition H7 - k6	Push or easy keying fit	For location fits, not requiring frequent removal or where vibration of the part is to be prevented.
Transition H7 - n6	Tight keying fit	Care needed in this selection as a transition fit. Some combinations may, in practice, give an interference fit.
Interference H7 - p6	Light drive fit	This is a true interference fit, providing a press fit for ferrous parts which are not to be damaged or overstrained in any subsequent dismantling.
Interference H7 - s6	Heavy drive fit	For ferrous parts requiring permanent or semi-permanent assembly. (Light and heavy drive fits are frequently used for the assembly of non-ferrous parts such as bearing sleeves and bushes, the actual type of fit, depending upon the size of bush and its function.)

TABLE 1 FOR TOLERANCE ZONES & LIMITS (DIMENSIONS IN m m)

		s6	r6	p6	n6	k6	js6	h6	h7	h9	h11	g6	f7	e8	d9	c11	b11	a11	S7	R7	P7	N7	K7	JS7	H7	H8	H9	H11	G7	F8	E9	D10	C11	B11	A11
From upto	1 3	+20 +14	+16 +10	+12 +6	+10 +4	+6 0	+3 -3	0 -6	0 -10	0 -25	0 -60	-2 -8	-6 -16	-14 -28	-20 -45	-60 -120	-140 -200	-270 -330	-14 -24	-10 -20	-6 -16	-4 -14	0 -10	+5 -5	+10 0	+14 0	+25 0	+60 0	+12 +2	+20 +6	+39 +14	+60 +20	+120 +60	+200 +140	+330 +270
Over upto	3 6	+27 +19	+23 +15	+20 +12	+16 +8	+9 +1	+4 -4	0 -8	0 -12	0 -30	0 -75	-4 -12	-10 -22	-20 -28	-30 -60	-70 -145	-140 -215	-270 -345	-15 -27	-11 -23	-8 -20	-4 -16	+3 -9	+6 -6	+12 0	+18 0	+30 0	+75 0	+16 +4	+28 +10	+50 +20	+78 +30	+145 +70	+215 +140	+345 +270
Over upto	6 10	+32 +23	+28 +19	+24 +15	+19 +10	+10 +1	+4.5 -4.5	0 -9	0 -15	0 -36	0 -90	-5 -14	-13 -28	-25 -47	-40 -76	-80 -170	-150 -240	-280 -370	-17 -32	-13 -28	-9 -24	-4 -19	+5 -10	+7.5 -7.5	+15 0	+22 0	+36 0	+90 0	+20 +5	+35 +13	+61 +25	+98 +40	+170 +80	+240 +150	+370 +280
Over upto	10 14	+39	+34	+29	+23	+12	+5.5	0	0	0	0	-6	-16	-32	-50	-95	-150	-290	-21	-16	-11	-5	+6	+9	+18	+27	+43	+110	+24	+43	+75	+120	+205	+260	+400
Over upto	14	+28 18	+23	+18	+12	+1	-5.5	-11	-18	-43	-110	-17	-34	-59	-93	-205	-260	-400	-39	-34	-29	-23	-12	-9	0	0	0	0	+7	+16	+32	+50	+95	+150	+290
Over upto	18 24	+48	+41	+35	+28	+15	+6.5	0	0	0	0	-7	-20	-40	-65	-110	-160	-300	-27	-20	-14	-7	+6	+10.5	+21	+33	+52	+130	+28	+53	+92	+149	+240	+290	+430
Over upto	24	+35 30	+28	+22	+15	+2	-6.5	-13	-21	-52	-130	-20	-41	-73	-117	-240	-290	-430	-48	-41	-35	-28	-15	-10.5	0	0	0	0	+7	+20	+40	+65	+110	+160	+300
Over upto	30 40	+59	+50	+42	+33	+18	+8	0	0	0	0	-9	-25	-50	-80	-120 -280	-170 -330	-310 -470	-34	-25	-17	-8	+7	+12.5	+25	+39	+62	+160	+34	+64	+112	+180	+280 +120	+330 +170	+470 +310
Over upto	40 50	+43	+34	+26	+17	+2	-8	-16	-25	-62	-160	-25	-50	-89	-142	-130 -290	-180 -340	-320 -480	-59	-50	-42	-33	-18	-12.5	0	0	0	0	+9	+25	+50	+80	+290 +130	+340 +180	+480 +320
Over upto	50 65	+72 +53	+60 +41	+51	+39	+21	+9.5	0	0	0	0	-10	-30	-60	-100	-140 -330	-190 -380	-340 -530	-42 -72	-30 -60	-21	-9	+9	+15	+30	+46	+74	+190	+40	+76	+134	+220	+330 +140	+380 +190	+530 +340
Over upto	65 80	+78 +59	+62 +43	+32	+20	+2	-9.5	-19	-30	-74	-190	-29	-60	-106	-174	-150 -340	-200 -390	-360 -550	-48 -78	-32 -62	-51	-39	-21	-15	0	0	0	0	+10	+30	+60	+100	+340 +150	+390 +200	+550 +360
Over upto	80 100	+93 +71	+73 +51	+59	+45	+25	+11	0	0	0	0	-12	-36	-72	-120	-170 -390	-220 -440	-380 -600	-58 -93	-38 -73	-24	-10	+10	+17.5	+35	+54	+87	+220	+47	+90	+159	+260	+390 +170	+440 +220	+600 +380
Over upto	100 120	+101 +79	+76 +54	+37	+23	+3	-11	-22	-35	-87	-220	-34	-71	-126	-207	-180 -400	-240 -460	-410 -630	-66 -101	-41 -76	-59	-45	-25	-17.5	0	0	0	0	+12	+36	+72	+120	+400 +180	+460 +240	+630 +410
Over upto	120 140	+117 +92	+88 +63													-200 -450	-260 -510	-460 -710	-77 -117	-48 -88													+450 +200	+510 +260	+710 +460
Over upto	140 160	+125 +100	+90 +65	+68 +43	+52 +27	+28 +3	+12.5 -12.5	0 -25	0 -40	0 -100	0 -250	-14 -39	-43 -83	-85 -148	-145 -245	-210 -460	-280 -530	-520 -770	-85 -125	-50 -90	-28 -68	-12 -52	+12 -28	+20 -20	+40 0	+63 0	+100 0	+250 0	+54 +14	+106 +43	+185 +85	+305 +145	+460 +210	+530 +280	+770 +520
Over upto	160 180	+133 +108	+93 +68													-230 -480	-310 -560	-580 -830	-93 -133	-53 -93													+480 +230	+560 +310	+830 +580
Over upto	180 200	+151 +122	+106 +77													-240 -530	-340 -630	-660 -950	-105 -151	-60 -106													+530 +240	+630 +340	+950 +660
Over upto	200 225	+159 +130	+109 +80	+79 +50	+60 +31	+33 +4	+14.5 -14.5	0 -29	0 -46	0 -115	0 -290	-15 -44	-50 -96	-100 -172	-170 -285	-260 -550	-380 -670	-740 -1030	-113 -159	-63 -109	-33 -79	-14 -60	+13 -33	+23 -23	+46 0	+72 0	+115 0	+290 0	+61	+122 +15 +50	+215 +100	+355 +170	+550 +260	+670 +380	+1030 +740
Over upto	225 250	+169 +140	+113 +84													-280 -570	-420 -710	-820 -1110	-123 -169	-67 -113													+570 +280	+710 +420	+1110 +820
Over upto	250 280	+190 +158	+126 +94	+88	+66	+36	+16	0	0	0	0	-17	-56	-110	-190	-300 -620	-480 -800	-920 -1240	-138 -190	-74 -126	-36	-14	+16	+26	+52	+81	+130	+320		+69	+137 +240	+400	+620 +300	+800 +480	+1240 +920
Over upto	280 315	+202 +170	+130 +98	+56	+34	+4	-16	-32	-52	-130	-320	-49	-108	-191	-320	-330 -650	-540 -860	-1050 -1370	-150 -202	-78 -130	-88	-66	-36	-26	0	0	0	0	+17	+56	+110	+190	+650 +330	+860 +540	+1370 +1050
Over upto	315 355	+226 +190	+144 +108	+98	+73	+40	+18	0	0	0	0	-18	-62	-125	-210	-360 -720	-600 -960	-1200 -1560	-169 -226	-87 -144	-41	-16	+17	+28.5	+57	+89	+140	+360	+75	+151	+265	+440	+720 +360	+960 +600	+1500 +1200
Over upto	355 400	+244 +208	+150 +114	+62	+37	+4	-18	-36	-57	-140	-360	-54	-119	-214	-350	-400 -760	-680 -1040	-1350 -1710	-187 -244	-93 -150	-98	-73	-40	-28.5	0	0	0	0	+18	+69	+125	+210	+760 +400	+1040 +680	+1710 +1350
Over upto	400 450	+232	+272 +126	+166 +108	+80	+45	+20	0	0	0	0	-20	-68	-135	-230	-440 -840	-760 -1160	-1500 -1900	-209 -272	-103 -166	-45	-17	+18	31.5	+63	+97	+155	+400	+83	+165	+290	+480	+840 +440	+1160 +760	+1900 +1500
Over upto	450 500	+292 +252	+172 +132	+68	+40	+5	-20	-40	-63	-155	-400	-60	-131	-232	-385	-480 -880	-840 -1240	-1650 -2050	-229 -292	-109 -172	-108	-80	-45	-31.5	0	0	0	0	+20	+68	+135	+230	+880 +480	+1240 +840	+2050 +1650

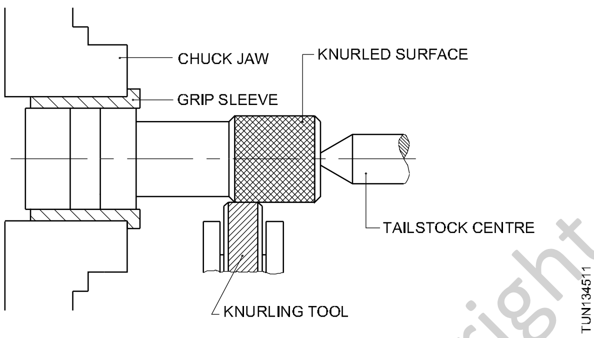
Knurling

Objectives : At the end of this lesson you shall be able to
- define knurling operation
- state the purpose of knurling
- list out the different types of knurls and knurling patterns
- list out the grades of knurls
- distinguish between the various types of knurling tool-holders.

Knurling (Fig 1)

It is the operation of producing straight lined, diamond shaped pattern or cross lined pattern on a cylindrical external surface by pressing a tool called knurling tool. Knurling is not a cutting operation but it is a forming operation. Knurling is done at a slow spindle speed (1/3 times the turning speed). Soluble oil is to be used as coolant mostly and, sometimes straight cutting oil may be used to get better finish.

Fig 1



Purpose of knurling

The purpose of knurling is to provide:

- a good grip and make for positive handling.
- good appearance
- for raising the diameter to a small range for assembly to get a press fit.

Types of knurls and knurling patterns

The following are the different types of knurling patterns.

Diamond knurling, Straight knurling, Cross knurling, Concave knurling and Convex knurling.

Diamond knurling (Fig 2)

It is a knurling of diamond shaped pattern. It is done by using a set of rolls. One roller has got right hand helical teeth and the other has left hand helical teeth.

Straight knurling (Fig 3)

It is a knurling of straight lined pattern. This is done by using either a single roller or a double roller with straight teeth.

Fig 2

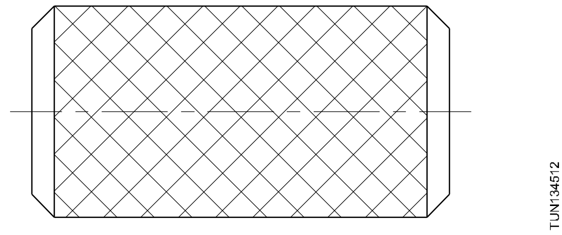
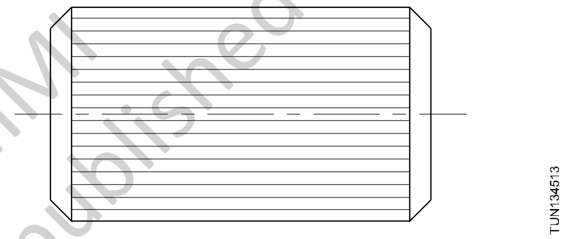


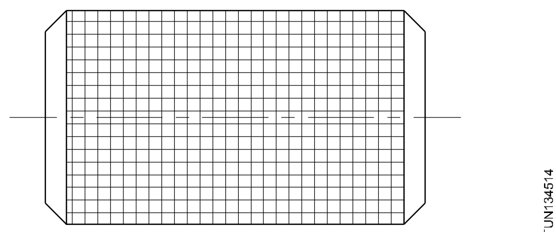
Fig 3



Cross knurling (Fig 4)

It is a knurling having a square shaped pattern. It is done by a set of rollers, one having straight teeth the other having teeth at right angles to the axis of knurl.

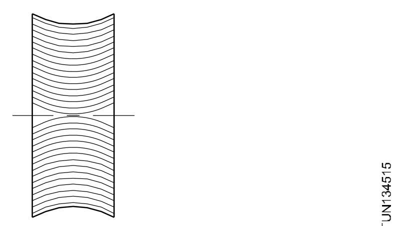
Fig 4



Concave knurling (Fig 5)

This is done by a convex knurl on a concave surface. This is done only by plunging the tool. The tool should not be moved longitudinally. The length of the knurling is limited to the width of the roller.

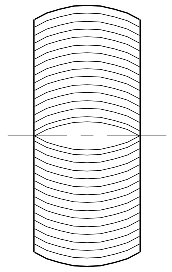
Fig 5



Convex knurling (Fig 6)

This is done by using a concave knurl on a convex surface. This is also done by plunging the tool.

Fig 6



Grades of knurling (Fig 7)

Knurling can be done in three grades.

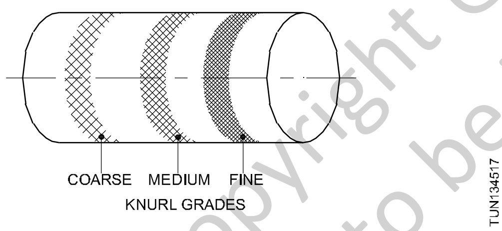
Coarse knurling, Medium knurling and Fine knurling

Coarse knurling is done by using coarse pitched knurls of 1.75 mm pitch. (14 TPI)

Medium knurling is done by using medium pitched knurls of 1.25 mm pitch. (21 TPI)

Fine knurling is done by using fine pitched knurls of 0.75 mm pitch. (33 TPI)

Fig 7



Types of knurling tool-holders

The different types of knurling tool-holders are:

- single roller knurling tool-holders (parallel knurling tool-holders)
- knuckle joint type knurling tool-holders
- revolving type knurling tool-holders (universal knurling tool-holders).

A knurling tool-holder has a heat-treated steel shank and hardened tool steel knurls. The knurls rotate freely on hardened steel pins.

Single roller knurling tool-holder (Fig 8)

It has only one single roller which produces a straight lined pattern.

Knuckle joint type knurling tool-holders (Fig 9)

This tool holder has a set of two rollers of the same knurling pitch. The rollers may be of straight teeth or helical teeth. It is self-centering.

Fig 8

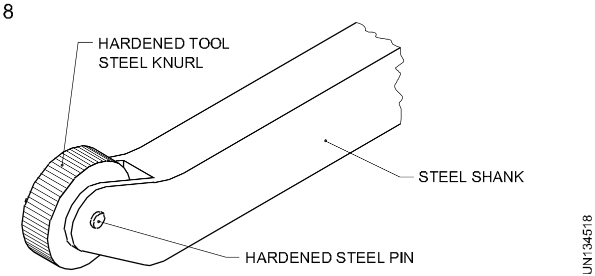
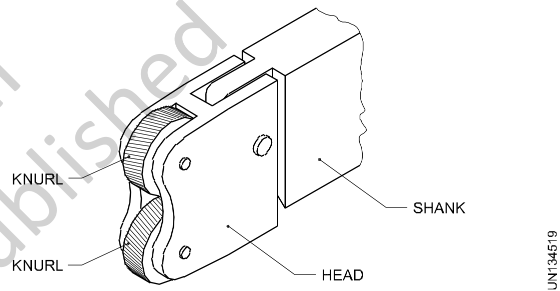


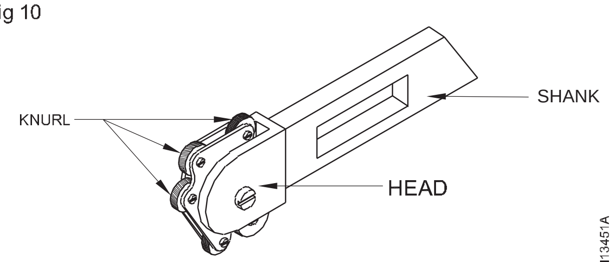
Fig 9



Revolving head knurling tool (Fig 10)

This tool-holder is also called a universal knurling tool-holder. It is fitted with 3 pairs of rollers having coarse, medium and fine pitches. These are mounted on a revolving head which pivots on a hardened steel pin. It is also self-centering.

Fig 10



REVOLVING TYPE

Differences between different types of knurling tool-holders are given in Table -1

Table -1

Single roller	**Knuckle joint**	**Revolving type**
Only one roller is used.	A pair of rollers are used.	Three pairs of rollers are used.
Only one pattern of knurling can be produced with this type of knurling tool-holder.	Cross or diamond knurling pattern can be produced.	Knurling patterns of different pitches can be produced.
It is not self-centering.	It is self-centering.	It is self-centering.

Knurling - Speed and Feed

The tables shown be used as a guide for determining the amount of end-feed or in-feed per revolution of the work. The rate of the feed for diamond pattern knurling is slower than that for straight or diagonal knurling.

Straight or Diagonal
End - FEED KNURLING
Approximate
FEED per REVOLUTION

T.P.I	**Alum Brass**	**Mild Steel**	**Alloy Steel**
12	.008”	.006”	.004”
16 - 20	.010”	.008”	.005”
25 - 35	.013”	.010”	.007”
40 - 80	.017”	.012”	.009”

Straight or Diagonal
IN - FEED KNURLING
Approximate
REVOLUTION

T.P.I	**Alum Bras**	**Mild Steel**	**Alloy Steel**
12	12	15	25
16-20	10	13	22
25-35	8	11	20
40-80	6	9	18

Driving plate and face plate

Objectives : At the end of this lesson you shall be able to
- **name the parts of a driving plate**
- **distinguish between the different driving plates**
- **state the uses of the different driving plates**
- **name the parts of a face plate**
- **distinguish between different face plates.**
- **list out the accessories used along with the face plates.**

Driving plates

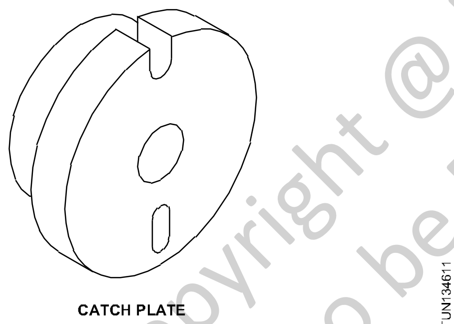
When turning a work in between the centres, the driving plate is used for transmitting the drive to the work.

They are grouped as catch plates and driving plates and safety driving plates.

Catch plate

It is designed with a 'u' slot and an elliptical slot to accommodate the bent tail of the lathe carrier. (Fig 1)

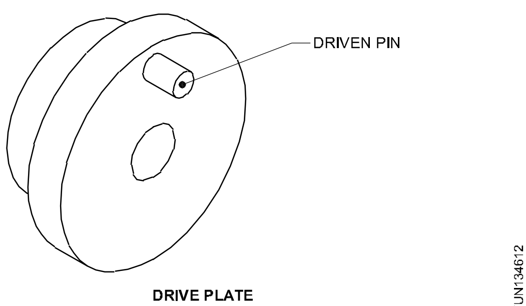
Fig 1



Driving plate

It is designed with a projected pin which locates the straight tail of the lathe carrier. (Fig 2)

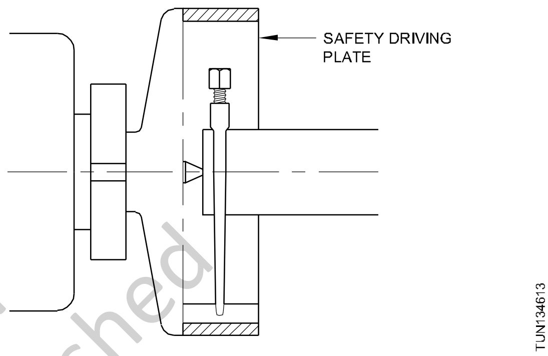
Fig 2



Safety driving plate

It is similar in construction to a driving plate but equipped with a cover to protect the operator from any injuries. (Fig 3)

Fig 3



The safety driving plates are made of cast steel and are machined to have their face perfectly at right angles to the bore. They are provided with a stepped collar at the back. The bore is designed to suit the spindle nose to which the plate has to be mounted.

The driving plate with a straight tail carrier provides a positive drive for the workpiece.

A catch plate with a bent tail carrier uses a minimum clamping length of the workpiece for clamping purposes.

A safety driving plate prevents likely injuries to the operator.

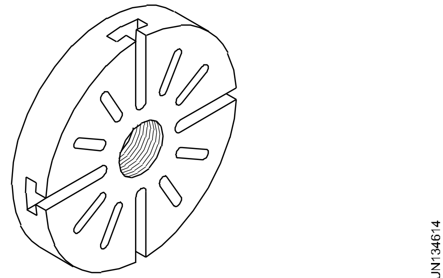
Face plates

They are similar in shape to the lathe catch plates but are larger in diameter.

The different types of face plates are:

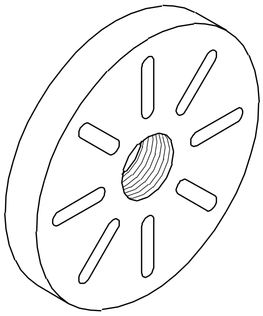
- face plates with elongated slots and 'T' slots (Fig 4)

Fig 4



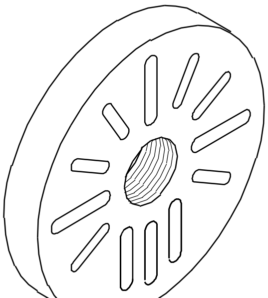
- face plates with only elongated radial slots (Fig 5)

Fig 5



- face plates with elongated radial slots and additional parallel slots (Fig 6)

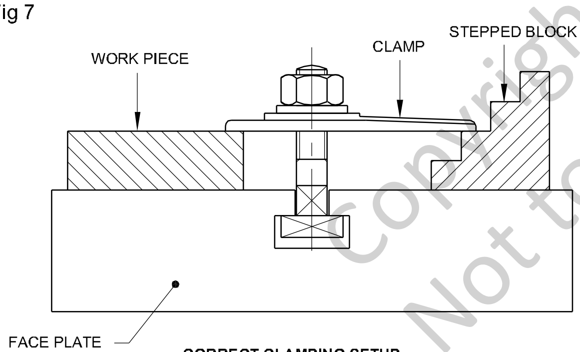
Fig 6



Face plates are used along with the following accessories when in use. The accessories are listed here.

- Clamps,'T' bolts and stepped block (Fig 7)

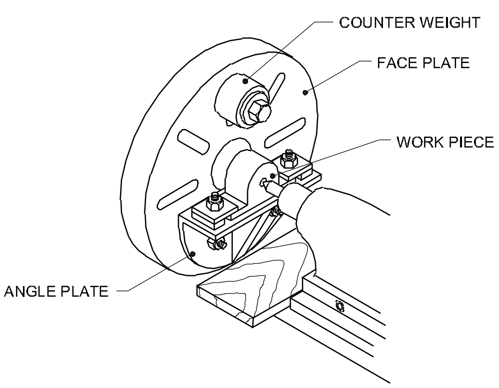
Fig 7



CORRECT CLAMPING SETUP

- Angle plate and counterweight (Fig 8)

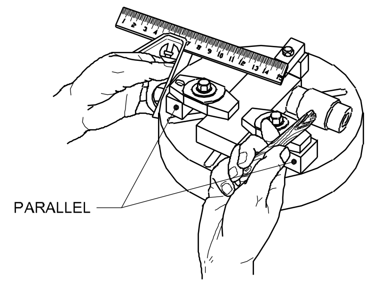
Fig 8



WORK HELD BY AN ANGLE PLATE

- Parallels (Fig 9)

Fig 9



LOCATING WORK ON A FACE PLATE

Uses

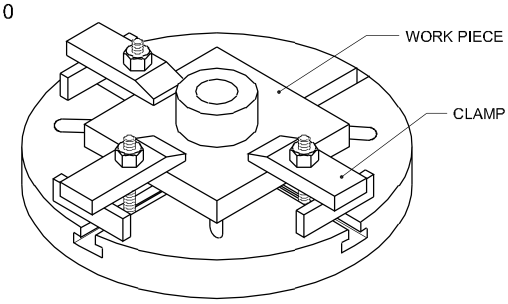
Large, flat, irregular shaped workpieces, castings, jigs and fixtures may be firmly clamped to a face plate for various turning operations .

The work can be mounted on a face plate while the face plate is on the lathe spindle or on the workbench. If the workpiece is heavy or irregular to hold, the workpiece is mounted while the face plate is on the workbench. Before mounting the face plate set up to the spindle, it is advantageous to locate the workpiece on the face plate and centre the workpiece with reference to the centre punch mark or hole approximately on the face plate. This makes it easier to true the work after the face plate is mounted on to the spindle.

The position of the bolts and clamps is very important, if a workpiece is to be clamped effectively.

If a number of duplicate pieces are to be machined, the face plate itself can be set up as a fixture, using parallel strips and stop blocks.

Fig 10



WORK CLAMPED DIRECTLY TO FACE PLATE

Fixed steady & travelling steady

Objectives : At the end of this lesson you shall be able to
- **state what is a steady rest**
- **identify and name the various types of steady rests**
- **distinguish between a fixed steady rest and a follower steady rest**
- **state the uses of a steady rest**
- **identify the cat head and its use.**

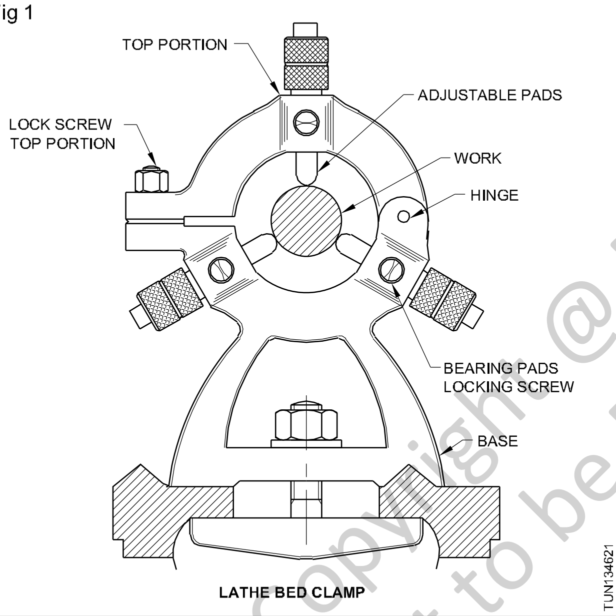
A steady rest is a lathe accessory used to give extra support for a long slender workpiece in addition to the centre support during turning.

The most common types of steady rests are :

- Fixed steady rest.
- Followed steady rest (travelling steady)

Fixed steady rest (Fig 1)

Fig 1



The figure shows the parts of a fixed steady rest.

A fixed steady rest is fixed to the lathe bed and it is stationary. It gives support at one fixed place only.

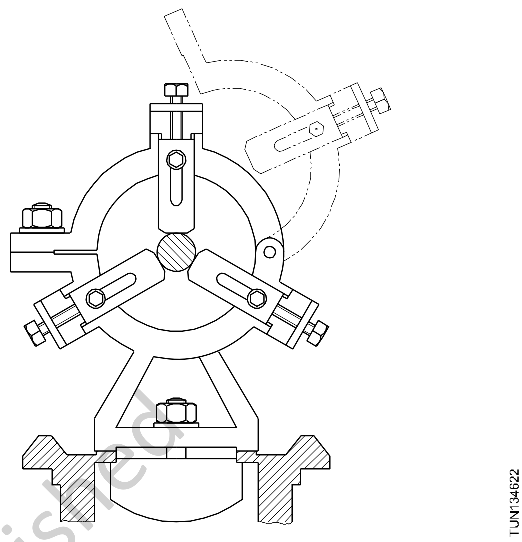
It consists of a frame containing three adjustable pads.

The base of the frame is machined to suit the inside ways of the lathe bed. The top portion is hinged at the back to permit the top to be lifted or assembled to the bottom half for allowing the work to be mounted or removed. A fixed steady can be clamped at any desired position on the lathe bed by the base clamping screw. (Fig 2)

The three adjustable pads can be moved radially in or out by means of adjusting screws. The three pads are adjusted on a trued cylindrical face of the workpiece.

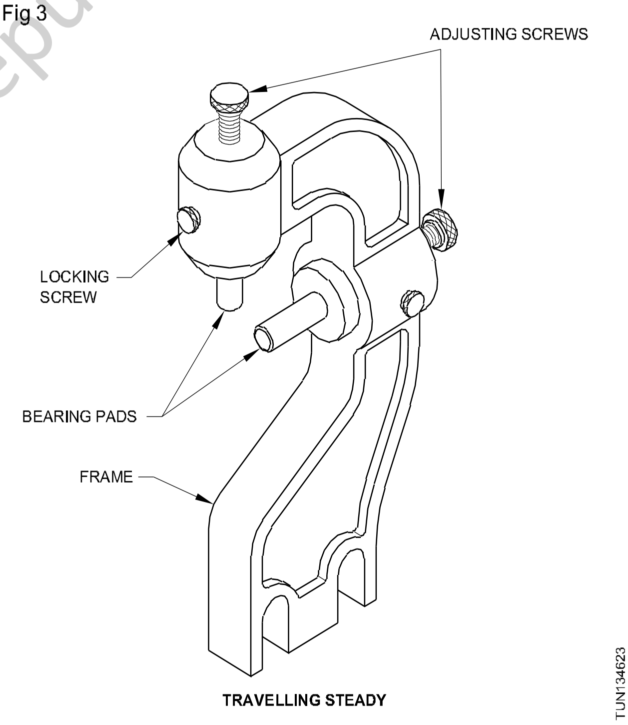
A follower steady is fixed to the saddle of the lathe. As it follows the tool, it gives support where cutting actually takes place. In the follower steady, the support is continuous to the entire length of cutting.

Fig 2



Follower steady rest (Fig 3)

Fig 3



The follower steady rest has usually two pads. One pad is located opposite to the cutting tool and the other pad bears the top of the workpiece to prevent it from springing up. The figure shows a travelling steady rest in action. (Fig 4)

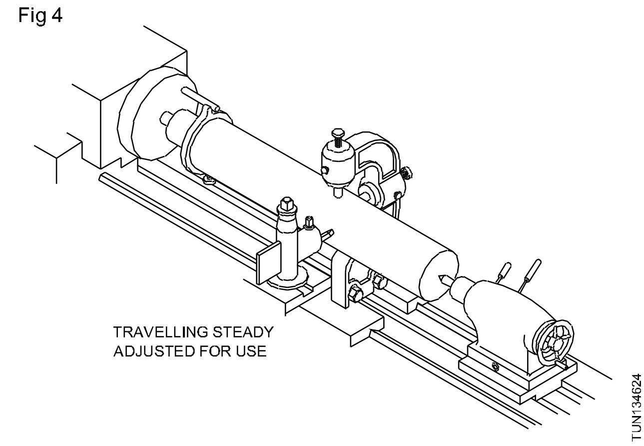


Fig 4

Cat head

If the job shape is not round or where we cannot turn a true cylindrical surface on the job, it is not possible to support the job, by a fixed steady rest. For those types of jobs, a device called cat head is fixed on the workpiece.

The cat head is a type of bush, its external surface is round. Fig 5 shows a cat head. The middle portion is cylindrical and free to rotate. The two ends have the adjusting screws for holding and centering the work. After centering the work the fixed steady is positioned, and pads are adjusted to hold the cat head's centre portion. When the lathe is running the work revolves along with the ends of the cat head whereas the centre portion is stationary. (Fig 6) Another type of cat head, shown in Fig 7, is a single piece and it rotates along with the job.

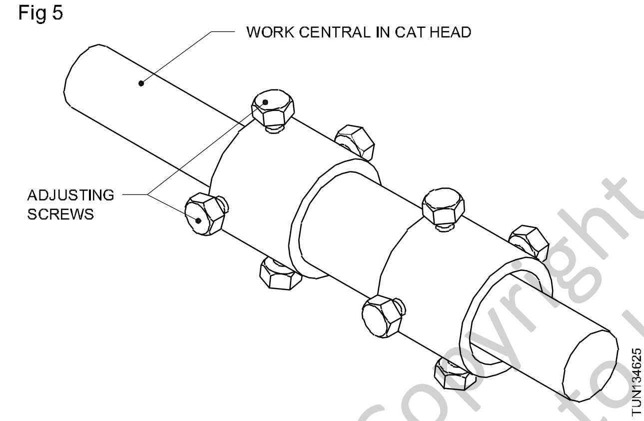


Fig 5

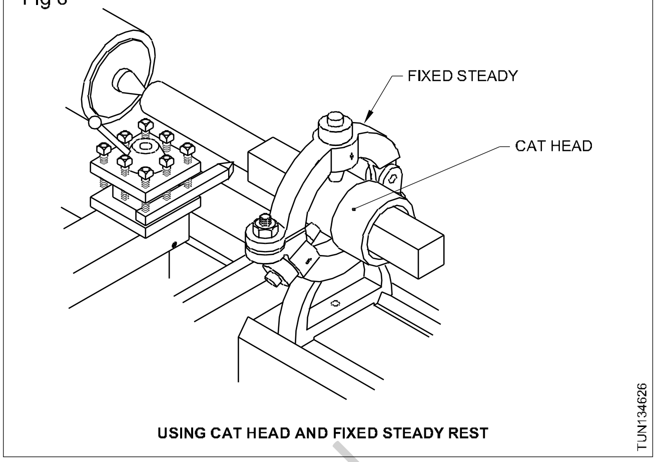


Fig 6

USING CAT HEAD AND FIXED STEADY REST

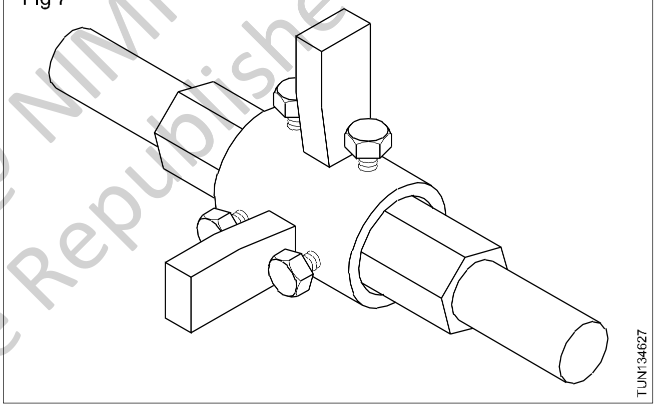


Fig 7

Lathe carriers

Objectives : At the end of this lesson you shall be able to
- **name the types of lathe carrier**
- **state the use of each type of lathe carriers.**

Accessories used for in-between centre work

The accessories used during turning work held in between centres are as follows.

Live centre, Dead centre, Catch plate, Driving plate, Lathe spindle sleeve and Lathe carriers.

Lathe carriers

They are also called lathe dogs. They are used to drive the work during turning between centres. The work is clamped firmly in the lathe carrier. It consists of a cast iron or forged steel body and a clamping screw. It is designed with a straight or bent tail. It is available in a set of 10, capable of accommodating work of a wide range of diameters. The tails of the carriers are meant to locate and drive the workpiece for turning. (Fig 1) To protect the finished surface from damages, a soft metal packing piece is used under the clamping screw.

The following are the four types of lathe carriers.

Straight tail carrier, Bent tail carrier, Clamp type carrier and Safety clamp type carrier.

A straight tailed carrier locates against the driving pin of the driving plate and provides a positive drive for the workpiece. (Fig 2)

Fig 1

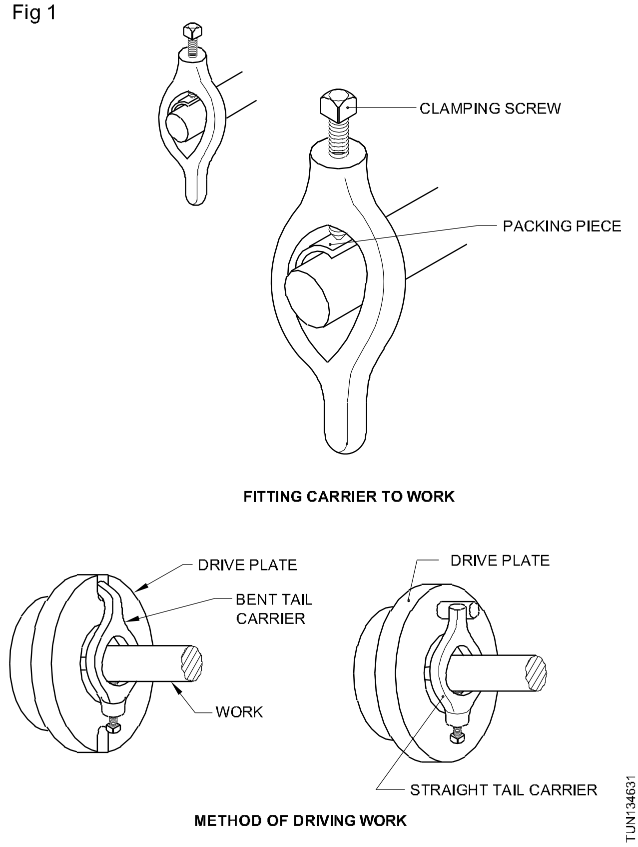
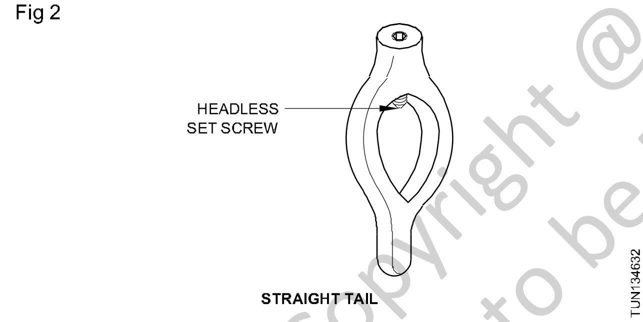


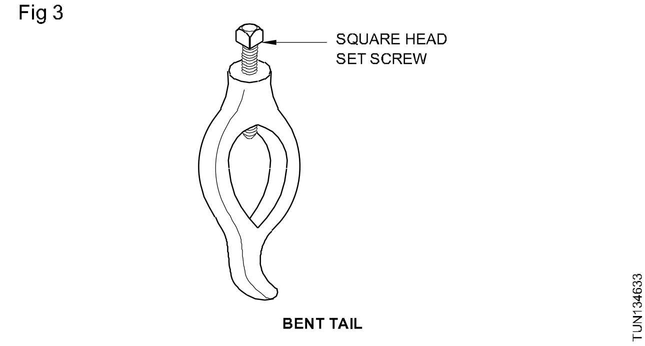
Fig 2



A bent tailed lathe carrier engages into a ‘u’ slot of the catch plate and drives the workpiece. (Fig 3).

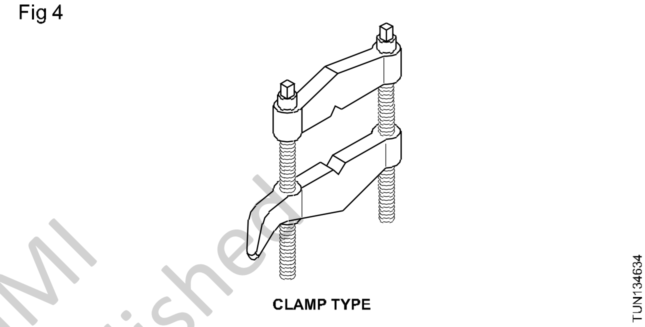
The clamp type lathe carrier is designed with a clamping plate and adjustable screws. It holds a wide range of diameters of work because it is provided with a ‘V’ groove

Fig 3



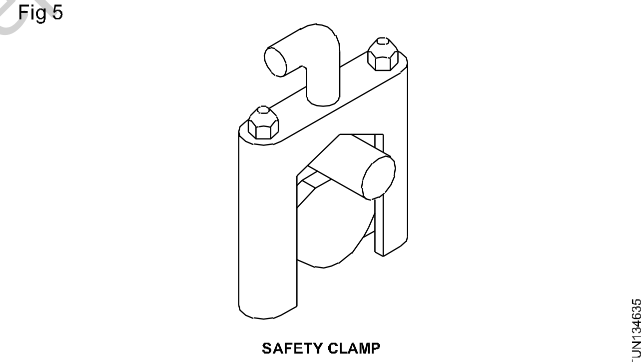
and adjustable bolts and nuts. This carrier may be used to hold square and rectangular sectioned rods also. They are also useful to hold small diameter jobs because of the provision of the ‘V’ groove. (Fig 4)

Fig 4



Safety clamp lathe carriers are desinged with safety - top and bottom clamping plates. These plates provide a positive grip of the work during turning. (Fig 5)

Fig 5



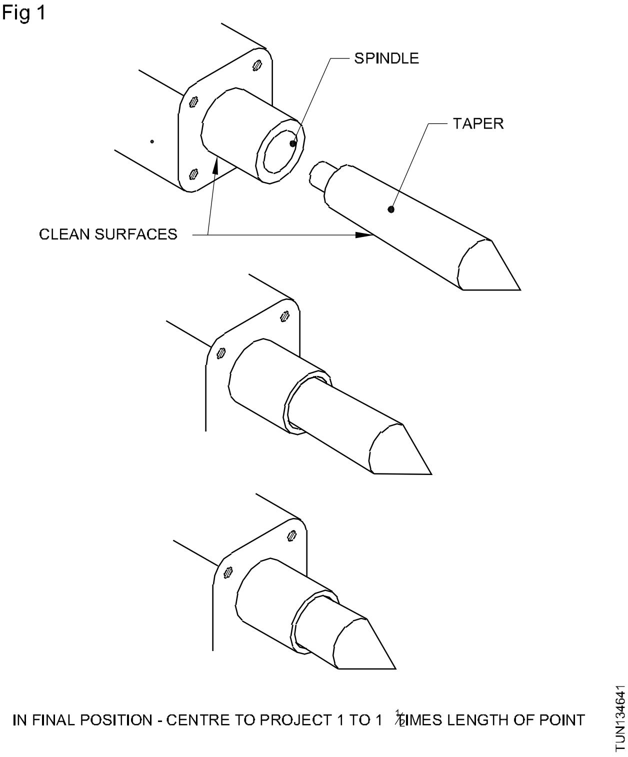
Lathe carriers

Objectives : At the end of this lesson you shall be able to
- **state what is a lathe centre**
- **distinguish between a live centre and a dead centre**
- **state the purpose of lathe centres**
- **identify and name the different types of centres**
- **indicate the specific uses of each type of centre.**

Lathe centre

It is a lathe accessory. It is used to support a lengthy work to carry out lathe operations. When a work is held in a chuck, the centre is assembled to the tailstock, and it supports the overhanging end of the work. The work is to be provided with a centre drilled hole on the face of the overhanging end. When the job is held in between centres to carry out the operation, it functions together with a driving plate and a suitable lathe carrier.

Fig 1



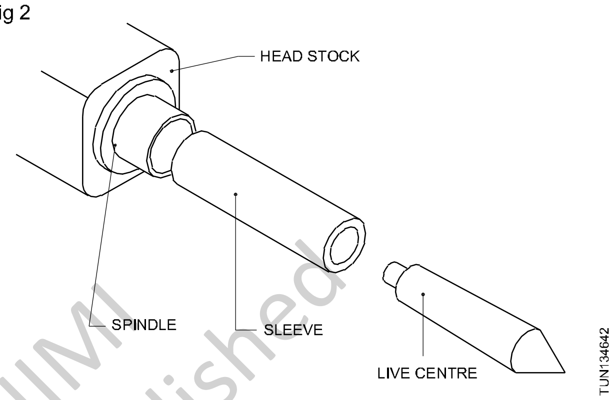
The centre, which is accommodated in the main spindle sleeve, is known as a 'live centre' and the centre fixed in the tailstock spindle is known as a dead centre. In construction, both centres are identical, made as one unit that consists of a conical point of 60° included angle, a body provided with a Morse taper shank and a tang.

The dead centre is made out of high carbon steel, hardened and around whereas the live centre need not have its conical tip hardened as it revolves with the work. A good lubricant should be used for the dead centre.

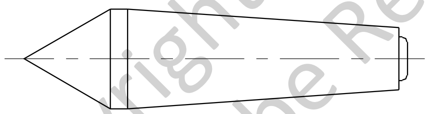
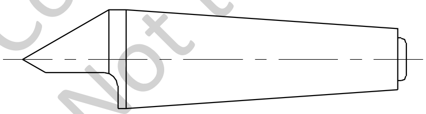
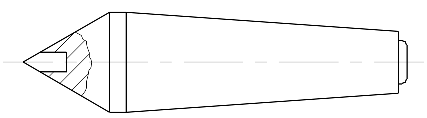
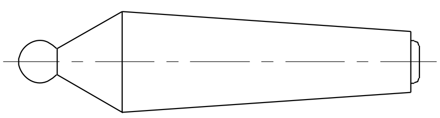
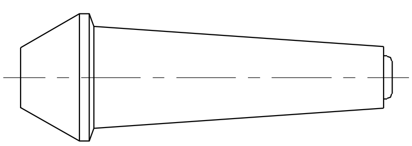
Types of centres and their uses

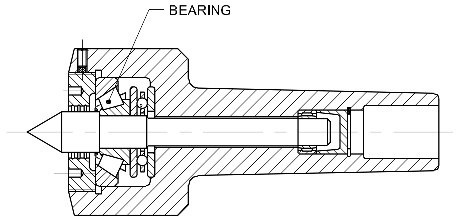
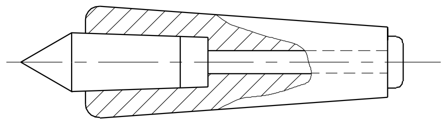
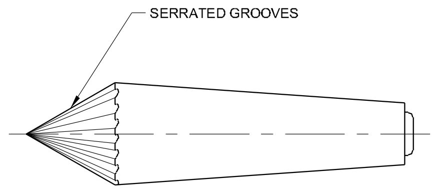
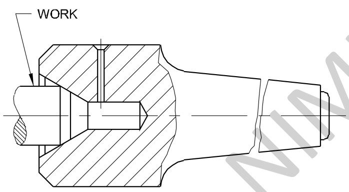
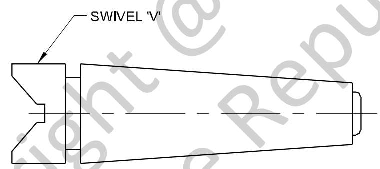
The following table gives the names of the most widely used types of lathe centres, their illustrations and their specific uses. (Fig 2)

Fig 2



Various Types of Lathe Centres

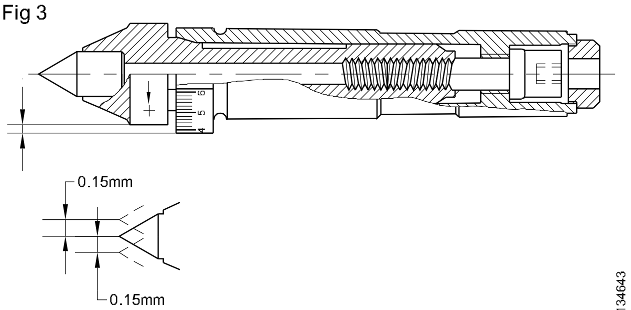
1	Ordinary centre-common type		Used for general purpose.
2	Half centre		Though it is termed as half centre, little less than half is relieved at the tip portion. eved at the tip portion. Used while facing the job without disturbing the setting.
3	Tipped centre		A carbide or a hard alloy tip is brazed into an ordinary steel shank. The hard tip is wear- resistant.
4	Ball centre		Minimum wear and strain. Particularly suitable for taper turning.
5	Pipe centre		Used for supporting pipes, shells and hollow end jobs.

6	Revolving centre		Frictionless. Used for supporting heavy jobs and jobs revolving with high speeds. A high-speed steel inserted centre is supported by two bearings housed in a body. It is also called the revolving dead centre.
7	Insert-type centre		Economical. Only the small high-speed steel insert is replaced.
8	Self-driving live centre		Usually mounted on the head-stock spindle. Used while machining the entire length of the job in one setting. Grooves cut around the circumference of the centre point provide for good gripping of the job and for getting the drive. This centre can be used for only soft jobs and not for hardened jobs.
9	Female centre		This centre is used to support the end of the job where no countersink hole is permitted.
10	Swivel 'V' centre		This centre is used to support a job in the `V' portion and to drill holes across the round job by using a drill bit in the head-stock spindle.

A micro-set adjustable centre fitted into the tailstock spindle provides a fast and accurate method of aligning lathe centres.(Fig 3)

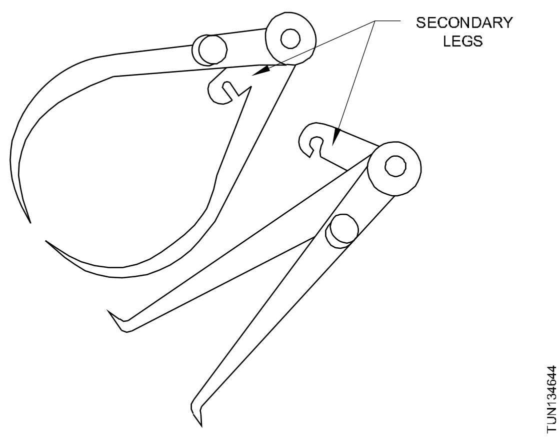
Some of these centres contain an eccentric, others contain a dovetail slide which permits slight adjustment of the centre itself to correct alignment.

Fig 3



MICRO-SET ADJUSTABLE

Fig 4



Transfer Caliper

Objectives : At the end of this lesson you shall be able to
- **Identify the parts of an transfer caliper**
- **State the function of the transfer caliper**
- **Read transfer caliper mesurment.**

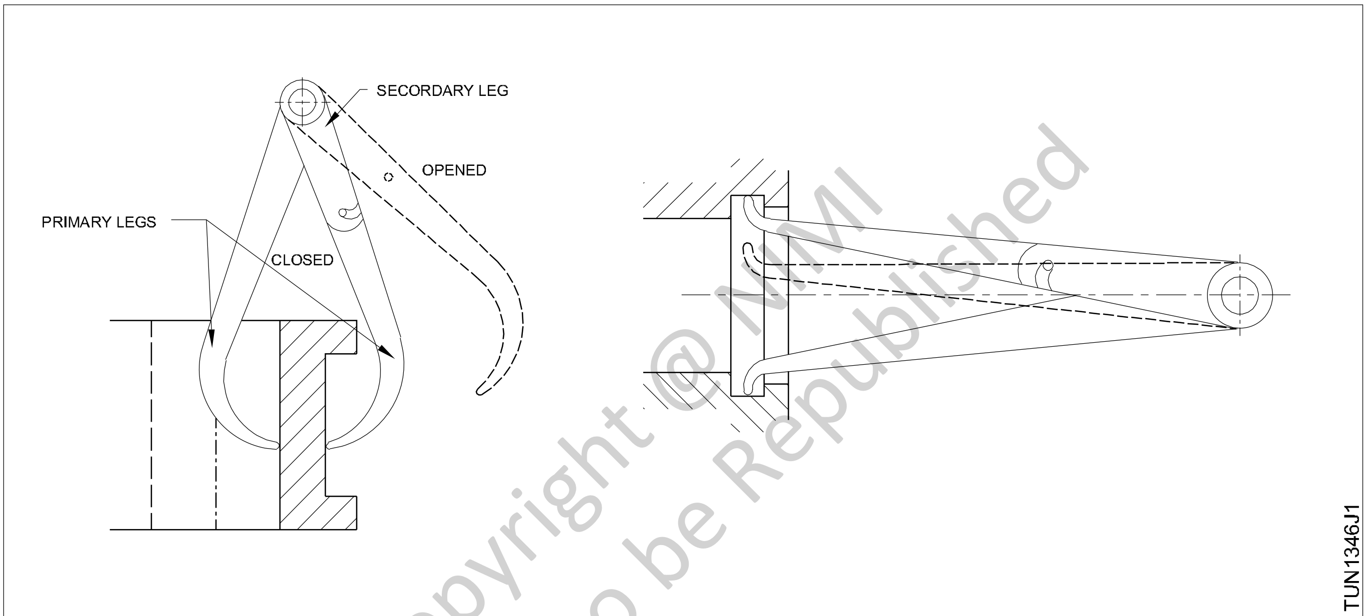
Transfer Caliper

This type of caliper (outside or inside) used where caliper cannot be access directly due steps, projections, grooves etc.

The construction is similar to ordinary (Pivoted or with Thumb nut) firm joint caliper with additional secondary leg at the top of one of the primary legs with or without lock met facility.

In this type the primary legs are made to touch the surface to be measured and then the secondary leg brought to position till the pin in primary leg coincides through the slot. New the position of secondary leg unchanged and primary leg with stopper pin in relieved of from measured surface.

Once caliper taken out, the primary leg which was relieved in to the position to secondary leg position. Then the dimension measure with the help of measuring instrument.



Adjustment of tool posts

Objectives : At the end of this lesson you shall be able to
- **identify and name the different types of tool posts**
- **state the constructional features of each types of tool post**
- **indicate the application of each type or tool post.**

Tool post

The tool post holds the tool or tools meant for the operation to be performed on the work.

The tool post is assembled to the top slide.

The three types of tool posts most commonly found lathes are listed here.

American type tool post or single way tool post

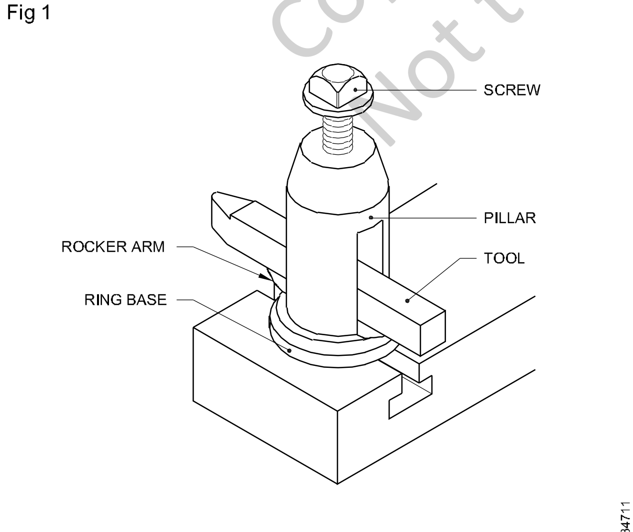
Indexing type of tool post or square tool post.

Quick change tool post.

Single way tool post (Fig 1)

It consists of a circular tool post body with a slot, for accommodating the tool or tool-holder. A ring base, a rocker arm, and a tool clamping screw complete the assembly of this type of tool post. The tool is positioned on the rocker arm and clamped. The centre height of the tool tip can be adjusted with the help of the rocker arm and the ring base. Only one tool can be fixed in this type of tool post. The rigidity of the tool is less as it is clamped with only one bolt.

Fig 1

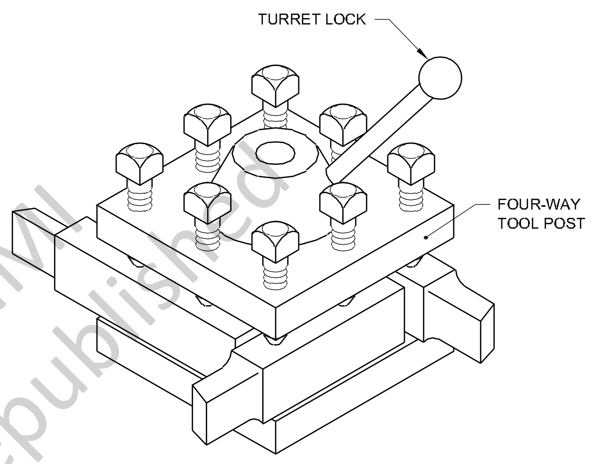


AMERICAN PILLAR TYPE TOOL POST

Indexing type tool post (Fig 2)

It is also called a square tool post or a four-way tool post. Four tools can be fixed in this type of tool posts and any one can be brought to the operating position and the square head is clamped with the help of the locking lever. By loosening the locking lever the next tool can be indexed and brought to the operating position. The indexing may be manual or automatic.

Fig 2



INDEXING TYPE TOOL POST

The advantages are

each tool is secured in the tool post by more than one bolt and so rigidity is more.

frequent changing of the tool for different operations need not be done as four tools can be clamped simultaneously.

The disadvantage is that skill is required to set the tools and it takes more time to set to the centre height.

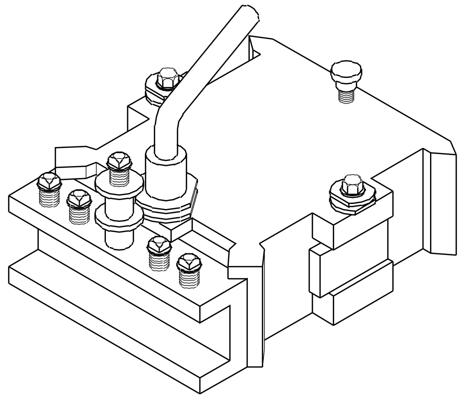
Quick change tool post/universal tool post (Fig 3)

Modern lathes are provided with this type of tool posts. Instead of changing the tools, the tool holder is changed in which the tool is fixed. This is expensive and requires a number of tool holders. But it has the advantage of ease with which it can be set to the centre height and has the best rigidity for the tool.

British type tool post (Fig 4)

This type of tool post is found mostly on British lathes. This also has provision for only one tool to be clamped for performing the operation. This is more rigid when compared to the pillar-type tool post, as the tool is held in position by

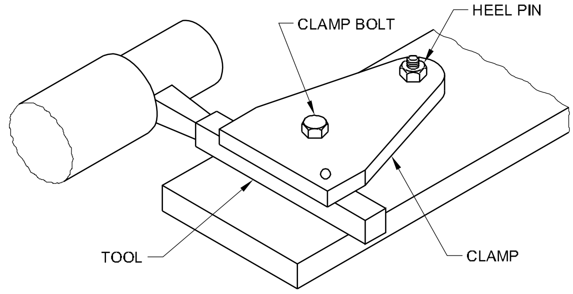
Fig 3



QUICK CHANGE TOOL POST

TUN134713

Fig 4



BRITISH (CLAMP) TYPE TOOL POST

TUN134714

the flat clamp. This requires greater skill in clamping as the adjustment of the heel pin is needed to give a grip on the full width of the tool.

Packing strips may be needed to be placed for adjusting the tool centre height.

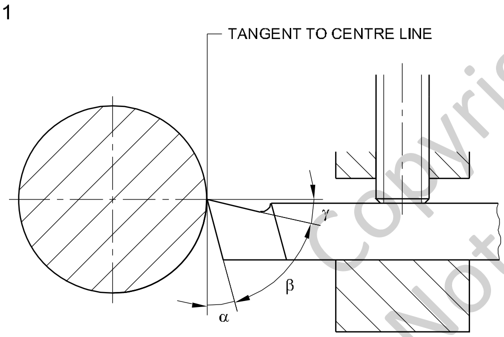
Tool setting

Objective : This shall help you to

- **set the tool in the tool post for performing the operation.**

For optimum cutting, the effective rake angle and clearance angle of the clamped tool must be equal to the ground angles of the tool. This requires clamping of the tool to have its axis perpendicular to the lathe axis, with the tool tip at the workpiece centre. (Fig 1)

Fig 1



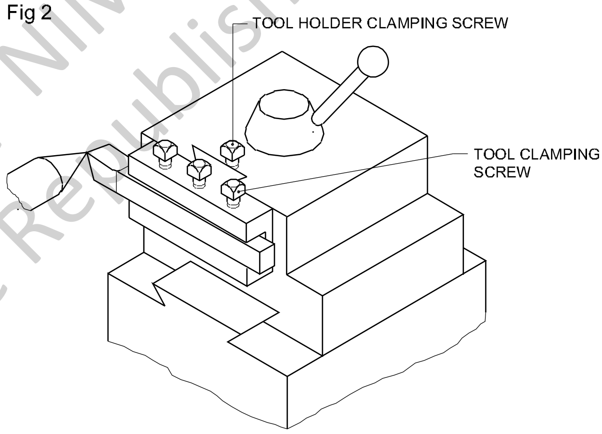
TUN134721

It is difficult to determine the effective angles of the tool when it is not set to the centre height.

The tool nose can be set to the work centre by means of a tool-holder with adjustable height. (Fig 1)

The tool nose can be set to the exact centre height by placing the tool in the tool post on the shims or packing strips. These packing strips should be preferably a little less in width than the width of the tool but should never be more. The length of these strips should be according to the shank length and the tool seating face of the tool post. (Fig 2)

Fig 2



TUN134722

The procedure to follow is given below.

Clean the tool post seating face, and place the shims on the seating face.

Use a minimum number of shims for height adjustment.

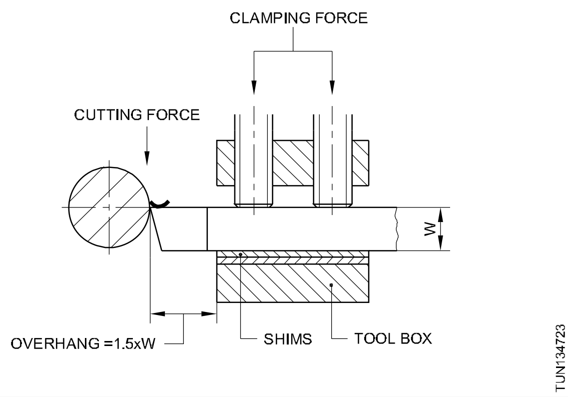
Shims must be flushed with the edge of the seating face.

Place the tool in the tool post on the shims, with the rear butting against the wall of the seating face. (Fig 3)

The unsupported length of the overhanging end of the turning tool should be kept to a minimum. As a rule, the overhanging length of tool is equal to the tool shank width x 1.5.

Tighten the tool with the centre screw of the tool post.

Fig 3

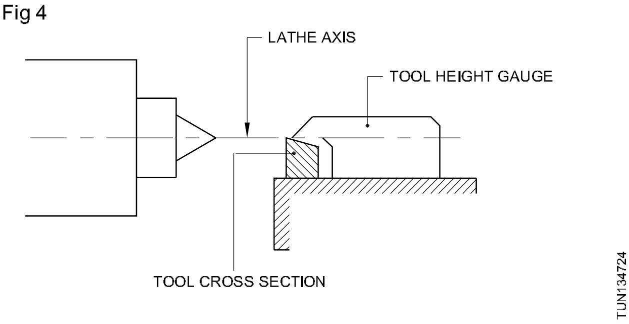


Check the centre height with a height setting gauge. (Fig 4)

Remove or add shims and check the height when the tool is tightened by the centre screw.

Tighten the other two tool-holding screws alternately applying the same amount of pressure.

Fig 4



When both the screws have a full gripping pressure, tighten the centre screw fully.

Check once again with a tool height setting gauge.

The gauge should be made according to the size of the machine. If a gauge is not available, use a surface gauge and set the pointer tip to the dead centre height fixed in the tailstock. Use this as the height to which the tool is to be set.

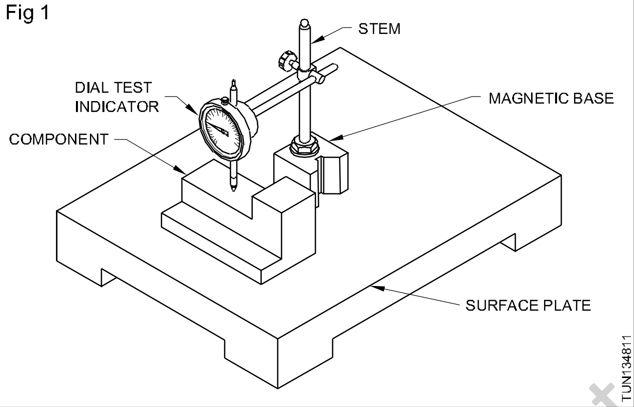
Dial test indicator

Objectives : At the end of this lesson you shall be able to
- **state the working principle of a dial test indicator**
- **identify the parts of a dial test indicator**
- **state the important features of a dial test indicator**
- **state the functions of a dial test indicator**
- **identify different types of stands.**

What are dial test indicators

Dial test indicators are fine precision type of instruments used for comparing and determining the variation in the sizes of components. (Fig 1)

Fig 1



These instruments cannot give the direct reading of the sizes like micrometers and vernier calipers. 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.

Principle of working

The principle of a dial test indicator is the magnification of a small movement of the plunger by converting it into rotary motion of a pointer on a circular scale. (Fig 2)

For converting linear motion of the plunger into rotary motion of the pointer, a rack and pinion mechanism is used.

Types

Two types of dial test indicators are in use according to the method of magnification.

- Plunger type (Fig 3)
- Lever type (Fig 4)

Important features of a dial test indicator

An important feature of the dial test indicator is that the scale can be rotated by a ring bezel, enabling it to be readily set to zero.

Fig 2

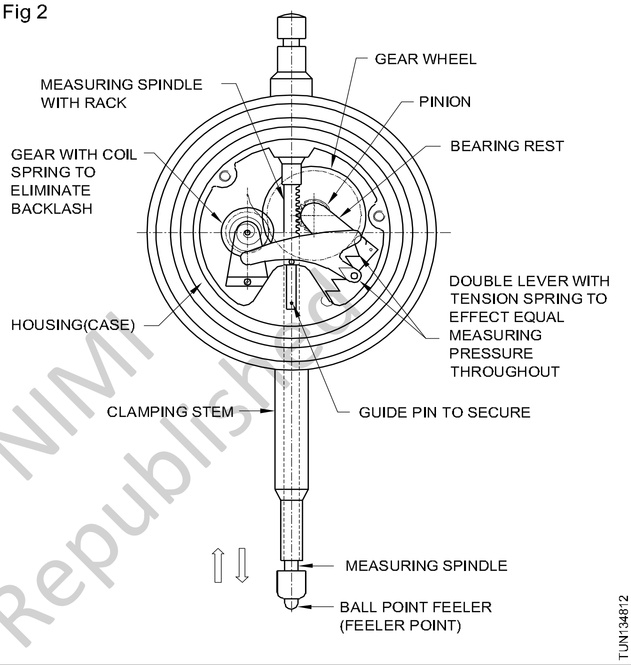
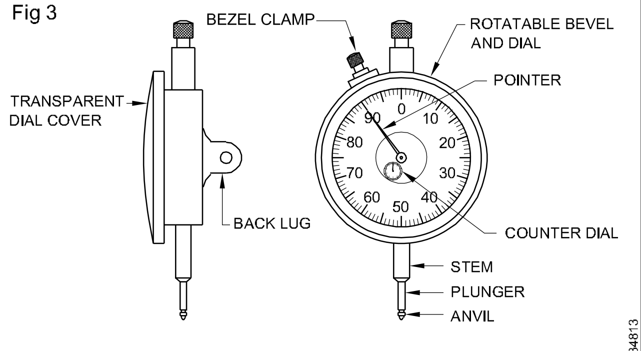
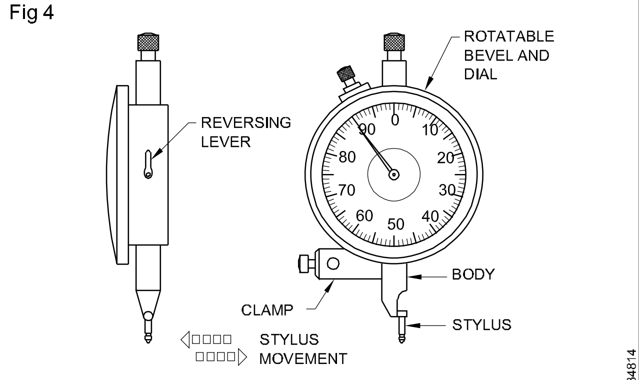


Fig 3



PLUNGER TYPE

Fig 4



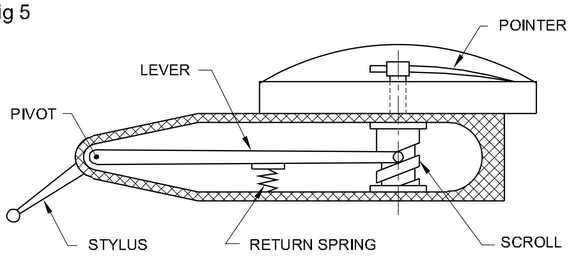
LEVER TYPE

Many dial test indicators read plus in a clockwise direction from zero and minus in a counter clockwise direction to give plus and minus indications.

The lever type dial test indicator

In the case of this type of dial test indicators the magnification of the movement is obtained by a mechanism of lever and scroll. (Fig 5)

Fig 5

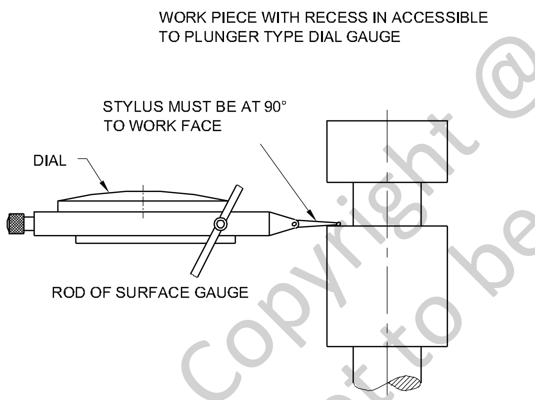


MECHANISM OF THE LEVER TYPE DIAL GAUGE

It has a stylus with a ball type contact operating in the horizontal plane.

This can be conveniently mounted on a surface gauge stand and can be used in places where the plunger type dial test indicator application is difficult. (Fig 6)

Fig 6



Uses (Figs 7 to 11)

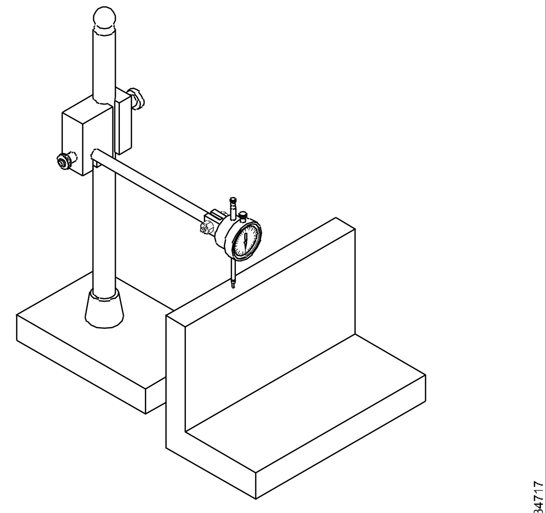
- To compare the dimensions of a workpiece against a known standard.
- To check plane surfaces for parallelism and flatness.
- To check parallelism of shafts and bars.
- To check concentricity of holes and shafts.

Stands

Dial test indicators are used in conjunction with stands for holding them so that the stand itself may be placed on the datum surface or machine tools.

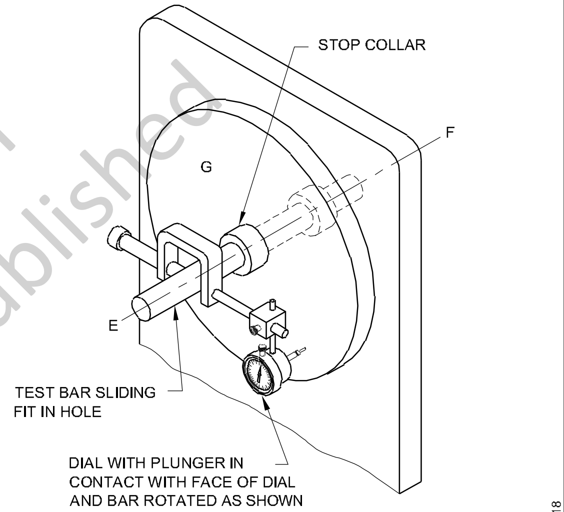
The following are the three types of stands available.

Fig 7



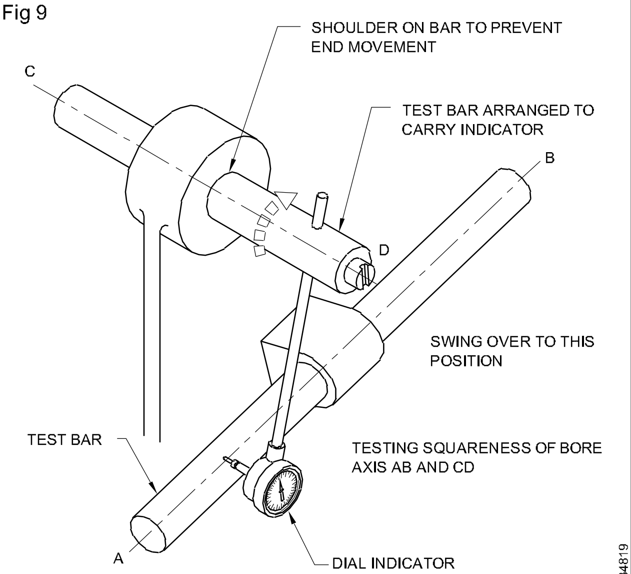
CHECKING FOR PARALLELISM

Fig 8



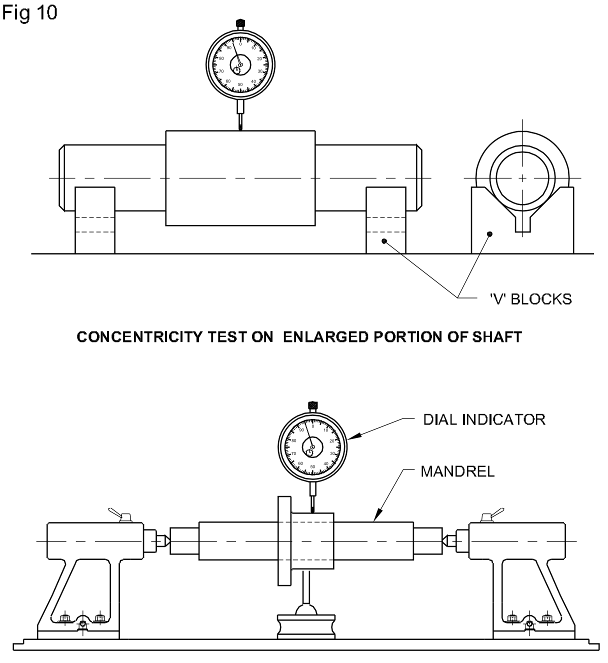
TESTING SQUARENESS OF FACE G
WITH AXIS EF OF CENTRE HOLE

Fig 9



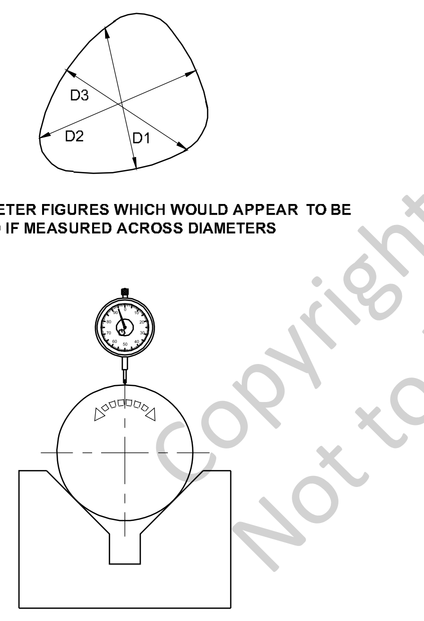
TEST SQUARENESS OF BORE AXIS USING TEST BAR

Fig 10



TESTING BUSH FOR CONCENTRICITY

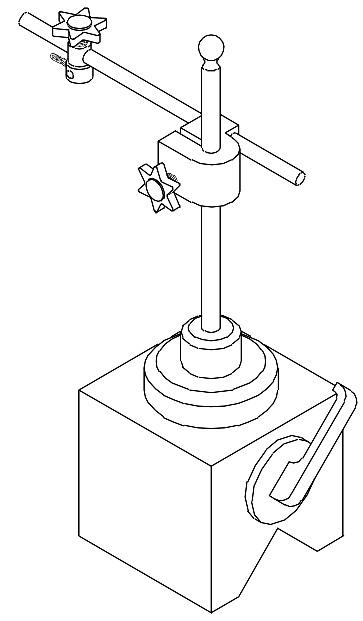
Fig 11



TEST FOR ROUNDNESS WITH VEE BLOCKS AND CLOCK INDICATOR

Magnetic stand with universal clamp. (Fig 12)

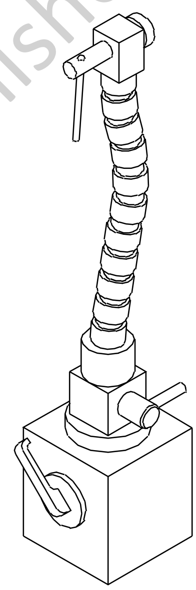
Fig 12



MAGNETIC STAND UNIVERSAL CLAMP

Magnetic stand with flexible post. (Fig 13)

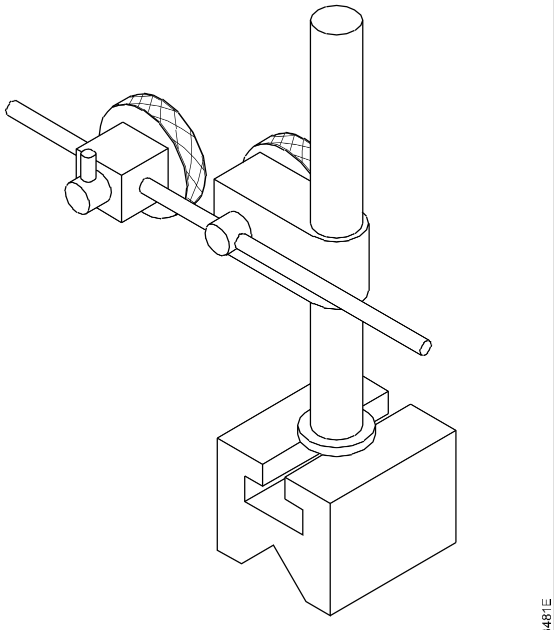
Fig 13



MAGNETIC STAND WITH FLEXIBLE POST

General purpose holder with cast iron base (Fig 14)

Fig 14



GENERAL PURPOSE HOLDER WITH CAST IRON BASE

Care for dial Indicator

1 Make sure clean greases and oils on the dial face
2 Use soft and clean cloth to clean the dial face to prevent from scratching.
3 Use thin film of oil to prevent rust
4 Be sure to store dial indicator properly to protect from dirt, moisture and damage.