SPINNING TECHNICIAN

NSQF LEVEL - 4

1st Year

TRADE THEORY

SECTOR: TEXTILE AND HANDLOOM

(As per revised syllabus 2022 - 1200 Hrs)

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : **Textile & Handloom**

Duration : **2 Years**

Trade : **Spinning technician - 1st Year - Trade Theory - (NSQF Level - 4) (Revised 2022)**

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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 2022 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 comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Spinning Technician - 1st Year - Trade Theory - NSQF Level - 4 (Revised 2022) in Textile and Handloom Sector** under **Yearly pattern**. The NSQF Level - 4 (Revised 2022) 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 - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

ATUL KUMAR TIWARI, I.A.S.,
Secretary,
Ministry of Skill Development & Entrepreneurship,
Government of India.

June 2025,
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 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 NCVET/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.

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 **Spinning Technician - 1st Year - NSQF Level - 4 (Revised 2022)** under **Textile & Handloom** Sector for ITIs.

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

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

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

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Spinning Technician** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022) syllabus are covered.

This manual is divided into twelve modules.

Module 1 **Basic Fitting**

Module 2 **Turning**

Module 3 **Sheet Metal and Welder**

Module 4 **Welding**

Module 5 **Carpenter**

Module 6 **Electrical**

Module 7 **Electronics**

Module 8 **Orientation to Textile**

Module 9 **Ginning**

Module 10 **Blow Room**

Module 11 **Auxiliary Blow Room Machines**

Module 12 **Carding department**

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances 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 trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Spinning Technician - 1st Year NSQF level- 4 (Revised 2022)** in **Textile & Handloom sector**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation 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 indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise at least 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 for the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING OUTCOME

On completion of this book you shall be able to

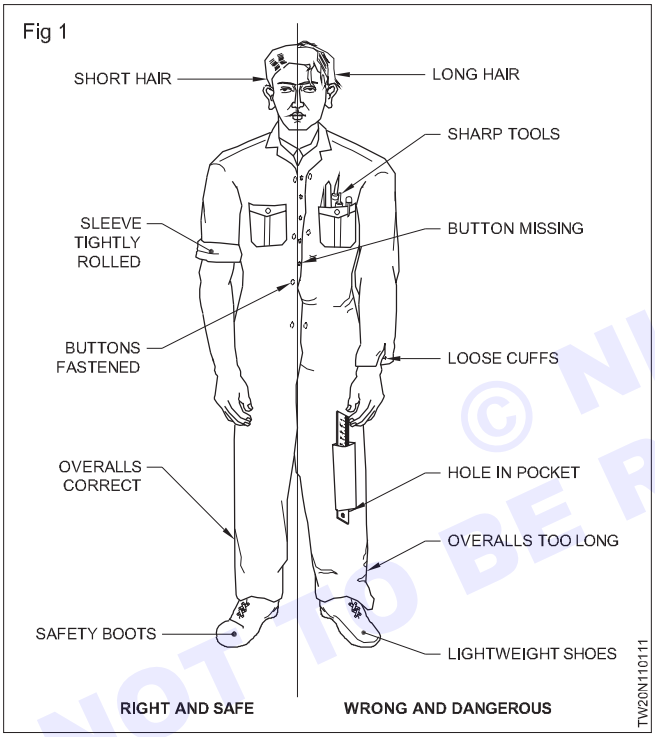
S.No.	Learning Outcome	Ref. Ex.No.
1	Plan and organize the work to make job as per specification applying different types of basic fitting operations and Check for dimensional accuracy following safety precautions. [Basic fitting operations - marking, Hack-sawing, punching, Chiselling, Filing, Drilling, Grinding and job setting] (Mapped NOS: TSC/N0402, TSC/N0407, TSC/N0412)	1.1.01 - 1.1.15
2	Plan and organize the work to make job on facing, chamfering, plain Turning, taper turning and simple thread. (Mapped NOS: TSC/N0402, TSC/N0407, TSC/N0412)	1.2.16 - 1.2.23
3	Plan and identify different types of skill related to sheet metal work and on various types of welding practices like square butt joint, single V butt joint, arc welding and gas welding. (Mapped NOS: TSC/N0402, TSC/N0407, TSC/N0412)	1.3.24 - 1.4.32
4	Apply a range of skill to execute different carpentry work. (Mapped NOS: TSC/N0402, TSC/N0407, TSC/N0412)	1.5.33 - 1.5.39
5	Plan, identify and test on electrical/ electronic measuring instruments (Mapped NOS: TSC/N0402, TSC/N0407, TSC/N0412)	1.6.40 - 1.7.55
6	Identify the fibre type i.e natural/synthetic/ regenerated fiber by chemical method, burning method and using microscope. (TSC/N9403))	1.8.56 - 1.8.61
7	Maintain the ginning machine, adjust the speed of opening roller and set the important settings in ginning machine (Mapped NOS: TSC/N0409)	1.9.62 - 1.9.66
8	Maintain the blow room machineries, setting of various parts of the opening roller, cleaning roller and check the speed of the machines in blow room line (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.10.67 - 1.10.79
9	Identify the auxiliary blow room machines (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.11.80 - 1.11.88
10	Identify the motors in blow room line and various switches in blow room panel board (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.11.89 - 1.11.93
11	Identify defects in blow room laps, causes and remedial measures. (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.11.94 - 1.11.97
12	Identify various parts of carding machine and identify their functions. (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.12.98 - 1.12.101
13	Maintain the carding machine and setting of various parts of the carding machine. (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.12.102 - 1.12.110
14	Identify and selection of the card clothing based on the type of fiber processed. (Mapped NOS: TSC/N0402, TSC/N0403, TSC/N0404)	1.12.111 - 1.12.118

Trade instruction, safety, types of safety, hand tools, safety, personal safety

Objectives: 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 industry/shop floor**
- **list out the personal safety precautions to be observed in machine shop**
- **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 any damage. To achieve this, it is essential that every person should follow safety procedure. (Fig 1)

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 crack practical jokes while on work.

Use the appropriate tools for the job.

Keep the tools at their proper place.

Wipe out split oil immediately.

Replace worn out or damaged tools immediately.

Never direct compressed air at yourself or at your co-worker.

Ensure adequate light in the workshop.

Clean the machine only when it is not in motion.

Sweep away the metal cuttings.

Know everything about the machine before you start it.

Personal safety

Wear a one piece overall or boiler suit.

Keep the overall buttons fastened.

Don't use ties and scarves.

Roll up the sleeves tightly above the elbow.

Wear safety shoes or boots

Cut the hair short.

Don't wear a ring, watch or chain.

Never lean on the machine.

Don't clean hands in the coolant fluid.

Don't remove guards when the machine is in motion.

Don't use cracked or chipped tools.

Don't start the machine until

– The workpiece is securely mounted
– The feed of machinery is in the neutral
– The work area is clear & neat.

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 methodological 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.

Machine safety

Switch off the machine immediately, if something goes wrong.

Keep the machine clean.

Replace any worn out or damaged accessories, holding devices, nuts, bolts etc as soon as possible.

Do not attempt operating the machine until you know how to operate it properly.

Do not adjust tool or the workpiece unless the power is off.

Stop the machine before changing the speed.

Disengage the automatic feeds before switching off.

Check the oil level before starting the machine.

Never start a machine unless all the safety guards are in position.

Take measurements only after stopping the machine.

Use wooden planks over the bed while loading and unloading heavy jobs.

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

Workshop safety

Objectives: At the end of this lesson you shall be able to
- **state what is hot working**
- **brief confined space work**
- **use of material handling equipment.**

Hot work: Hot work is defined as forging, gas cutting, welding, soldering and brazing operations for construction, maintenance/repair activities.

Hot work has fire and explosive hazards. Workers performing hot work such as welding, gas cutting, brazing, soldering are exposed to the risk of fires from ignition or flammable or combustible materials in the space, and from leaks of flammable gas into the space, from hot work equipment.

A confined space also has limited or restricted means for entry or exist and is not designed for continuous occupancy. It includes but are not limited to tanks, vessels, silos, storage bins, hoppers, vaults, pits, manholes, tunnels, equipment housings, duct work, pipelines, etc.

Materials handling equipment: Materials handling equipment is a mechanical equipment used for the movement, storage, control and protection / protecting of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal.

Different types of material handling equipment

- Tools
- Vehicles
- Storage units
- Appliance and accessories

Racks

Pallet racks, drive-through or drive-in racks, push back racks, and sliding racks.

Truck/Trolley

Conveyor system

- Fork lift
- Cranes
- Pallet truck

Lifting and handling loads

Objectives : At the end of this lesson you shall be able to
- **state the types of injury caused by the improper method of lifting and carrying loads and how to prevent them**
- **state the 6 points in the process of manual lifting methods.**

Many of the accidents reported involve injuries caused by lifting and carrying loads. Wrong lifting techniques can result in injury.

A load need not necessarily be very heavy to cause injury The wrong way of lifting may cause injury to the muscles and joints even though the load is not heavy.

Further injuries during lifting and carrying may be caused by tripping over and object and falling or striking an object with a load.

Type of injury and how to prevent them?

Cuts and abrasions: Cuts and abrasions are caused by rough surfaces and jagged edges

By splinters and sharp or pointed projections. (Fig 1)

Leather hand gloves will usually be sufficient for protection, but the load should be checked to make sure of this, since large or heavy loads may involve body contact as well.

Crushing of feet or hands

Feet or hands should be so positioned that they will not be trapped by the load. Timber wedges can be used when raising and lowering heavy loads to ensure fingers and hands are not caught and crushed.

Safety shoes with steel toe caps will protect feet (Fig 2)

Fig 1

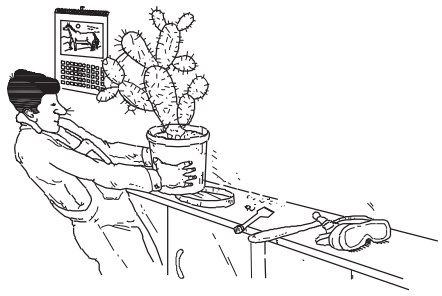


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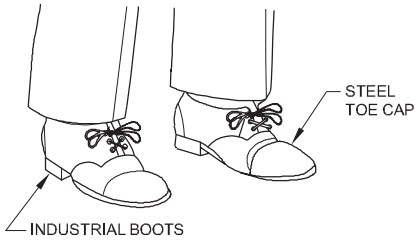
Fig 2



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Strain to muscles and joints

Strain to muscles and joints may be result of:

- Lifting a load which is too heavy, or of lifting incorrectly.

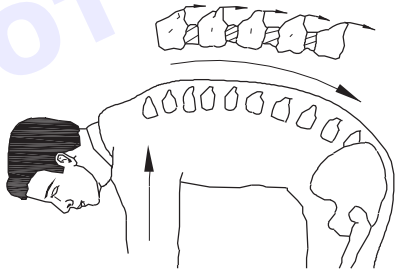
Sudden and awkward movements such as twisting or jerking during a lift can put severe strain on muscles.

Stop lifting'-lifting from a standing position with the back rounded increases the chance of back injury.

The human spine is not an efficient weight lifting machine and can be easily damaged if incorrect techniques are used.

The stress on a rounded back can be about six times greater than if the spine is kept straight. Fig 3 shows and example of stoop lifting.

Fig 3



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Preparing to lift

Before lifting or handling any load ask yourself the following questions.

What has to be moved?

Where from and where to?

Will assistance be required?

Is the route through which the load has to be moved is clear of obstacles?

Is the place where the load has to be kept after moving is clear of obstacles?

Load which seems light enough to carry at first will become progressively heavier, the farther you have to carry it.

The person who carries the load should always be able to see over or around it.

The weight that a person can lift will vary according to:

- Age
- Physique, and
- Condition

It will also depend on whether one is used to lifting and handling heavy loads.

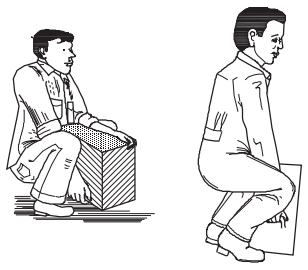
What makes an object difficult to lift and carry?

- Weight is not the only factor which makes it difficult to lift and carry.
- The size and shape can make an object awkward to handle.
- Loads high require the arms to be extended in front of the body, place more strain on the back and stomach.
- The absence of hand holds or natural handling points can make it difficult to raise and carry the object.

Correct manual lifting techniques

- Approach the load squarely, facing the direction of travel
- The lift should start with the lifter in a balanced squatting position, with the legs slightly apart and the load to be lifted held close to the body.
- Ensure that a safe firm hand grip is obtained. Before the weight is taken, the back should be straightened and held as near the vertical position as possible. (Fig 4)

Fig 4



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- To raise the load, first straighten the legs. This ensures that the lifting strain is being correctly transmitted and is being taken by the powerful thigh muscles and bones.
- Look directly ahead, not down at the load while straightening up, and keep the back straight, this will ensure a smooth, natural movement without jerking or straining (Fig 5)
- To complete the lift, raise the upper part of the body to the vertical position. When a load is near to an individual's maximum lifting capacity it will be necessary to lean back on the hips slightly (to counter balance the load) before straightening up.(Fig 6)

Keeping the load well near to the body, carry it to the place where it is to be set down. When turning, avoid twisting from the waist- turn the whole body in one movement.

Fig 5

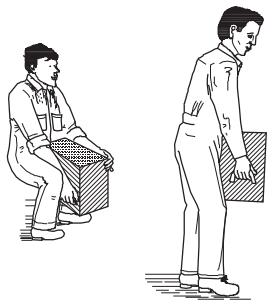

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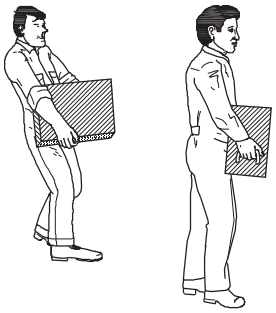
Fig 6



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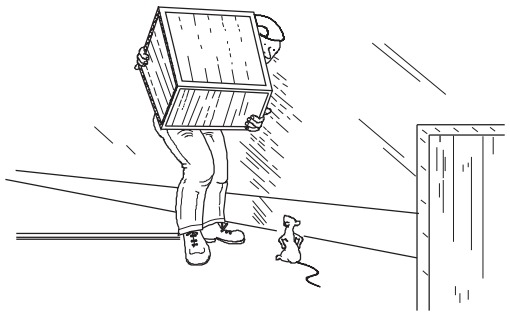
Lowering the load

Make sure the area is clear of any obstructions. (Fig 7)

Fig 7



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Bend the knees to a semi- squatting position, keep the back and head erect by looking straight ahead, not down at the load. It may be helpful to rest the elbows on the thighs during the final stage of lowering.

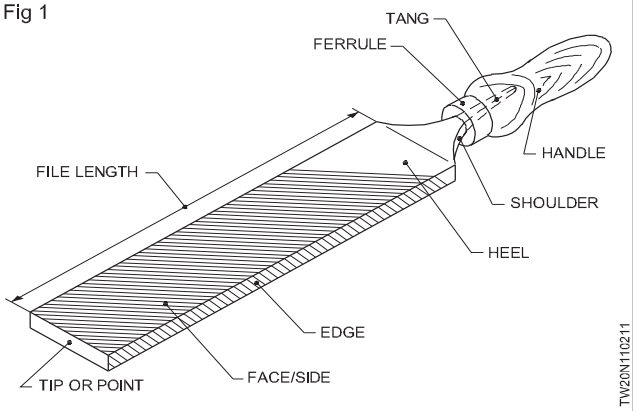
Hand tool, types of hand tools used, vices specification, uses, care and maintenance

Objectives: At the end of this lesson you shall be able to
- **follow the prevention and safety rules.**

Hand tools

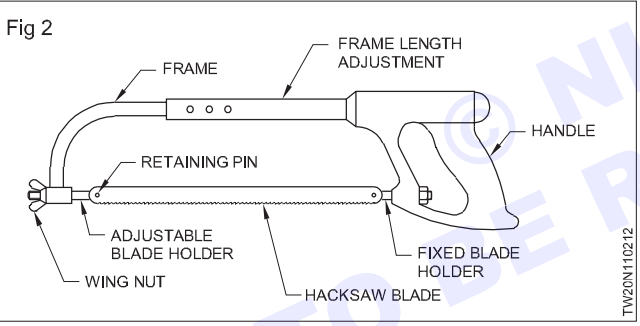
File (Fig 1)

Fig 1



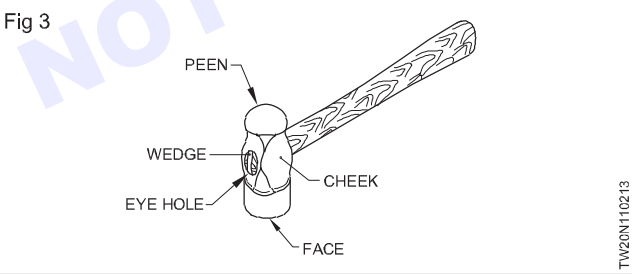
Parts of Hacksaw (Fig 2)

Fig 2



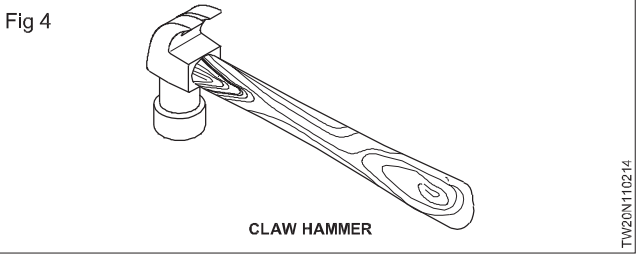
Ball peen hammer (Fig 3)

Fig 3



Claw hammer (Fig 4)

Fig 4



Claw hammer face is used to drive the nails into the wood and other shirking purpose and the claw is used for extracting the nails out of the wood.

Chisels

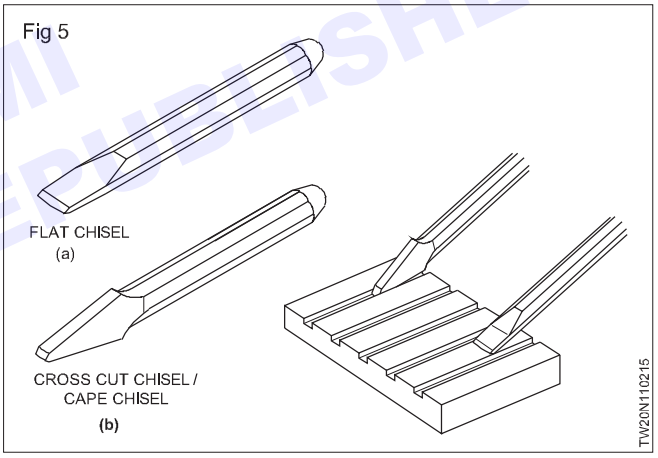
Common types of chisels: There are five common types of chisels.

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

Flat chisels (Fig 5a): They are used to remove metal from large flat surfaces and chip-off excess metal of welded joints and castings.

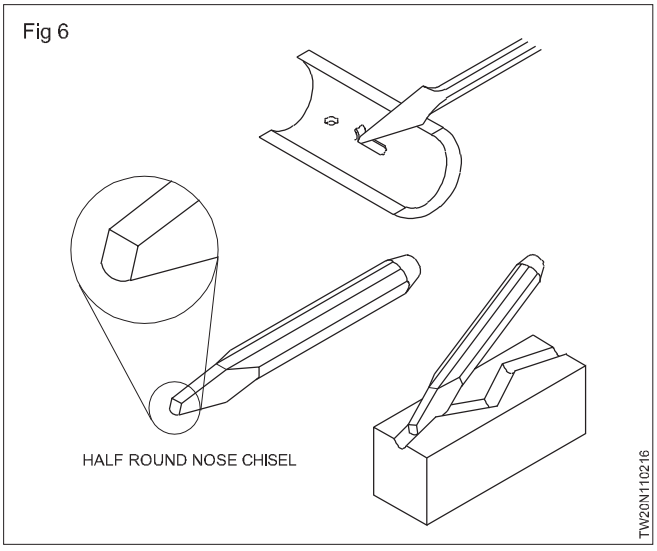
Cross-cut or cape chisels (Fig 5b): These are used for cutting key ways, grooves and slots.

Fig 5



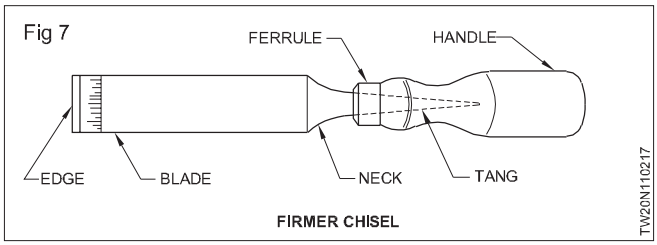
Half-round nose chisels (Fig 6): They are used for cutting curved grooves (oil grooves).

Fig 6



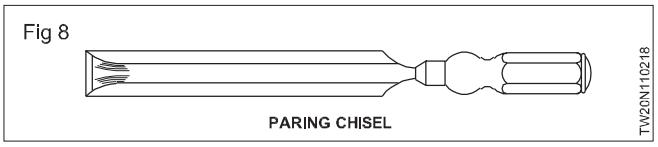
Bench firmer chisel (Fig 7)

This chisel is used for general chiselling purpose.



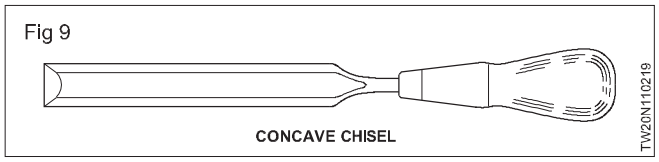
Paring chisel (Fig 8)

It is most suitable for all paring work such as finishing off joints.



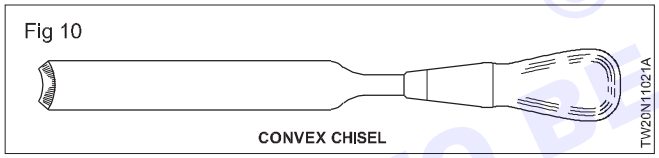
Gouge chisel (Concave) (Fig 9)

This chisel is used for cut curves and hollows works.

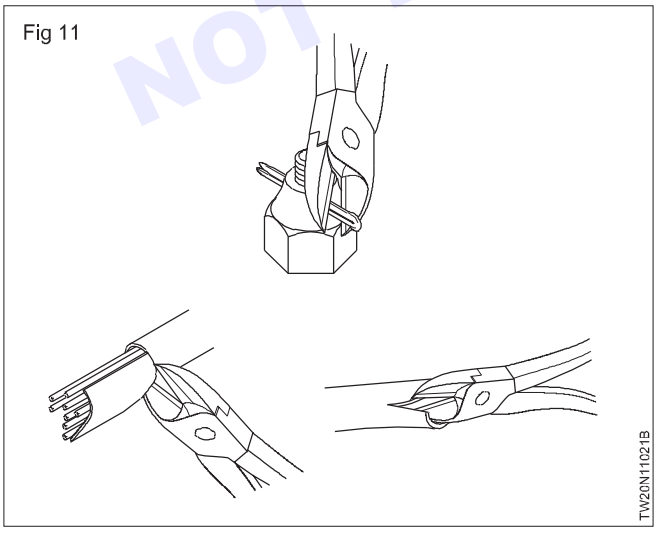


Gouge chisel (Convex) (Fig 10)

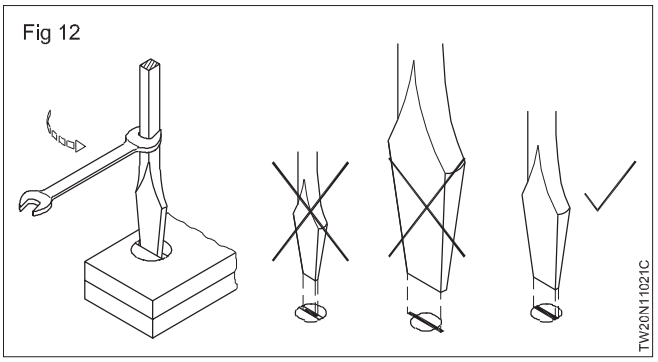
This chisel is used for roughing out and heavy wood removal work.



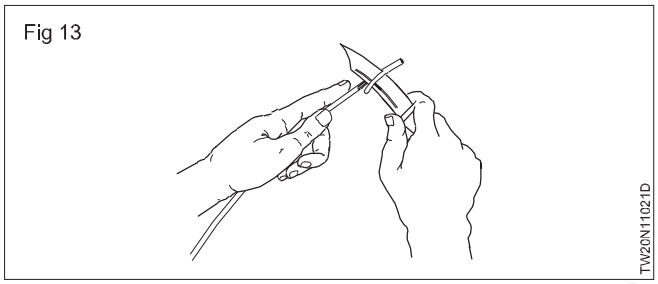
Pliers - diagonal cutting (Fig 11)



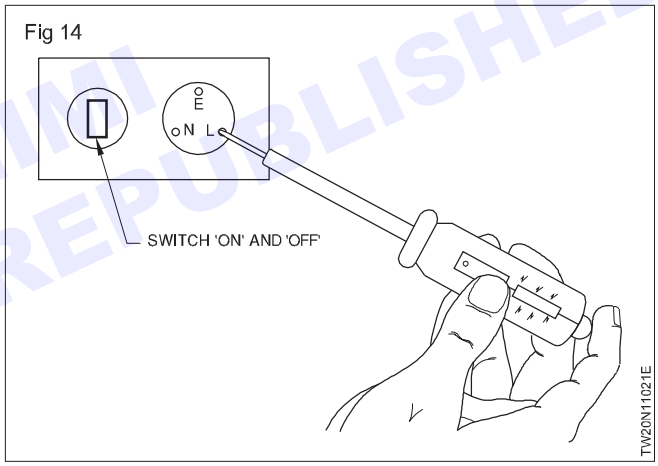
Screwdriver (Fig 12)



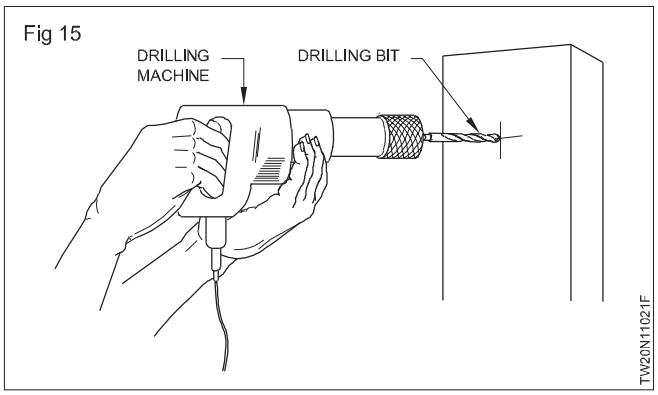
Electrician's knife (Fig 13)



Neon tester (Fig 14)

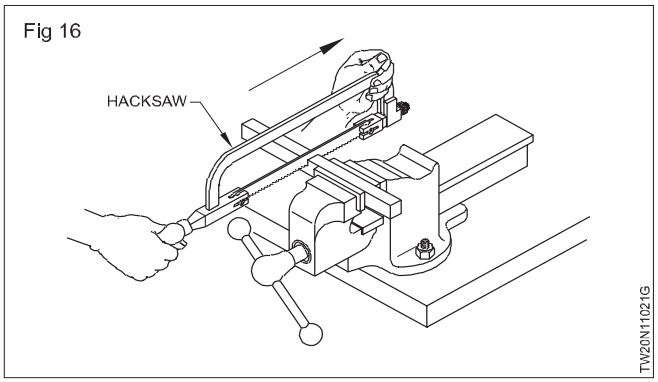


Portable electric drilling machine (Fig 15)



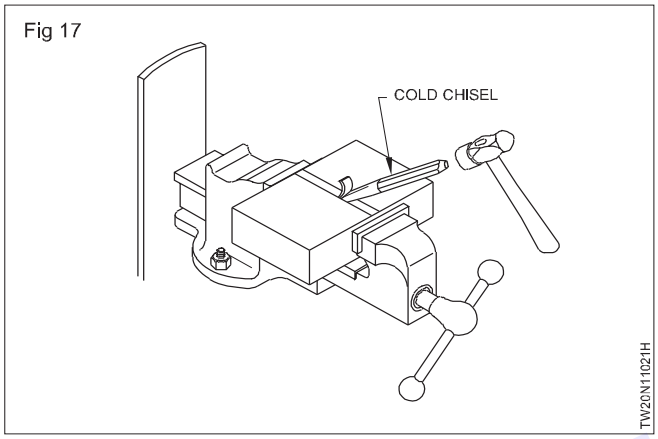
Hacksaw (Fig 16)

Fig 16



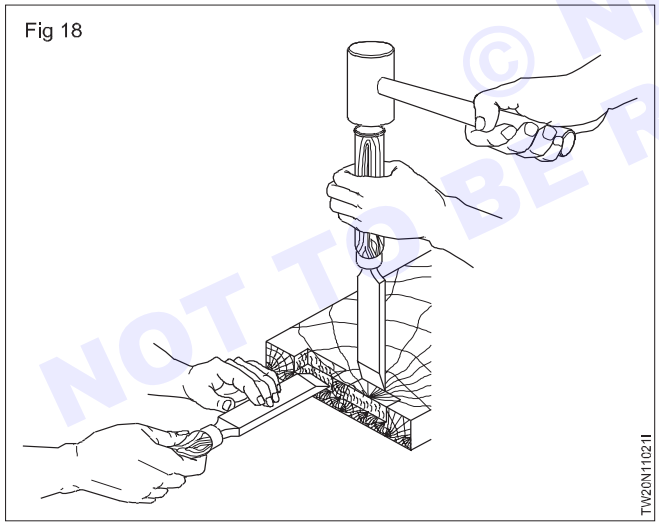
Cold chisel (Fig 17)

Fig 17



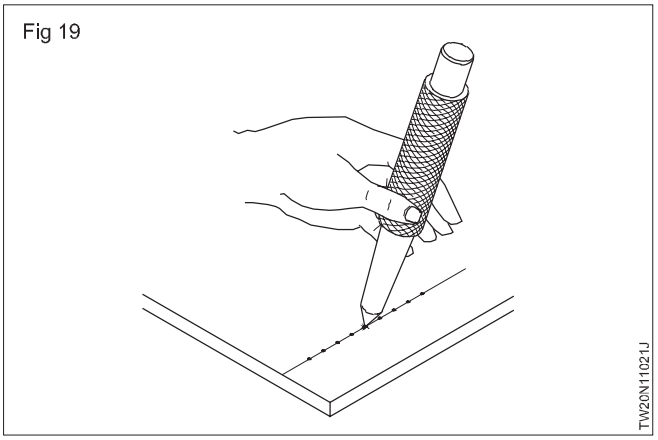
Firmer chisel (Fig 18)

Fig 18



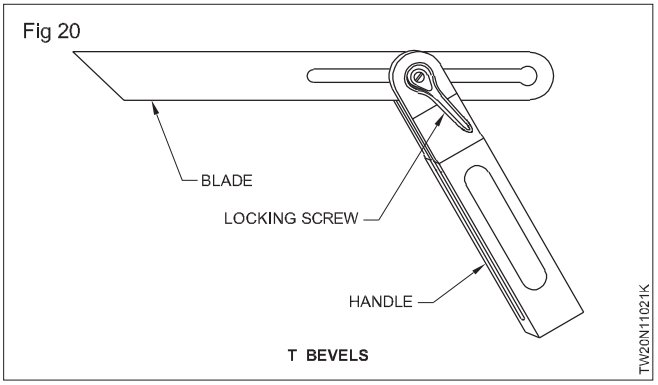
Centre punch (Fig 19)

Fig 19



Bevel square (Fig 20)

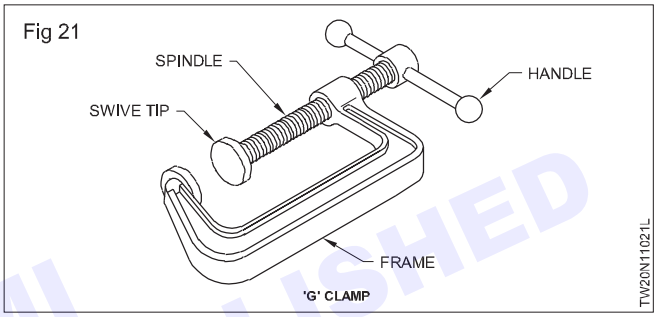
Fig 20



The bevel square is used for laying out dove tails, chamfers, bevels and transferring angles from the drawing to the work pieces.

'C' Clamp (Fig 21)

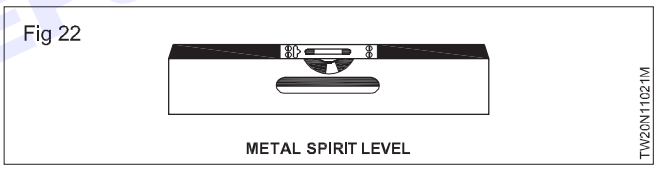
Fig 21



Holding small joint and wooden gloving purpose.

Spirit level (Fig 22)

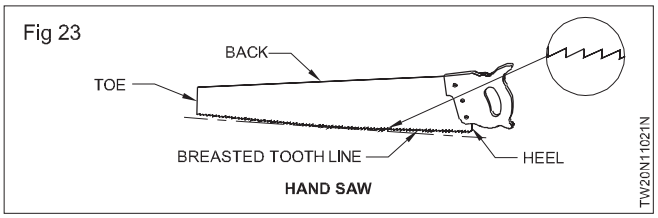
Fig 22



Spirit level is used to test the perpendicular of walls doors and cabinets.

Hand saw (Fig 23)

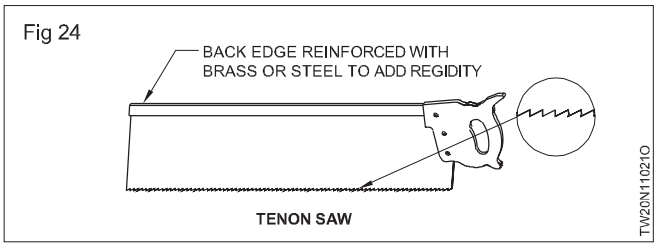
Fig 23



Hand saw is used for lighter sawing work.

Tenon saw (Fig 24)

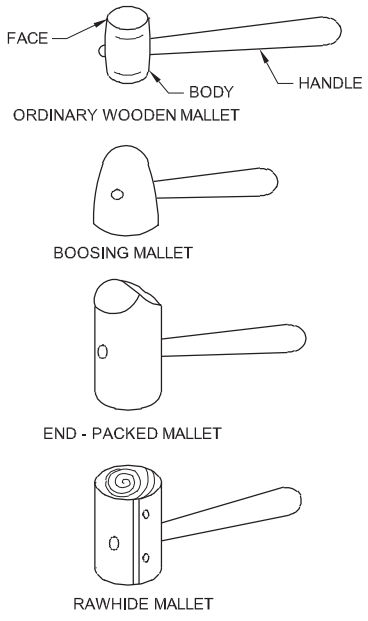
Fig 24



Tenon saw is rectangular in shape.

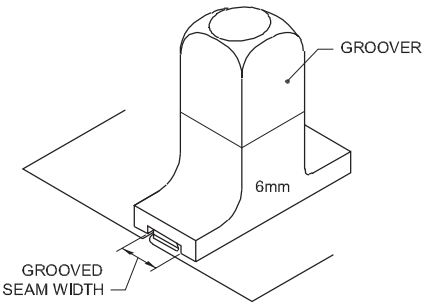
Mallets (Fig 25)

Fig 25



Size of groove & seam (Fig 26)

Fig 26



Types of vices

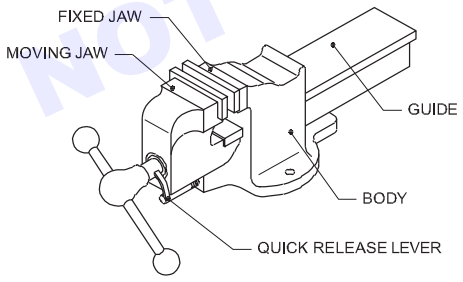
Objectives: At the end of this lesson you shall be able to

- **state the different types of vices**
- **state the uses of quick releasing vice, pipe vice, hand vice, pin vice and leg 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 the 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 Fig 2.

Hand vice (Fig 3): Hand vices 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 44 mm. 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 2

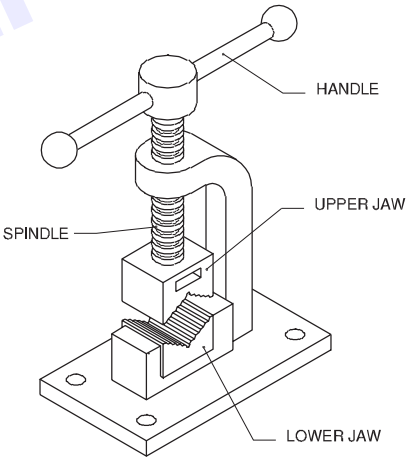
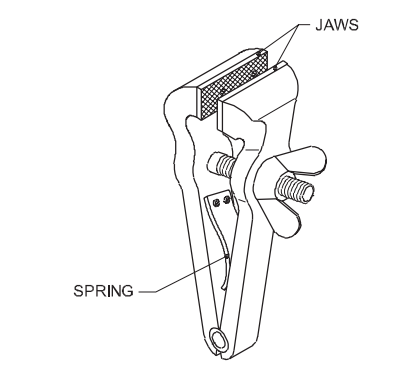
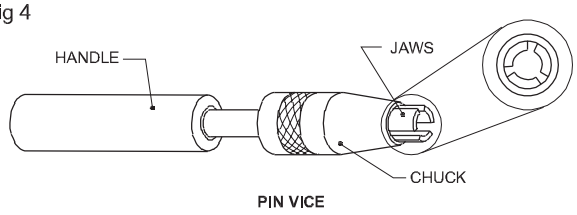


Fig 3



Pin vice (Fig 4): The pin vice is used for holding small diameter jobs. It consists of a handle and a small collet chuck at one end. The chuck carries a set of jaws which are operated by turning the handle.

Fig 4

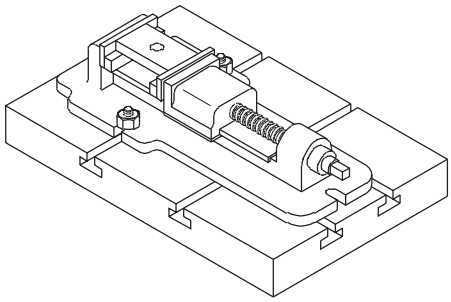


PIN VICE

Toolmaker's vice (Fig 5): The toolmaker'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.

Toolmaker's vice is accurately machined.

Fig 5



Accident - prevention - machine, men - industry

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

- **name the methods followed in industry to move heavy equipment**
- **describe the procedure to be followed for moving heavy equipment on layers and rollers**
- **list the safety consideration while raising a load and moving a load.**

Heavy equipment's are moved in industry using any of the following methods.

Crane and slings

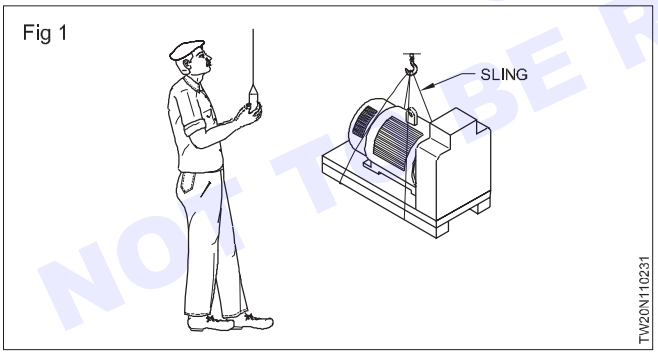
Winches

Machine moving platforms

Layers and rollers

Using crane and slings: This method is used whenever loads are to be lifted and moved. (Fig 1)

Fig 1



Examine the steel rope sling for any cut, abrasion, wear fraying or corrosion.

Damaged slings must not be used.

Distribute the weight as evenly as possible between the slings when using more than one sling. (Fig 1)

Keep the slings as near to vertical as possible.

Winches

Winches are used to pull heavy loads along the ground. They may be power-driven (Fig 2) or hand operated. (Fig 3).

Ensure that the safe working load (SWL) of the winch is adequate for the task.

Secure the winch to a structure which is strong enough to withstand the pull.

Fig 2

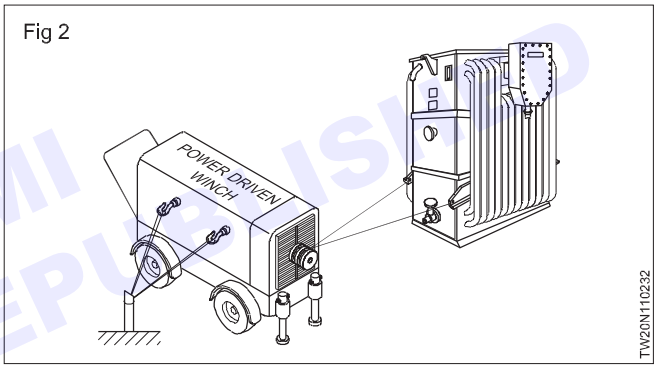
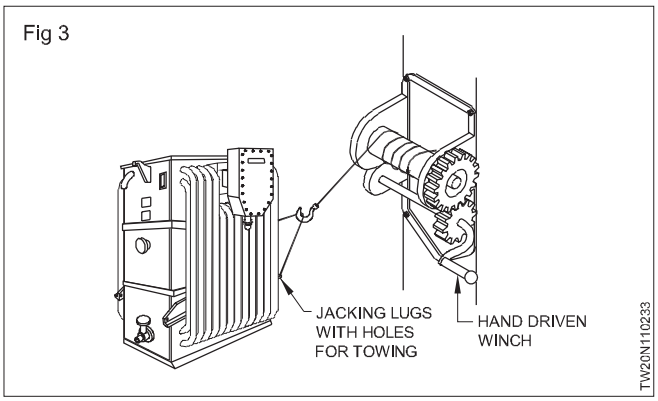


Fig 3



On open ground, drive long stakes into the ground and secure the winch to them.

Choose a suitable sling and pass it around the base of the load. Secure it to the hook of the winch.

Some heavy items have special lugs welded to them for jacking and towing purposes.

Safety consideration

Before using any winch, check that the brake and ratchet mechanism are in working order. Practice how to use the brakes.

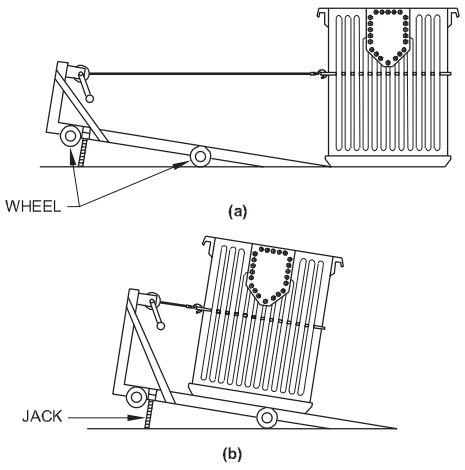
Keep hands and fingers well away from the gear wheels.

Keep the bearings and gears oiled or greased.

Machine moving platforms

This is a special device made to move heavy equipment in industry. Fig 4 shows the method of loading a heavy transformer.

Fig 4



Pass a suitable sling round the load at a convenient height.

Attach the sling to the hook of the winch and draw the load on the platform until its centre of gravity lies between the front and rear wheels.

Lower the jacks so that the platform rests on its wheels.

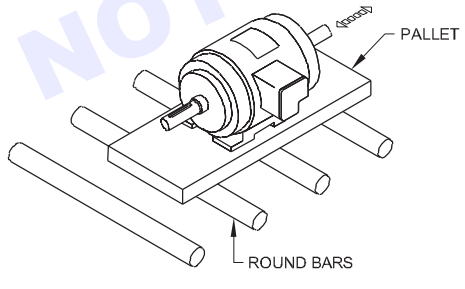
For unloading follow the procedure in the reverse order.

Using layers and rollers

Sometimes a load cannot be moved along the ground because of the irregular shape of its base or because it is not rigid enough.

Place such a load on a flat-bottomed pallet or 'layer' resting on the round bars. (Fig 5)

Fig 5



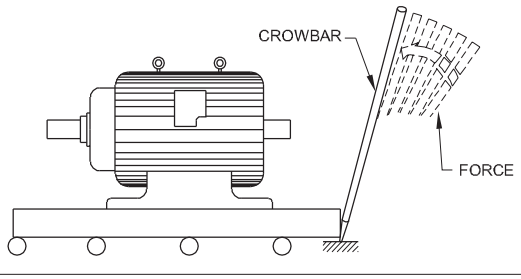
Ensure the bars (rollers) are long enough to project at each side of the load, for ease of handling.

They should be large enough to roll easily over any uneven surface along the route but should be small enough to be handled easily.

Two or three bars of equal diameter are sufficient for most loads but if four or more are used, the load may be moved faster as there is no delay when moving the rear bar to the front. (Fig 5)

Move the load by using a crowbar as shown in Fig 6. Keep the crowbar at the end of the pallet with an angle and a firm grip on the ground. Apply the force at the top of the bar as shown.

Fig 6



Caution

When a load is on rollers, only shallow slopes can be negotiated.

Hold the load in check all the time if it is on the slope.

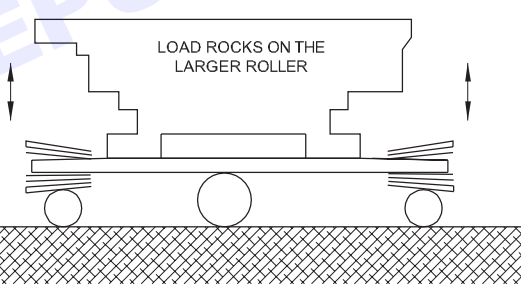
Use a winch with an effective brake for this operation.

To negotiate a corner on rollers

For a moderate load, insert one roller a little larger in diameter than the others as the corner is approached.

When this roller is under the centre of gravity of the load, the load can be rocked to and fro on the roller and swiveled around sideways. (Fig 7)

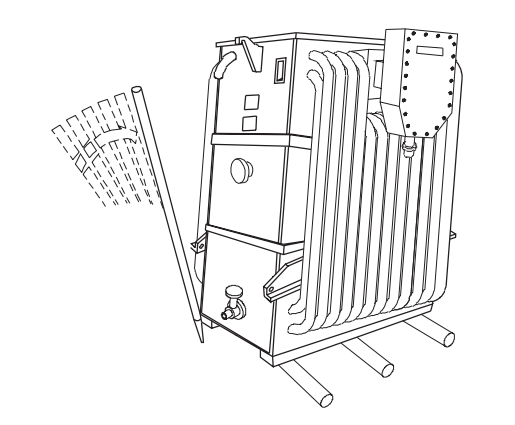
Fig 7



For heavier loads Stop the load on the roller at the beginning of the corner.

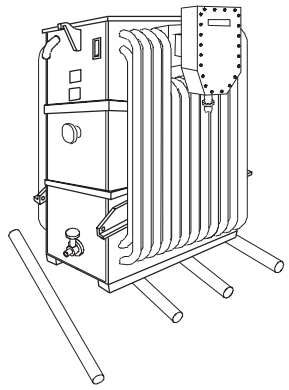
Twist the load round on the rollers by pushing the sides with crowbars until the load is just over the ends of the rollers. (Fig 8)

Fig 8



Place some rollers at an angle to the front of the load. (Fig 9)

Fig 9



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Push the load forward on to these rollers.

Twist the load further round and place the freed rollers in front of and at an angle to the load.

Continue until the load is pointing in the desired direction.

Safety consideration

Moving heavy loads with crowbars or jacks

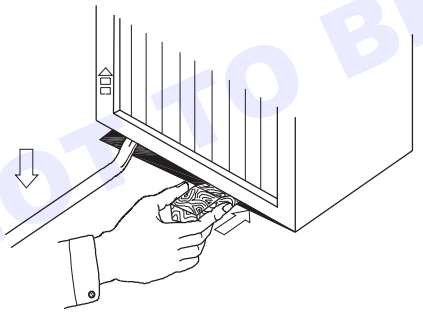
Make sure your hands are clear of the load before lowering it on to the packing or rollers.

Do not use your hands underneath the packing when positioning it. Use a push block.

Place the packing on the floor and push it under the load. (Fig 10)

Hold it by its side faces keeping the fingers well away from the lower edge of the load and from the floor. (Fig 10)

Fig 10



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Raising a load: Check that the slings are correctly secured to the load and to the hook. Ensure they are not twisted or caught on a projecting part of the load.

Before starting to lift a load, if you cannot see an assistant on the far side of the load, verify that he is ready to lift the load and ensure that his hands are clear of the slings.

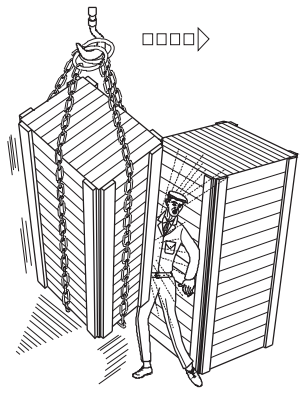
Warn nearby workers that the lifting is about to begin.

Lift slowly.

Take care to avoid being crushed against other objects as the load rises. (Fig 11) It may swing or rotate as it leaves the ground.

Minimise such movement by locating the hooks as accurately as possible above the centre of gravity of the load.

Fig 11



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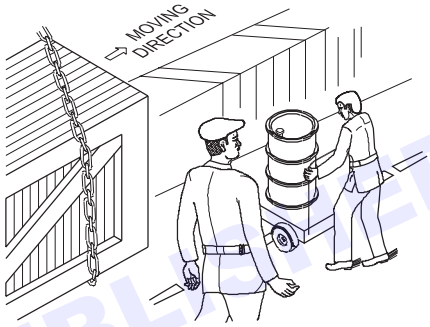
Keep the floor clear of unnecessary objects.

Moving a load: Check that there are no obstacles in the way of the crane and load. (Fig 12)

Fig 12



TW20N11023C

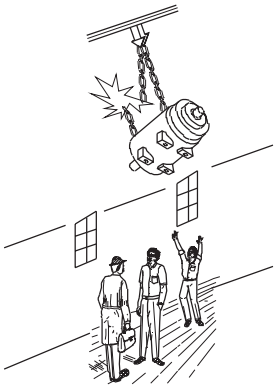
Stand clear off the load and move it steadily.

Be prepared to stop the load quickly if somebody moves into its path.

Allow for the natural swing of the load when changing speed or direction.

Ensure that the load will not pass over the head of other people. (Fig 13)

Fig 13



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The tackle or sling may fall or slip.

Warn other workers to stand clearly away from the route of the load.

Remember that accidents do not happen, they are caused.

Marking tools - calipers, dividers, surface plates, angle plates, scribers and punches

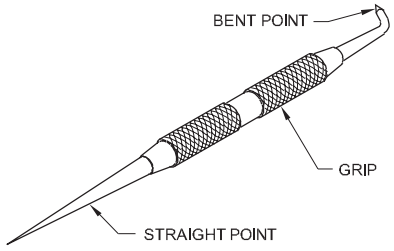
Objectives: At the end of this lesson you shall be able to
- **state the features of scribers**
- **state the uses of scribers.**

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 hardened. For drawing clear and sharp lines, the point should be ground and honed frequently for maintaining its sharpness.

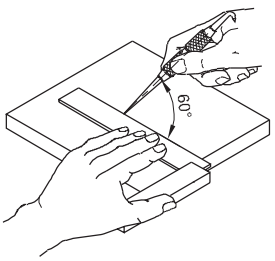
Scribers are available in different shapes and sizes. The most commonly used one is the plain scriber. (Fig 1)

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.

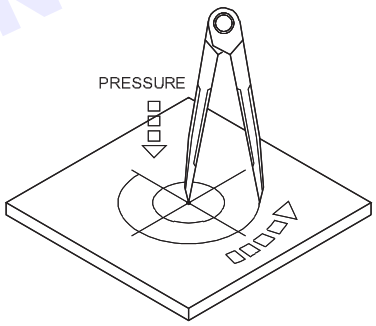
Place a cork on the point when not in use to prevent accidents.

Dividers

Objectives: At the end of this lesson you shall be able to
- **name the parts of a divider**
- **state the uses of dividers**
- **state the specifications of dividers**
- **state the important hints on divider points.**

Dividers are used for scribing circles, arcs and for transferring and stepping off distances. (Fig 1, 2 and 3)

Fig 1



Dividers are available with firm joints and spring joints. (Figs 1 & 4). The measurements are set on the dividers with a steel rule. (Fig 2)

The sizes of dividers range between 50 mm to 200 mm.

The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 4)

Fig 2

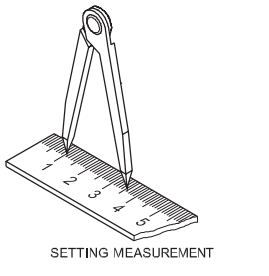
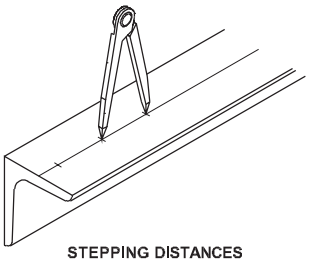
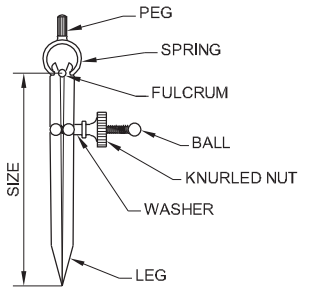


Fig 3



For the correct location and seating of the divider point prick punch marks of 30° are used.

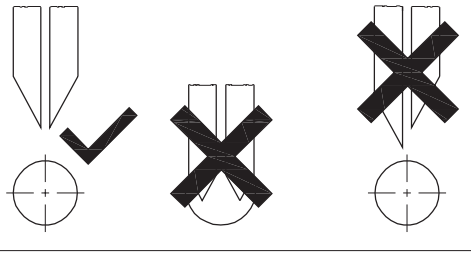
Fig 4



SPRING JOINT DIVIDER

The two legs of the divider should always be of equal length. (Fig 5) Dividers are specified by the type of their joints and length.

Fig 5



The divider point should be kept sharp in order to produce fine lines. Frequent sharpening with an oilstone is better than sharpening by grinding. Sharpening by grinding will make the points soft.

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.

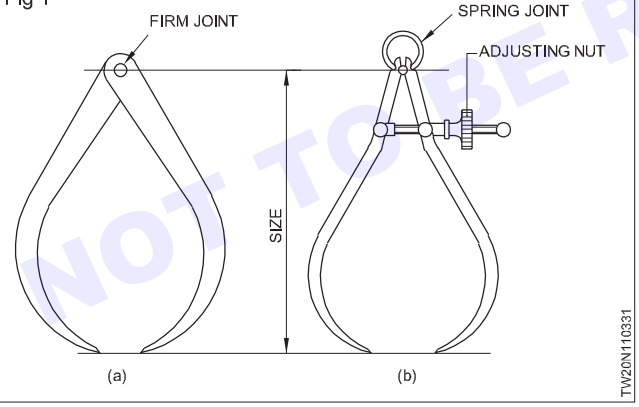
Calipers are classified according to their joints and their legs.

Joint

– Firm joint calipers (Fig 1a)

– Spring joint calipers (Fig 1b)

Fig 1



Legs

– Inside caliper for internal measurement. (Fig 2)

– Outside caliper for external measurement. (Fig 3)

Fig 2

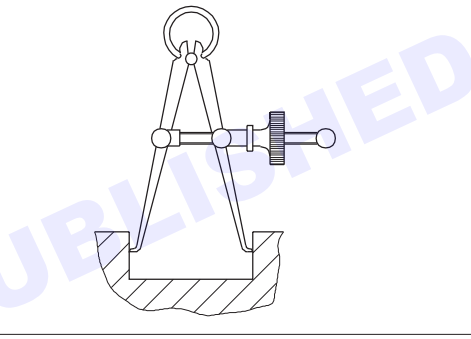
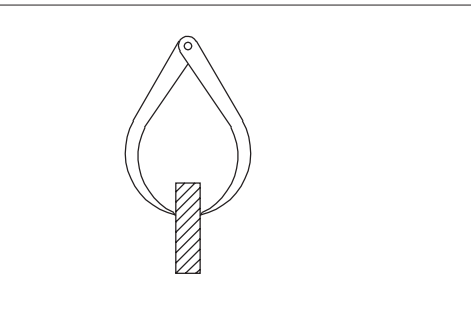


Fig 3



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.

Jenny calipers

Objectives: At the end of this lesson you shall be able to
- **state the uses of a jenny caliper**
- **state the two types of legs of a jenny caliper.**

Jenny calipers have one leg with an adjustable divider point, while the other is a bent leg. (Fig 1) These are available in sizes of 150 mm, 200 mm, 250 mm and 300 mm.

Jenny calipers are used

– for marking lines parallel to the inside and outside edges (Fig 2)

Fig 1

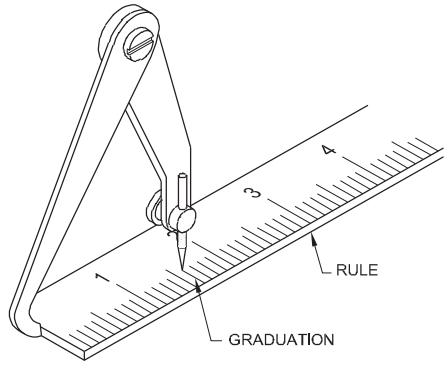
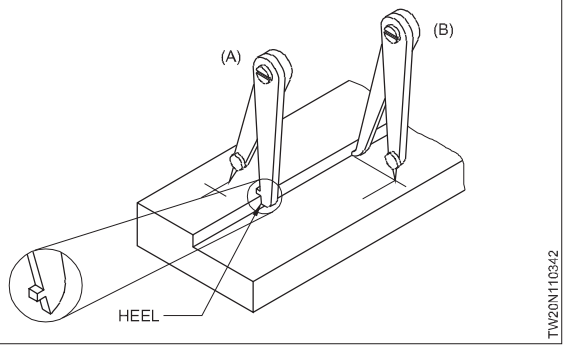
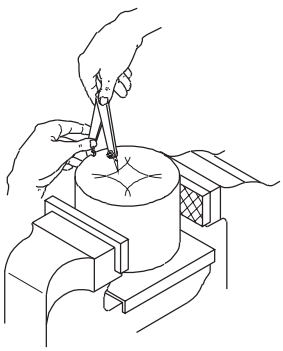


Fig 2



- for finding the centre of round bars. (Fig 3)

Fig 3



These calipers are available with the usual bent leg or with heel.

Calipers with bent leg (Fig 2B) are used for drawing lines parallel along an inside edge, and the heel type (Fig 2A) is used for drawing parallel lines along the outer edges.

The other names for this caliper are:

- Hermaphrodite calipers
- Leg and point calipers
- Odd leg caliper

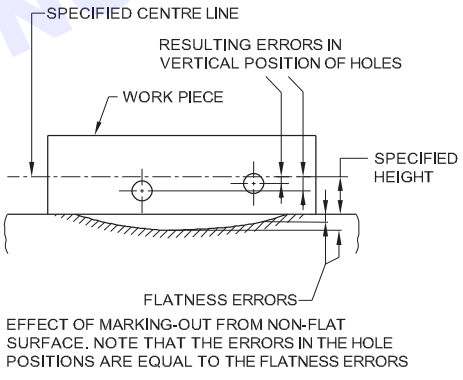
Surface plates

Objectives: At the end of this lesson you shall be able to
- **state the necessity of surface plate**
- **state the material of surface plate**
- **state the specification of surface plate.**

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

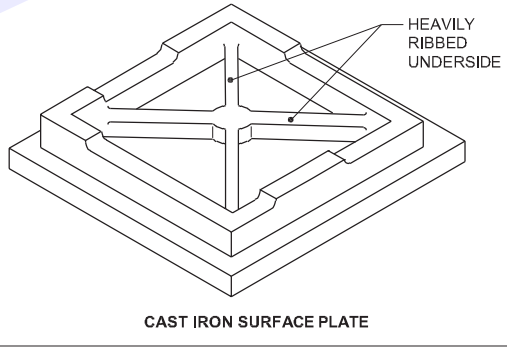


Materials and construction

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

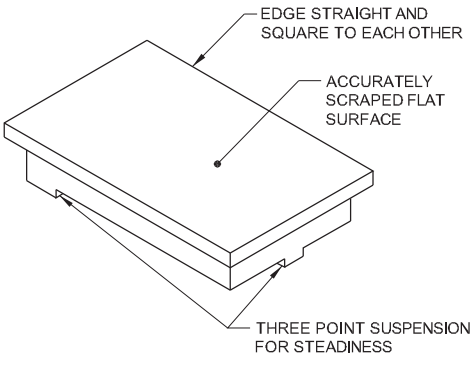
The work-surface is machined and scraped. The underside is heavily ribbed to provide rigidity. (Fig 2)

Fig 2



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.

Care & maintenance

- Clean before and after use.
- Do not keep job on the surface plate.
- Don't keep any cutting tool on the table.

Angle plates

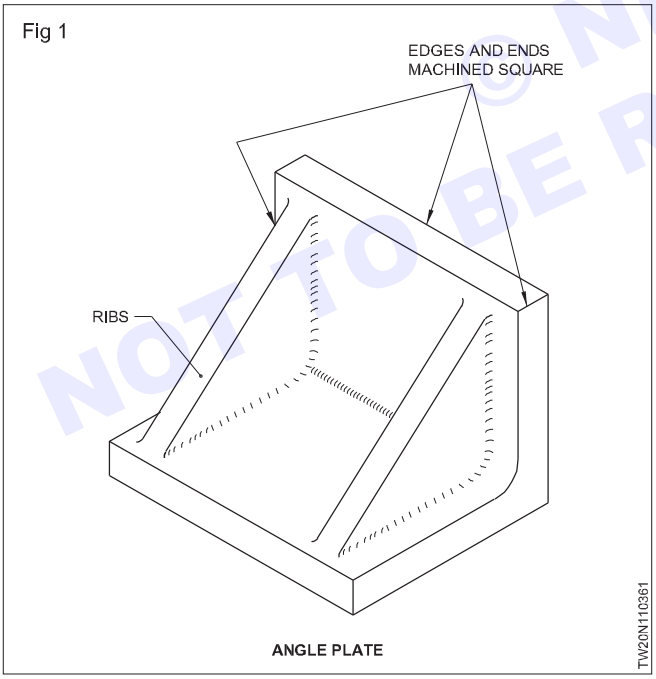
Objectives: At the end of the lesson you shall be able to
- **state the constructional features of different types of angle plates**
- **name the types of angle plates**
- **state the uses of different types of angle plates**
- **state the grades of angle plates.**
- **specify angle plates, constructional features**

Angle plates have two plane surfaces, machined perfectly flat and at right angles. Generally these are made of closely grained cast iron or steel. The edges and ends are also machined square. They have ribs on the machined part for good rigidity and to prevent distortion.

Types of angle plates

Plain solid angle plate (Fig 1)

Fig 1

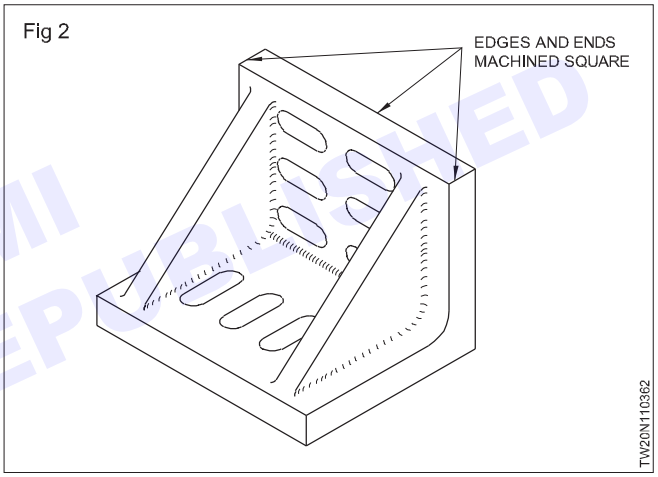


ANGLE PLATE

Among the three types of angle plates normally used, the plain solid angle plate is the most common. It has the two plane surfaces perfectly machined at 90° to each other. Such angle plates are suitable for supporting work-pieces during layout work. They are comparatively smaller in size.

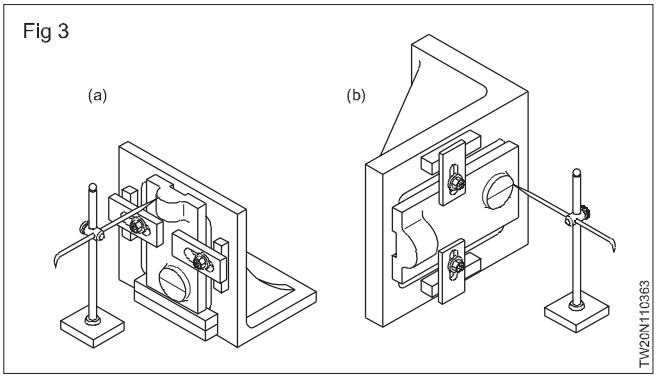
Slotted type angle plate (Fig 2): The two plane surfaces of this type of angle plate have slots milled. It is comparatively bigger in size than the plain solid angle plate.

Fig 2



The slots are machined on the top plane surfaces for accommodating clamping bolts. This type of angle plate can be tilted 90° along with the work for marking or machining. (Fig 3 & 4)

Fig 3



Swivel type angle plate (Fig 5): This is adjustable so that the two surfaces can be kept at an angle. The two machined surfaces are on two separate pieces which are assembled. Graduations are marked on one to indicate the angle of tilt with respect to the other. When both zeros coincide, the two plane surfaces are at 90° to each other. A bolt and nut are provided for locking in position.

Fig 4

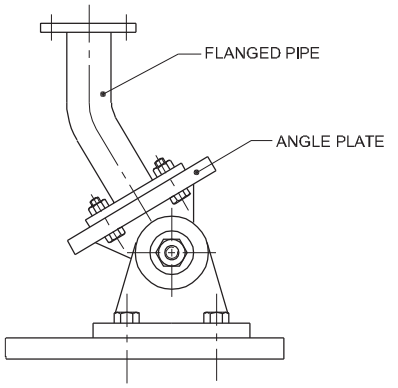
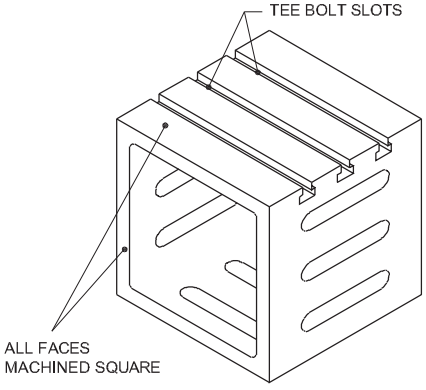


Fig 5



BOX ANGLE PLATE

Box angle plate: They have applications similar to those of other angle plates. After setting, the work can be turned over with the box enabling further marking out or machining. This is a significant advantage. This has all the faces machined square to each other.

Grades: Angle plates are available in two grades - Grade 1 and Grade 2. The Grade 1 angle plates are more accurate and are used for very accurate tool room type of work. The Grade 2 angle plates are used for general machine shop work. In addition to the above two grades of angle plates, precision angle plates are also available for inspection work.

Sizes : Angle plates are available in different sizes. The sizes are indicated by numbers. Table 1 gives the number of the sizes and the corresponding size proportions of the angle plates.

Specification of angle plates

a Size 6 Grade 1

Box plate will be designated as - box angle plate 6 Gr 1 IS 623.

b Size 2 - Grade 2 angle plate will be designated as

Angle plate 2 Gr 2 I.S 623.

Table 1

Size No	L	B	H
1	125	75	100
2	175	100	125
3	250	150	175
4	350	200	250
5	450	300	350
6	600	400	450
7	700	420	700
8	600	600	1000
9	1500	900	1500
10	2800	900	2200
Grade 2 only			

Care & maintenance

– Clean before and after use.

– Apply oil after the use.

Types of marking punches

Objectives: At the end of this lesson you shall be able to
- **name the different punches 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 of high carbon steel, hardened and ground.

Centre punch

The angle of the point is 90° in a centre punch. The punch mark made by this is wide and not very deep. This punch is used for locating centre of the holes. The wide punch mark gives a good seating for starting the drill. (Fig 1a)

Prick punch/Dot punch

The angle of the prick punch is 30° or 60°. (Fig 1b) The 30° point punch is used for making light punch marks needed to position dividers. The divider point will get a proper seating in the punch mark. The 60° punch is used for marking witness marks and called as dot punch. (Fig 2)

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

Fig 1

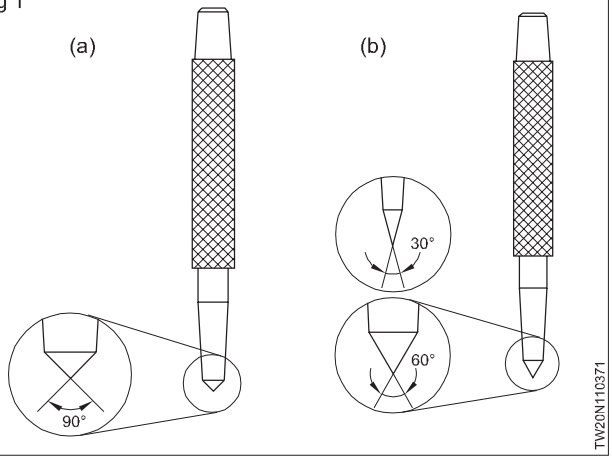
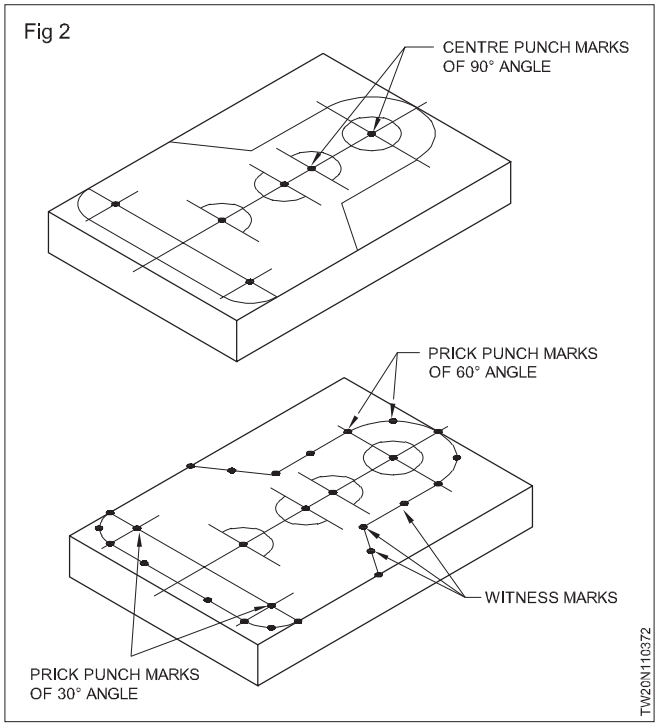


Fig 2



Cutting tools - files - chisels, hacksaw blades - scrapper- various cutting angles and their uses - care & maintenance

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

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 - tubular - 250 - 300mm or 8" - 12"

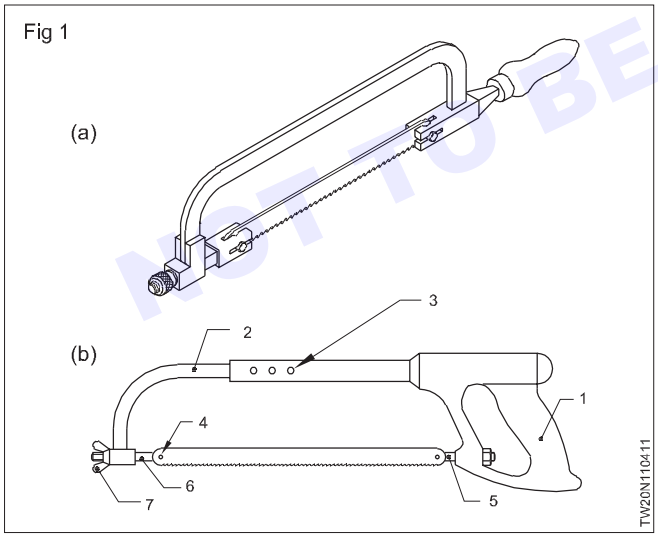
Types of hacksaw frames

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

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

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

Fig 1

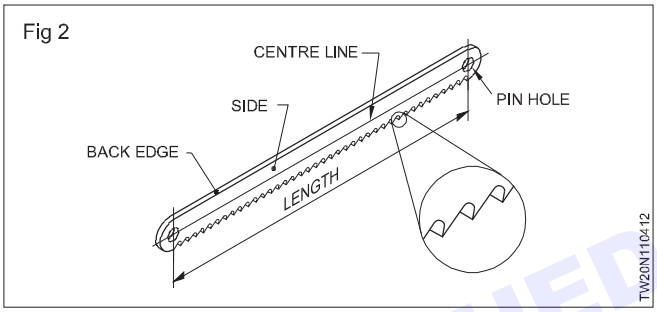


Parts of a hacksaw frame

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

A hacksaw blade is made of either low alloy steel (LA) or high speed steel (HSS), and is available in standard lengths of 250 mm and 300mm. (Fig 2)

Fig 2



Parts of a hacksaw blade (Fig 2)

1 Back edge
2 Side
3 Centre line
4 Pin holes

Type of hacksaw blades

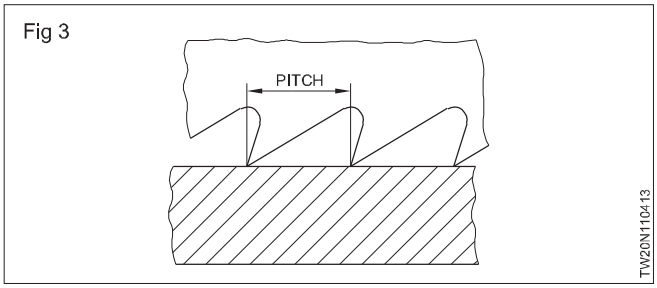
All-hard blade: The full length of the blade between the pins is hardened and it is used for harder metals such as tool steel, die steel and HCS.

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 3): The distance between adjacent teeth is known as the 'pitch' of the blade.

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

Fig 3



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

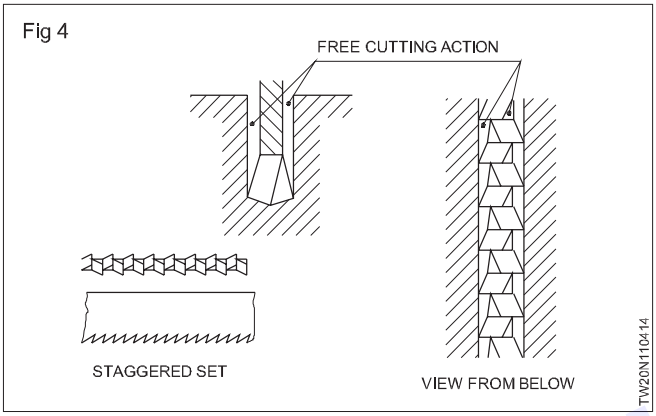
Example

300 x 1.8 mm pitch 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.

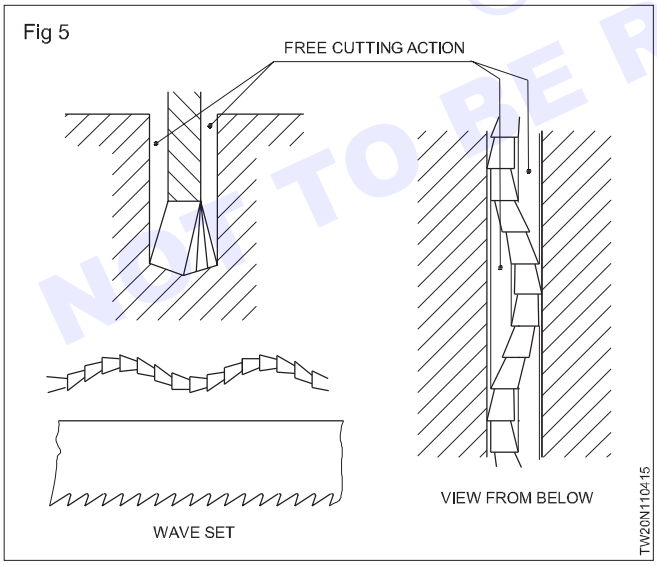
Staggered set (Fig 4): Alternate teeth or groups of teeth are staggered. This arrangement helps for free cutting, and provides for good chip clearance.

Fig 4



Wave set (Fig 5): In this, the teeth of the blade are arranged in a wave-form. The types of sets for different pictures are as follows

Fig 5



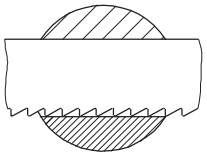
Pitch	Type of set
0.8 mm	Wave-set
1.0 mm	Wave-set or staggered
Over 1.0 mm	Staggered

For the best results, the blade with the right pitch should be selected and fitted correctly.

Selection of blade: The selection of the blade depends on the shape and hardness of the material to be cut.

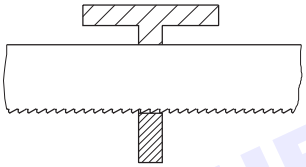
Pitch selection (Fig 6): For soft materials such as bronze, brass, soft steel, cast iron, heavy angles etc. use a 1.8 mm pitch blade.

Fig 6



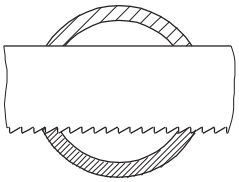
For tool steel, high carbon, high speed steel etc. use a 1.4 mm pitch. For angle iron, brass tubing, copper, iron pipe etc. use a 1 mm pitch blade. (Fig 7)

Fig 7



For conduit and other thin tubing, sheet metal work etc. use a 0.8 mm pitch. (Fig 8)

Fig 8



Method of sawing

Select the correct blade for the material to be cut.

HSS - Blades are used for tough resistant materials

High Carbon Steel - General cutting

Select the correct number of teeth / inch the general rule is that atleast 3 teeth should extend across the surface of the material to be cut.

The hand holds the hacksaw handle, and the index finger is to support the handle and also points in the direction of cutting.

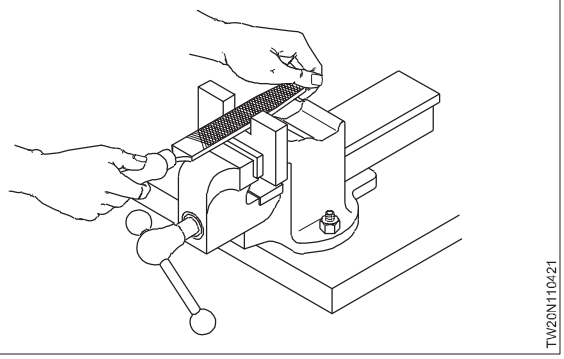
The other hand holds the frame, near the wing nut. Cutting/sawing should be carried out close to the jaws of the vice. This ensures that the metal does not flex or bend under the force of the hacksaw and the sawing motion.

Elements of a file

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

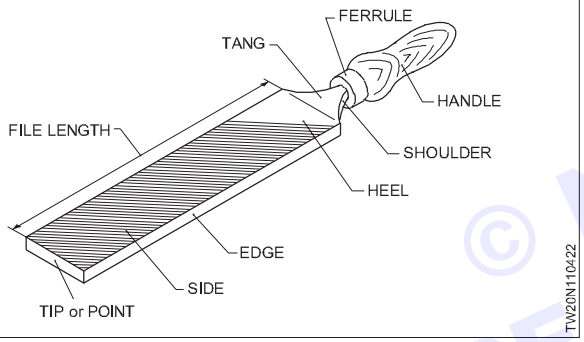
Filing is a method for removing excess material from a workpiece by using a file which acts as a cutting tool. Figure shows how to hold a file. Files are available in many shapes and sizes.

Fig 1



Parts of a file (Fig 2)

Fig 2



The parts of a file can be seen in figure 5, are

Tip or point

the end opposite to tang

Face or side

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

Edge

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

Heel

The portion of the broad part without teeth

Shoulder

the curved part of the file separating tang from the body

Tang

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

Handle

The part fitted to the tang for holding the file

Ferrule

A protective metal ring to prevent cracking of the handle.

Materials

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

Types of files

Objectives: At the end of this lesson you shall be able to
- **identify the different shape of files(types)**
- **state the uses of flat files, Hand files square, round, half round, triangular and knife-edge files**
- **state the correct shape of files for filing different profiles.**

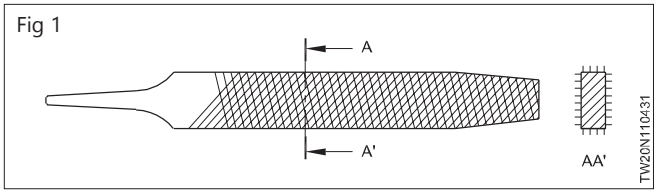
For filing and finishing different profiles, files of different shapes are used

The shape of files is stated by its cross section.

Common files of different shapes: Flat file, Hand file, Square file, Round file, Half round file, Triangular file and Knife-edge file.

Flat file (Fig 1)

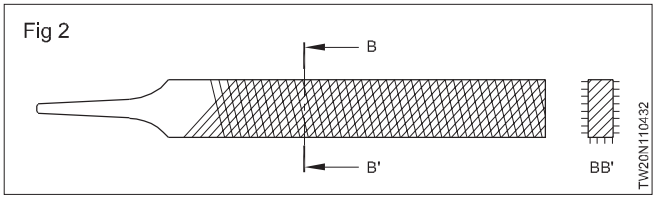
Fig 1



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

Hand file (Fig 2)

Fig 2

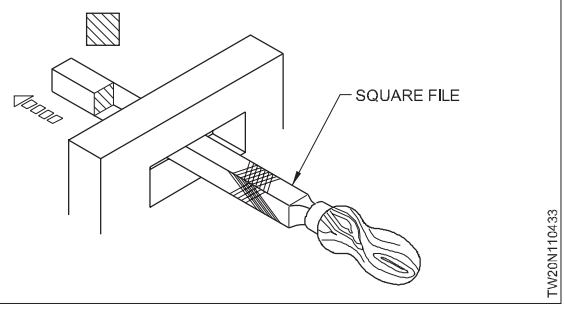


These files are similar to the flat files in their cross section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is single cut whereas the other is safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces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

Flat files are general purpose files. They are available in all grades. Hand files are particularly useful for filling at right angles to a finished surface.

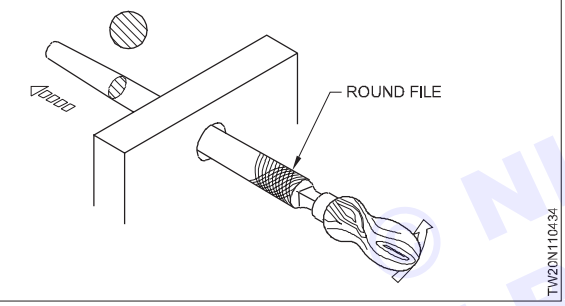
Square file: The square file is square in its cross section. It is used for filing square holes, internal square corners, rectangular openings, keyways and splines. (Fig 3)

Fig 3



Round file: A round file is circular in its cross section. It is used for enlarging the circular holes and filing profiles with fillets. (Fig 4)

Fig 4



Half round file: A half round file is in the shape of a segment of a circle. It is used for filing internal curved surfaces. (Fig 5)

Triangular file: A triangular file is of a triangular cross section. It is used for filing corners and angles which are more than 60°. (Fig 6)

Fig 5

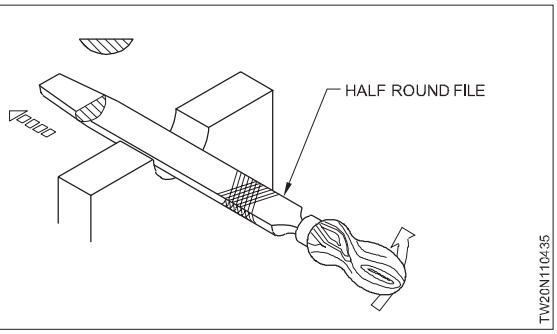
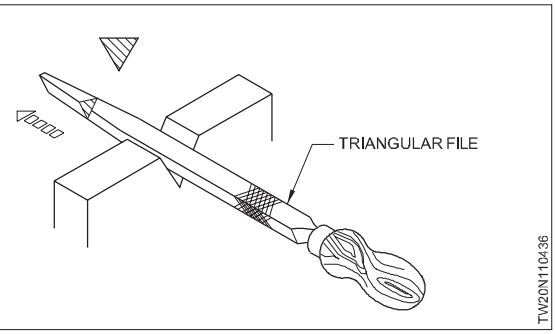
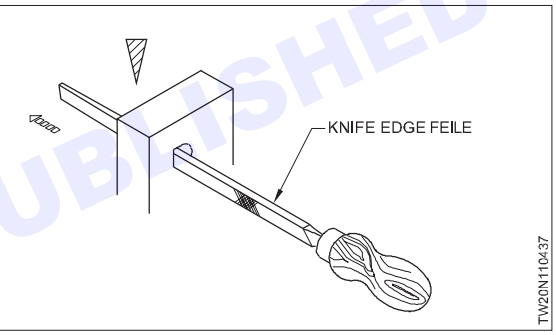


Fig 6



Knife edge file: A knife edge file has the cross section of a sharp triangles. It is used for filing narrow grooves and angles above 10° (Fig 7)

Fig 7



The above files have one third of their lengths tapered. They are available both single and double cuts.

Square, round, half-round and triangular files are available in lengths of 100, 150, 200, 250, 300 and 400mm. These files are made in bastard, second cut and smooth grades.

Needle files

Objectives: At the end of this lesson you shall be able to
- **name the different shapes of needle files**
- **designate needle files as per BIS.**

Needle files are usually available in sets with assorted shapes. These types of files are used for delicate, light kinds of work. These files are available in bastard and smooth grade.

Shapes: The common shapes of needle files are shown in figure 1. The shapes are round edge, flat edge, flat taper, half round, triangular, square, round, knife, feather edge, crossing, barred and marking. (Fig 1)

Nomenclature of needle files. (Fig 2)

Length: These files are available in a nominal length of 120mm to 180mm.

Grades

The grades of cut may be identified by the cut number as follows

- Bastard - Cut 0.
- Smooth - Cut 2.

Designation of needle files: The needle files are designated by their names

- Grade of cut
- Nominal length
- BIS number

Fig 1

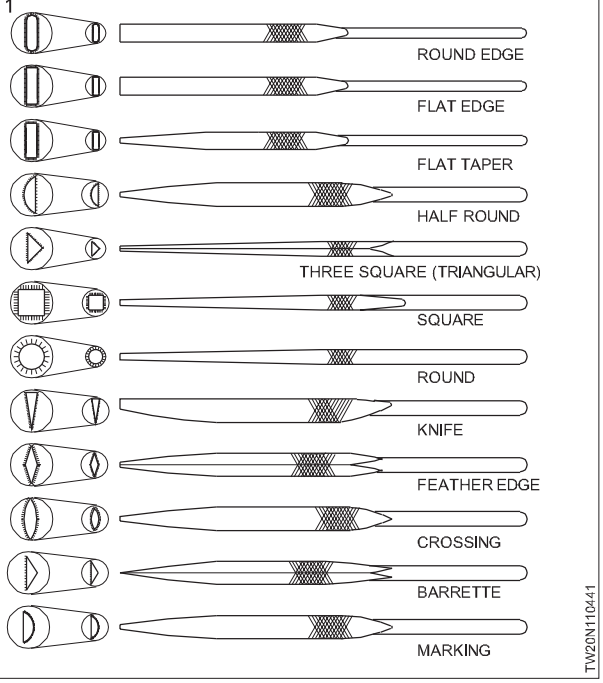
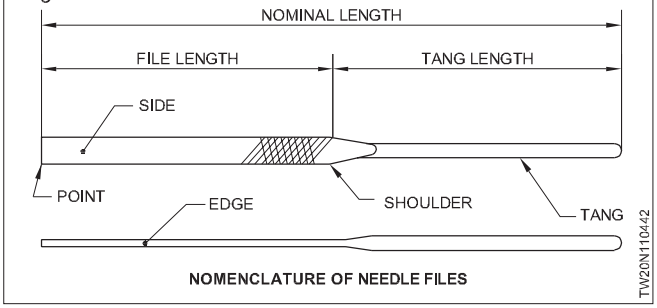


Fig 2



NOMENCLATURE OF NEEDLE FILES

Example

A flat edge needle file with grade of cut bastard, having a nominal length of 160mm shall be designated as flat edge needle file bastard, 160 IS 3152.

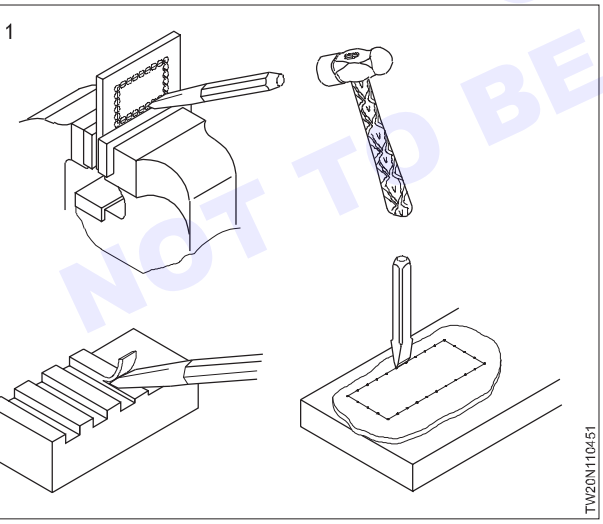
Chisel

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 chisel**
- **specify the chisel.**

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

Fig 1



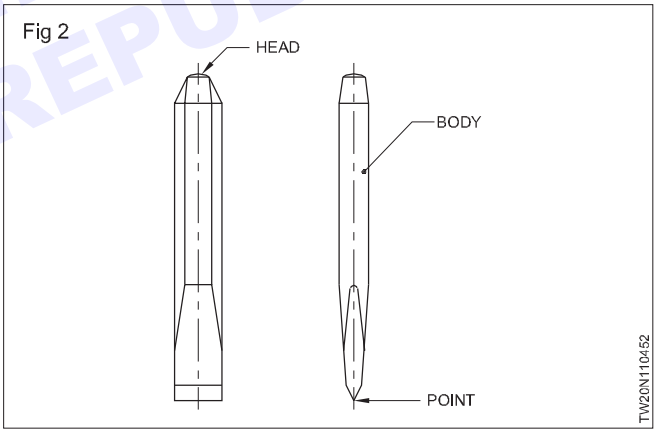
Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

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

Head, body, point or cutting edge.

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.

Fig 2



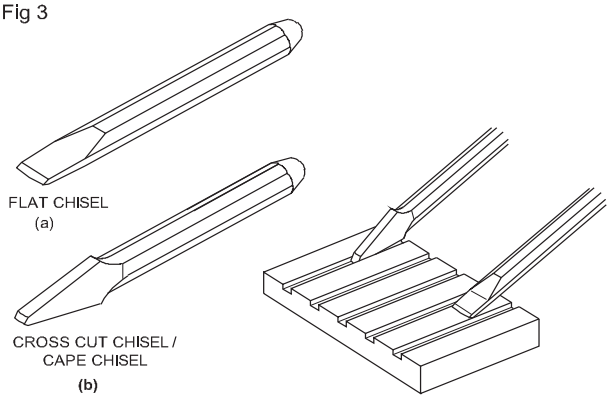
Common types of chisel: There are five common types of chisels.

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

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

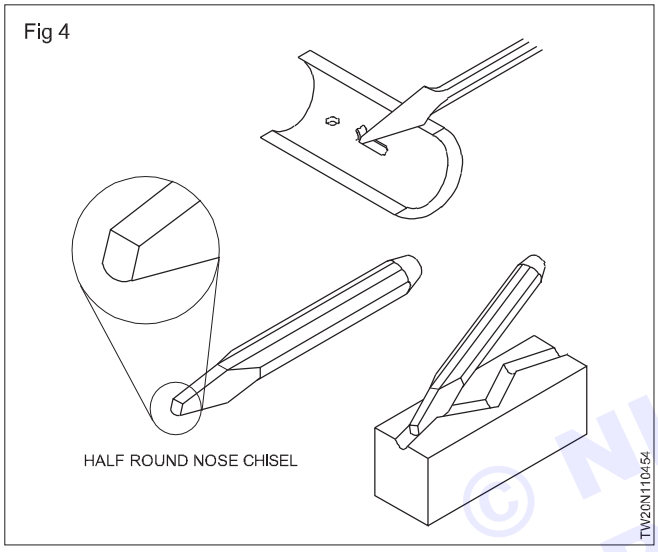
Cross-cut or cape chisels (Fig 3b): These are used for cutting key ways, grooves and slots.

Fig 3



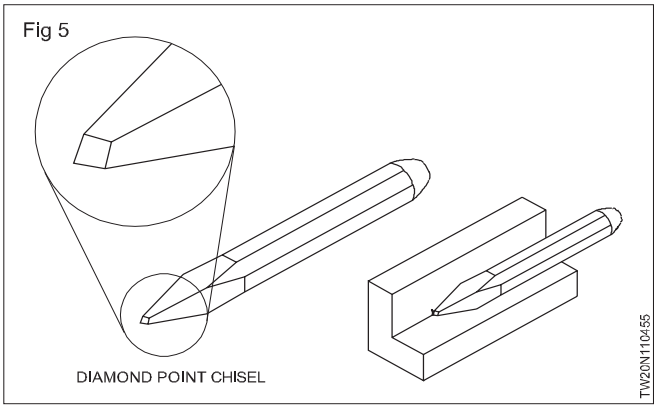
Half-round nose chisels (Fig 4): They are used for cutting curved grooves (oil grooves).

Fig 4



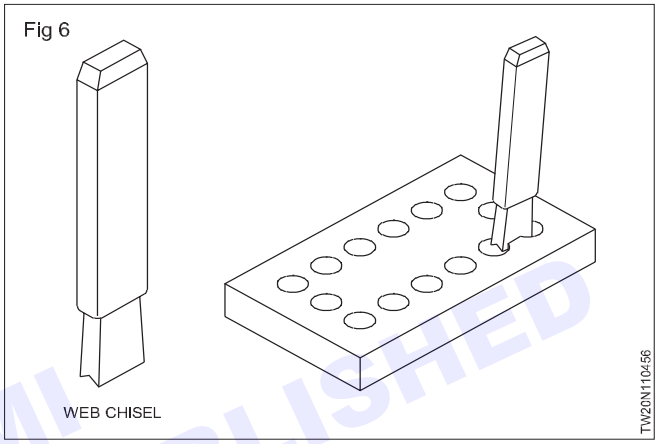
Diamond point chisels (Fig 5): These are used for squaring materials at the corners, joints.

Fig 5



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

Fig 6



Chisels are specified according to their

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

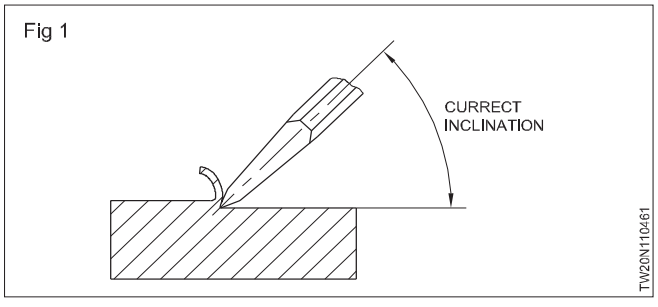
Angles of chisel

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

Point angles and materials: The correct point/cutting angle of the chisel depends on the material to be chipped. Sharp angles are given for soft materials, and wide angles for hard materials.

The correct point and angle of inclination generate the correct rake and clearance angles. (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)

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)

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 2

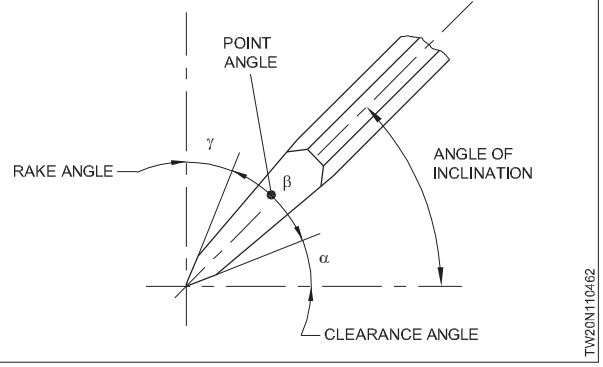
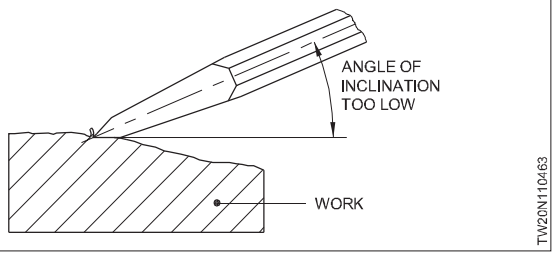


Fig 3

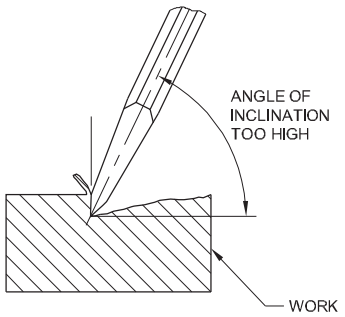


Crowning: A slight curvature is ground called "Crowning" to the cutting edge of the chisel, to prevent digging of corners, which leads to breakage of chisel point. "Crowning" allows the chisel to move freely along a straight line while chipping.

Table 1

Material to be cut	Point angle	Angle 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°

Fig 4



Care & maintenance

- Sharpen the chisel before use.
- Apply oil to avoid rust.
- Don't use the mushroom head chisel.
- Use safety goggles while chipping.
- While chipping.
- No greasy subject on the head of the chisel.

Simple scrapers and scraping

Objectives: At the end of this lesson you shall be able to
- **state the necessity of scraping surfaces**
- **state what is high spots**
- **state what is bearing surface**
- **list the types of scrapers used, material and size**
- **hold the scraper at correct angle/position.**

Necessity of scraping surface: Scrapers are used to correct slight errors on all flat or curved surfaces that must be finished more decorate.

Scraping is used to produce a high degree of fit between two flat or two curved surfaces particularly where the surfaces can rub together in use.

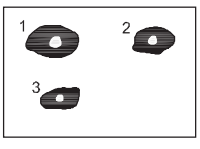
After a surface is filed or machined as accurately as possible, it can be further improved by rough scraping after which finish scraping is employed. Finish scraping is used to remove minute amount of material.

High spots and bearing surfaces: On the surface plate apply the coating of Prussian blue or red lead mixed with oil or apply used carbon. Placing the job to be scraped, move the job under light downward pressure keeping all edges of the job within the limits of surface. Carefully lift off the job in a perpendicular direction.

Study the patches of marking compound before you begin scraping.

– First test having 3 shiny patches. Only patch 3 would be scraped (high spots) (Fig 1)

Fig 1



– Second test having even distribution of marking compound. (High spots) (Fig 2)

– Types of bearing contact obtained (Fig 3)

Fig 2

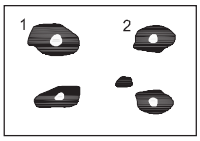


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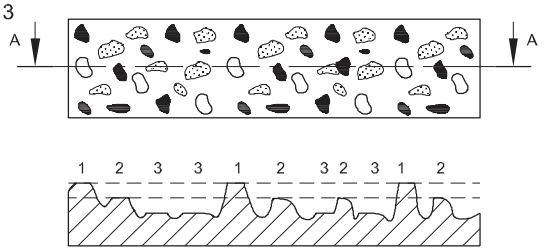
Fig 3



1 HARD CONTACT POINTS
2 NORMAL CONTACT POINTS
3 NON-CONTACT POINTS

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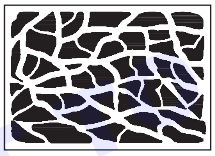
1 Metal contact with the surface plate. The points have been rubbed shiny.

2 They have been contact with the marking compound and coloured by it. This portion is called normal contact point.

3 Non-contact point, have not been in contact with the marking compound.

– After third scraping completed and testing the shining shows the shiny spots are more than those coloured with marking compound. The patches are greater in number in size more evenly distributed. (High spots) (Fig 4)

Fig 4



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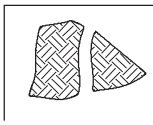
– The enlarged view of the pattern of scraping marks on the small patches shown in Fig 5.

Fig 5



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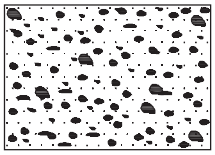
– Further testing, scraping would produce a more even distribution of larger number of smaller sized patches (bearing spots). (Fig 6)

Fig 6



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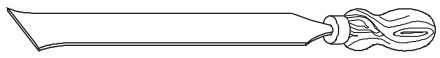
In 25 mm SQ = 25 bearing parts.

Types and uses of scraper: For scraping flat surfaces

– Flat scrapers with rectangular blades. (Fig 7)

Fig 7



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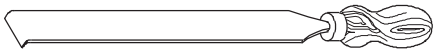
Used for scraping large flat surfaces. The working edge is not thicker than 3 mm.

– Hook scrapers with rectangular blades. (Fig 8)

Fig 8



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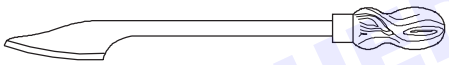
Hook scrapers are used for scraping the center portion of large flat surface where it is not convenient to use of flat scraper.

For scraping curved surfaces

– Half round scraper is curved slightly towards the curved surfaces. (Fig 9)

Fig 9



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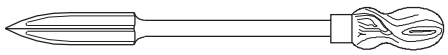
It is used to scrape bearing blocks or brasses, pressure is applied in radial direction and cutting edge moved at right angles to its length. So that scraping marks are circumferential.

– Three square or triangular scraper

Each of the three faces are hallow ground Fig 10. It is used for scraping small diameter holes and deburring edges of accurate holes. The cutting edge is moved at right angles to its length.

Fig 10



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– Bull-nose scraper is forged to a disc like end. (Fig 11) It is used for scraping large bearings. It can be used two ways either with the circumferential movement of a flat scraper or with the longitudinal movement of flat scraper.

Fig 11

TW20N110147B

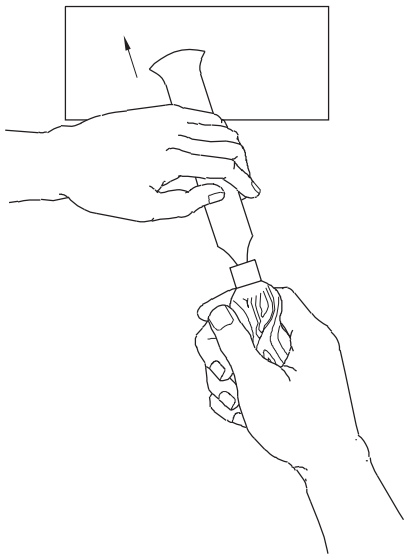
Scraper material: High grade tool steel or special alloy steel and tungsten carbide tipped tool.

Specification: The overall length of blade and handle may range from 150 to about 500 mm.

Holding position of flat scraper: The handle of the scraper is held and pushed by right hand. Hold the right elbow out of from the body when beginning forward cutting stroke. As you finish the short cutting stroke bring the elbow into the body.

The blade is guided and pressed down by the left hand. Grasp the blade with the root of the little finger above the blade and about 40 mm to 50 mm from the cutting edge. (Fig 12)

Fig 12



TW20N11047C

Curl the little finger and second finger lightly around the blade. The first finger lies loosely around the blade and thumb lies on top of the blade and at right angle to it.

For work of average hardness blade of scraper is held at an angle about 30° to surface. For very hard work the angle may be greater, while for softer metals this angle may be decreased to about 20°. (Fig 13)

After scraping in one general direction and testing in the surface plate. Change the general direction of scraping by about 90°. (Fig 14)

Fig 13

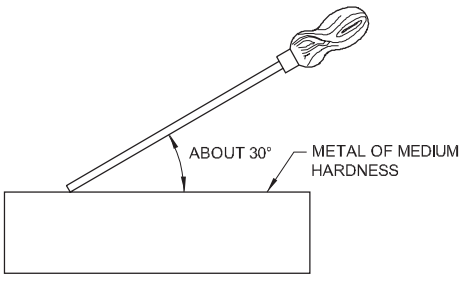


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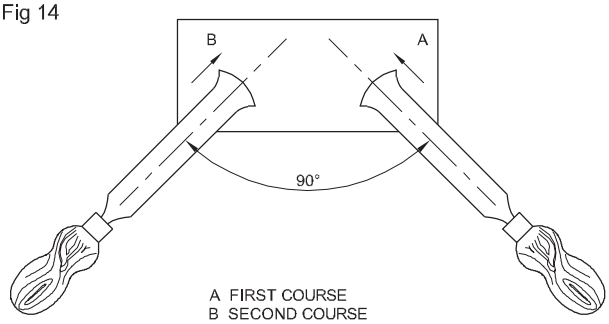
Fig 14



GENERAL DIRECTIONS FOR SCRAPING

TW20N11047E

Care and maintenance of scrapers

- Scrapers must be sharp and kept with good condition to handle.
- Cover the cutting edge with rubber or leather sheath.
- After use apply grease on cutting edge to avoid corroding.
- Scraper should not fall down from the bench.
- Don't mix with other tool.

Scraping curved surfaces

Objective: At the end of this lesson you shall be able to
- **scrape and test curved surfaces.**

A half round scraper is the most suitable scraper for scraping curved surfaces. This method of scrapping differs from that of flat scraping.

Method

For scraping curved surfaces the handle is held by hand in such a way as to facilitate the movement of the scraper in the required direction.(Fig 1)

Pressure is exerted with other hand on the shank for cutting.

Rough scraping will need excessive pressure with longer strokes.

For fine scraping, pressure is reduced and the stroke length also becomes shorter.

Cutting action takes place both on forward and return strokes. (Fig 2)

Fig 1

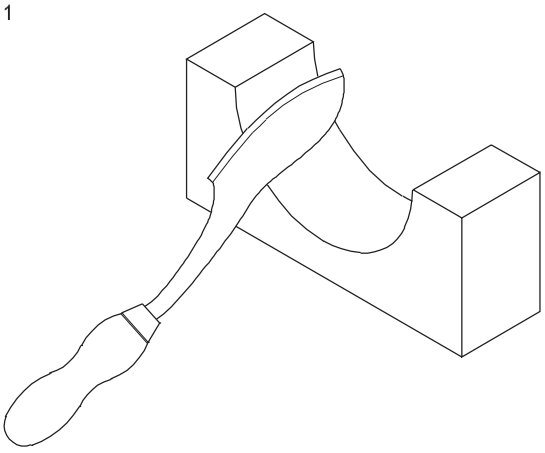


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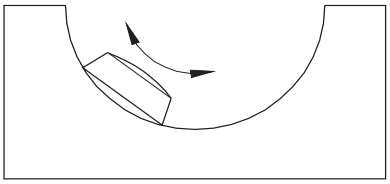
Fig 2



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During the forward movement one cutting edge acts, and on the return stroke, the other cutting edge acts.

After each pass, change the direction of cutting. This ensures a uniform surface. (Figs 3 & 4)

Fig 3

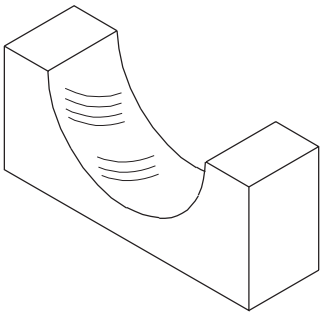

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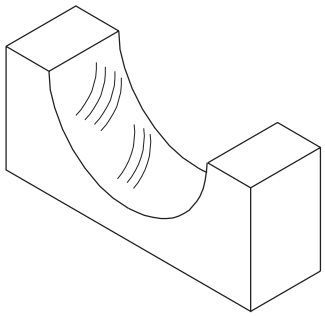
Fig 4



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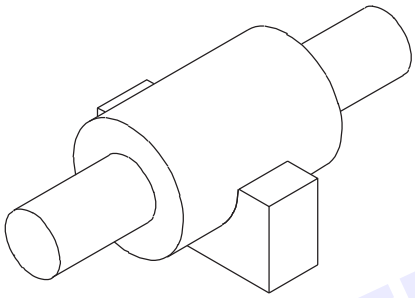
Use a master bar to check the correctness of the surface being scraped. (Fig 5)

Fig 5



TW20N110485

Apply a thin coating of Prussian blue on the master bar to locate the high spots.

Specification of steel flats

Objectives: At the end of this lesson you shall be able to
- **state the types of metals used in sheet metal work**
- **state the uses of the different types of metals.**

In sheet metal work, different types of metal sheets are used. The sheets are specified by their standard gauge numbers.

It is very essential to know the different uses and applications of these metal sheets.

Black iron sheets: The cheapest sheet metal is the black iron, which is rolled to the desired thickness. The sheets are rolled in two conditions. When it is rolled in cold state, it is called cold rolled and when it is rolled in hot state, it is called hot rolled. Hot rolled sheets have a bluish black appearance, and are often referred to as uncoated sheets, since they are uncoated. They corrode rapidly.

Cold rolled sheets have plain silver whitish appearance and are uncoated. To decrease the work hardness, the cold ruled sheets are annealed in a closed atmosphere. These sheets are known as C.R.C.A (Cold rolled close annealed) sheets.

The use of this metal is limited to making articles that are to be painted or enameled such as tanks, pans, stoves, pipes etc.

Galvanised iron sheets: Zinc coated iron is known as 'galvanised iron'. This soft iron sheet is popularly known as G.I.sheet. The zinc coating resist corrosion and improves the appearance of the metal and permit it to be soldered with greater ease. Because it is coated with zinc, galvanised iron sheet withstands contact with water and exposure to weather.

Articles such as pans, buckets, furnaces, heating ducts, cabinets, gutters etc. are made mainly from G.I.sheets.

Stainless sheets: This is an alloy of steel with nickel, chromium and other metals. It has good corrosive resistance and can be welded easily. Stainless steel used in a sheet metal shop can be worked similar to galvanised iron sheets, but is tougher than G.I. sheets. The cost of stainless steel is very high.

Stainless steel is used in dairies, food processing, chemical plants, kitchenware etc.

Copper sheets: Copper sheets are available either as cold rolled or hot rolled. They have a very good resistance to corrosion and can be worked easily. They are commonly used in sheet metal shops. Copper sheet has better appearance than other metals.

Gutters, expansion joints, roof flashings, hoods, utensils and boiler plates are some of the common examples where copper sheets are used.

Aluminium sheets: Aluminium cannot be used in its pure form, but is mixed with very small amount of copper, silicon, manganese and iron. Aluminium sheets are whitish in colour and light in weight. They are highly resistant to corrosion and abrasion.

Aluminium is now widely used in the manufacture of articles such as household appliances, refrigerator trays, lighting fixtures, windows and also in the construction of airplanes and in many electrical and transport industries.

Tinned plate: Tinned plate is sheet iron coated with tin, to protect it against rust. This is used for nearly all solder work, as it is the easiest metal to join by soldering.

This metal has a very bright silvery appearance and is used in making roofs, food containers, dairy equipment, furnace fittings, cans and pans etc.

Lead sheets: Lead is very soft and heavy in weight.

Lead sheets are used for making the highly corrosive acid tanks.

When lead is coated on black iron sheets, they are called Terni sheets. They are highly anti-corrosive and commonly used in preservation of chemicals.

Flats: Flats have a rectangular cross-section with straight and flat edges. They come in various widths, thicknesses, and lengths, and they are typically produced from hot-rolled steel. The choice of material and dimensions depends on the specific engineering requirements and the intended use of the flats.

Flats shall be designated by the width(mm) & the thickness (mm).

Indian standard sheet sizes & strip sizes

Objectives: At the end of this lesson you shall be able to
- **specify the Indian Standard sheet sizes**
- **specify the Indian Standard strip sizes**
- **calculate the weight of the steel sheet, and the measure of the strip.**

Indian Standard sheet sizes & strip sizes: As per Indian Standard are designated as ISSH received by figures denoting length (mm) x width (mm) x thickness (mm) of the sheet as per IS 1730 : 1989.

Example

ISSH 3200 x 600 x 1.00

Where

3200 is the length of the sheet (mm)

600 is the width of the sheet (mm)

1.00 is the thickness of the sheet (mm)

Table 1 gives the weight of steel sheets of different standard sizes.

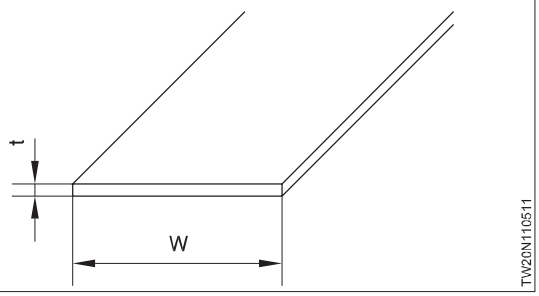
Indian standard strip sizes

Indian Standard strips are designated as ISST followed by width (mm) x thickness (mm) of the strip as per IS 1730 - 1989. (Fig 1)

Example

ISST 1050 x 3.15: Where 1050 mm is the width of the strip and 3.15mm is the thickness.

Fig 1



Exercise

Calculate the weight of the steel sheet given below.

ISSH 1800x1200 x 1.40mm

_____

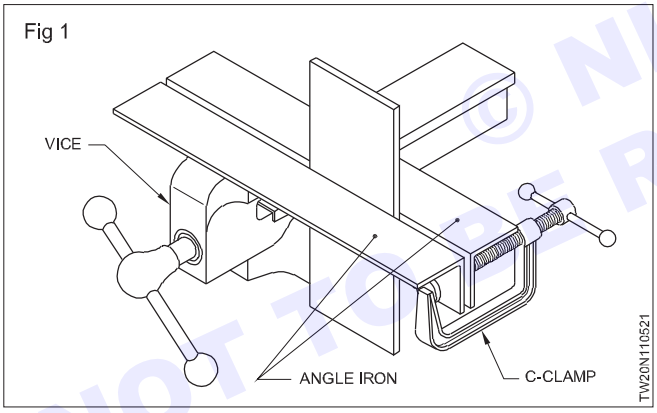
_____

Angle iron

Objectives: At the end of this lesson you shall be able to
- **state what is an angle iron.**

Angle iron (Fig 1): Angle iron is nothing but a standard mild steel angle used as a holding tool in folding sheet metal to a required angle.

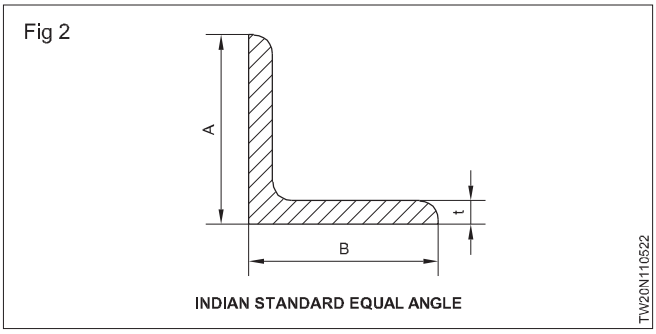
Fig 1



Generally, standard size mild steel angles are used as holding tools in sheet metal work. Length of the angle iron can vary according to the length of sheet metal to be folded.

According to IS808-1989, steel angles are classified as Indian Standard Equal leg angles, Indian Standard unequal leg angles. They are available in the following standard sizes. (Fig 1 & 2)

Fig 2



Indian standard equal angles

Size A x B in mm	Thickness (t) mm
20 x 20	3.0 4.0
25 x 25	3.0 4.0 5.0
30 x 30	3.0 4.0 5.0
35 x 35	3.0 4.0 5.0 6.0
40 x 40	3.0 4.0 5.0 6.0
45 x 45	3.0 4.0 5.0 6.0
50 x 50	3.0 4.0 5.0 6.0
55 x 55	5.0 6.0 8.0 10.0

Size A x B in mm	Thickness (t) mm
60 x 60	5.0 6.0 8.0 10.0
30 x 20	3.0 4.0 5.0
40 x 25	3.0 4.0 5.0 6.0
45 x 30	3.0 4.0 5.0 6.0
50 x 30	3.0 4.0 5.0 6.0

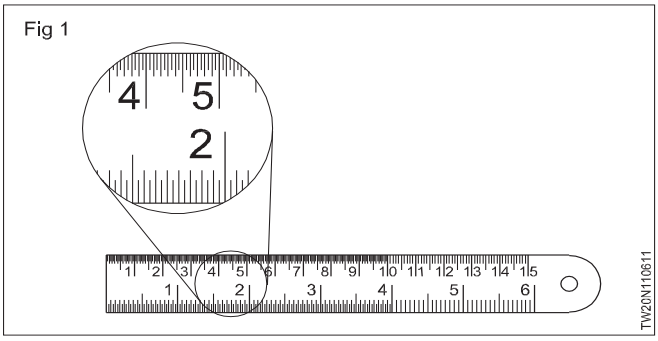
Size A x B in mm	Thickness (t) mm
60 x 40	3.0 6.0 8.0
65 x 45	5.0 6.0 8.0 10.0
70 x 45	5.0 6.0 8.0 10.0
75 x 50	5.0 6.0 8.0 10.0
80 x 50	5.0 6.0 8.0 10.0

Measuring tools - precision and non - precision - steel rule, calipers - vernier caliper micrometer - vernier height gauge - depth gauge types uses and specification

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

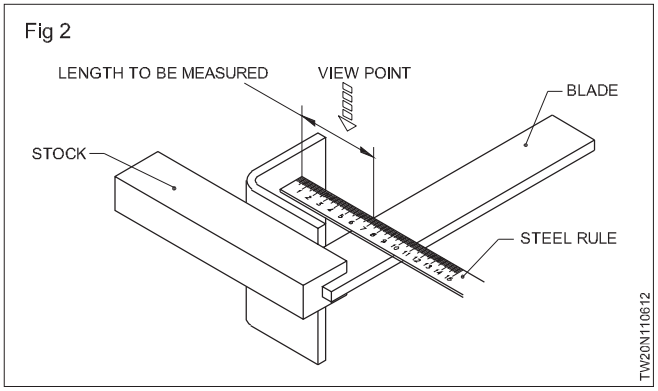
Steel rule: Engineer's steel rules (Fig 1) are used to measure the linear dimensions of workpieces. Steel rules are made of spring steel or stainless steel. These rules are available in lengths of 150 mm, 300 mm and 600 mm and 1000 mm. The reading accuracy of the steel rule is 0.5 mm.

Fig 1



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

Fig 2



For maintaining the accuracy of the 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 film of oil when not in use.

Measuring with inside and outside calipers

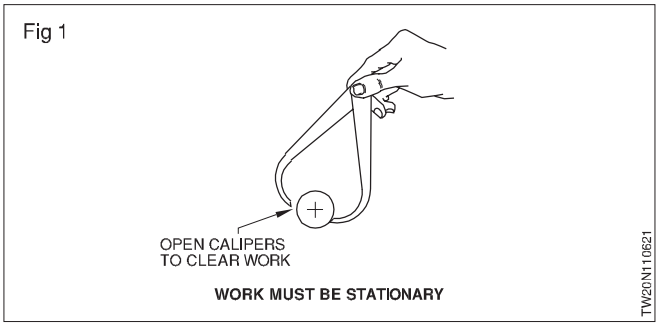
Objectives: At the end of this lesson you shall be able to
- **select the right capacity caliper for measurement**
- **set the sizes both in firm joint and spring calipers**
- **read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.**

Outside calipers: Select a caliper based on the diameter to be measured.

A 150 mm capacity outside caliper is able to measure sizes from 0-150 mm.

Open out the jaws of the calipers until they pass clearly over the diameter to be measured. The work must be stationary when measuring the sizes. (Fig 1)

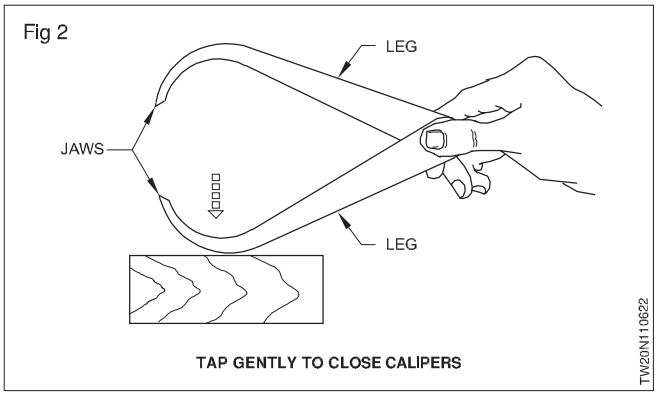
Fig 1



Place one point of the leg over the workpiece and get the sense of feel of the other point of the leg.

If there is clearance on the other point of the leg, gently tap the back of one leg of the firm joint calipers on a wooden piece until it just slips from the external diameter of the workpiece to give the right sense of 'feel'. (Fig 2)

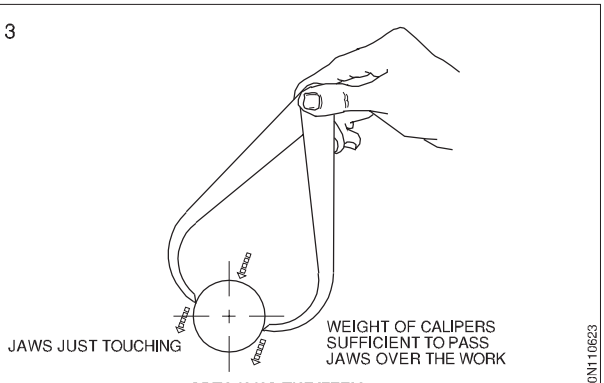
Fig 2



Because the accuracy of reading depends mainly upon the sense of feel of the user, high care should be exercised to get the correct `feel'.

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the jaws just slips from the external diameter of the workpiece to give the right sense of feel. (Fig 3)

Fig 3

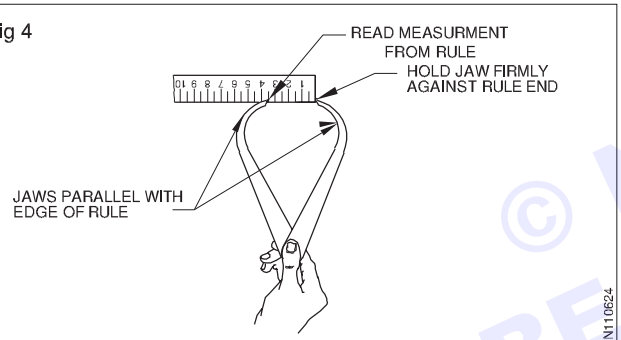


OBTAINING THE 'FEEL'

When you have adjusted the outside caliper for the correct 'feel' transfer the measurement to a steel rule or any other precision measuring instrument as the case may be.

Keep the graduated steel rule on a flat surface and hold the point of one jaw firmly against the rule end. (Fig 4)

Fig 4



CHECKING THE DIMENSION

The point of one jaw must be placed over the graduation so that the point of the other jaw is parallel with the edge of the steel rule.

Record the reading to an accuracy of ±0.5 mm.

In the case of precision measurements, transfer the measurements over an inside micrometer or vernier caliper. This measurement will give an accuracy of ± 0.01 or ± 0.02 mm. Here, the sense of feel of the user is very important in deciding the reading.

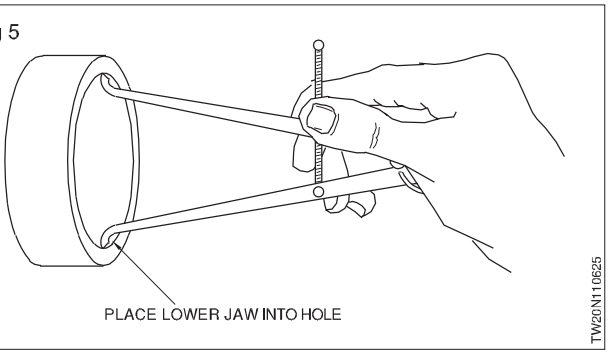
Inside caliper

Open out the jaws slightly less than the size to be measured.

Hold the caliper lightly in one hand with your thumb and first finger on the adjusting screws.

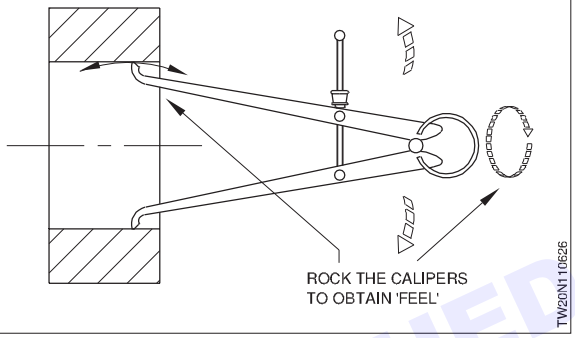
The point of one jaw should sit against the surface being measured. Support the weight of the caliper with the middle or third finger. (Fig 5)

Fig 5



Open out the other jaw and until you get the sense of 'feel' by rocking the other measurable surface. (Fig 6)

Fig 6



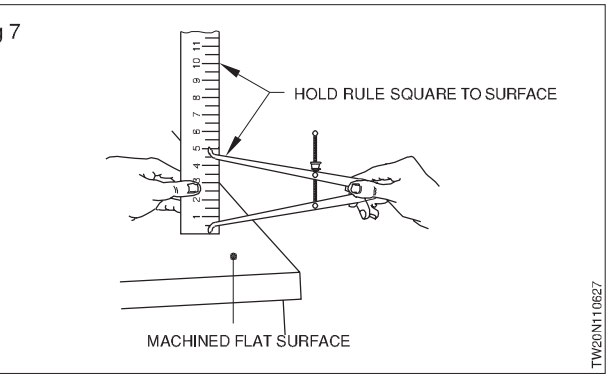
When a satisfactory sense of 'feel' is felt, transfer the measurement over a steel rule or precision measuring instrument as the case may be.

Hold the steel rule square on the machined flat surface.

Place one measuring jaw near the steel rule edge so that the point firmly touches the flat machined surface.

Keep the other measuring jaw parallel to the edge of the steel rule. (Fig 7)

Fig 7



Read the graduation to an accuracy of ± 0.5 mm.

While transferring the measurement over to outside micrometer or universal vernier caliper, hold the caliper in the left hand, and the micrometer or the vernier caliper in the right hand.

Place one measuring jaw over the anvil surface and close the spindle over the other measuring jaw of the other leg.

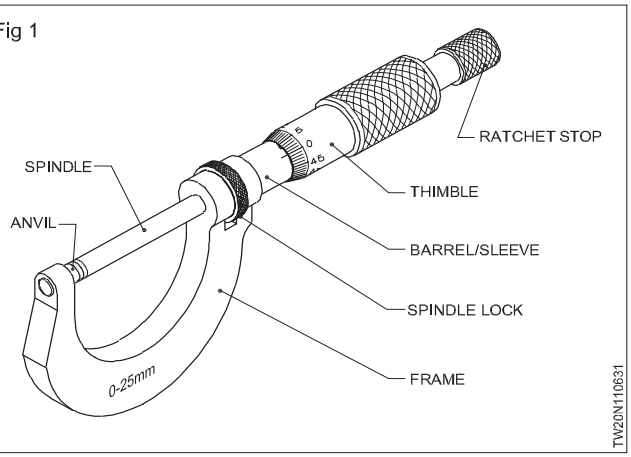
Outside micrometer

Objectives: At the end of this lesson you shall be able to
- **name 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 beveled 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.

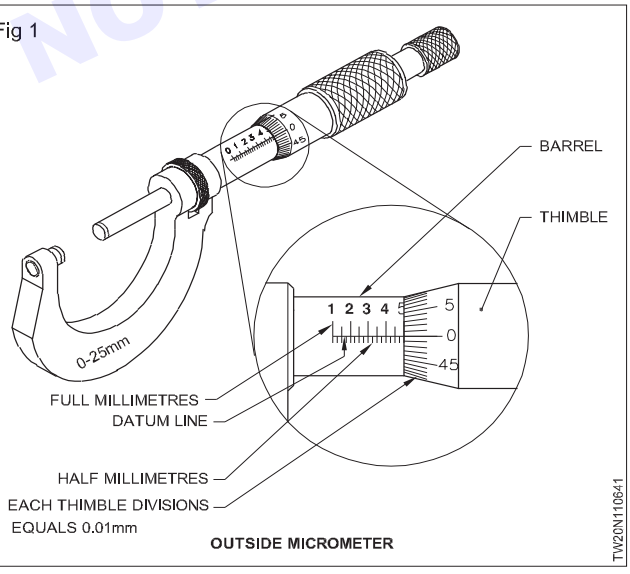
Graduations of metric outside micrometer

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)

Fig 1



OUTSIDE MICROMETER

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 0.01 mm.

Reading dimensions with outside micrometer

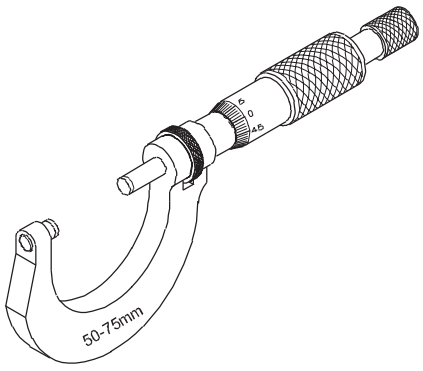
Objectives: At the end of this lesson you shall be able to
- **select the required range of a micrometer**
- **read micrometer measurements.**

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)

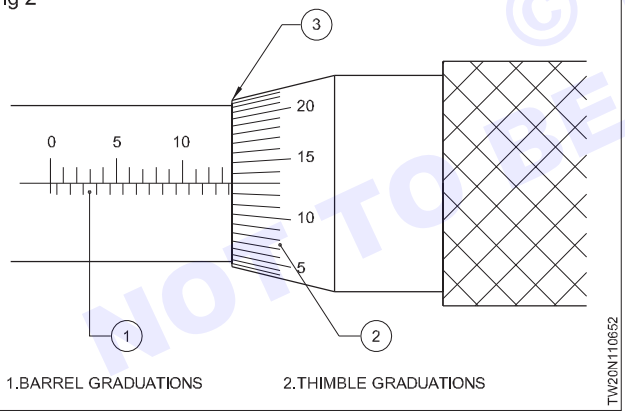
Fig 1



Reading micrometer measurements

How to read a measurement with an outside micrometer? (Fig 2)

Fig 2



First note the minimum range of the outside micrometer. While measuring with a 50 to 75 mm micrometer, note it as 50 mm.

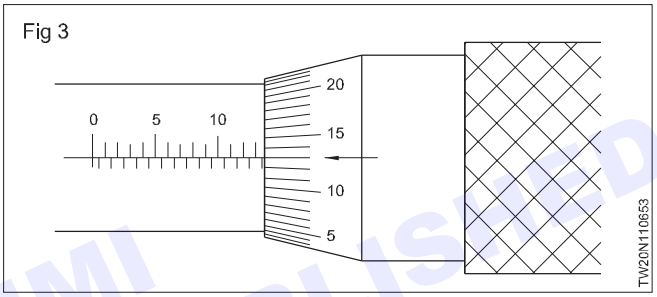
Then read the barrel graduations. Read the value of the visible lines on the left of the thimble edge.

13.00 mm (Main division reading on barrel)
+ 00.50 mm (Sub division reading on barrel)
13.50 mm (Main division + sub division value)

Next read the thimble graduations.

Read the thimble graduations in line with the barrel datum line, 13th div. (Fig 3)

Fig 3



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.

Inside micrometer

Objectives: At the end of this lesson you shall be able to
- **list the purposes of an inside micrometer**
- **identify the parts of an inside micrometer**
- **state the safety precautions to be followed while using an inside micrometer.**

An inside micrometer is a precision measuring instrument which measures with an accuracy of 0.01mm.

Purpose

An inside micrometer is used to measure the diameter of holes. (Fig 1)

To measure the distance between internal parallel surfaces like slots (Fig 2)

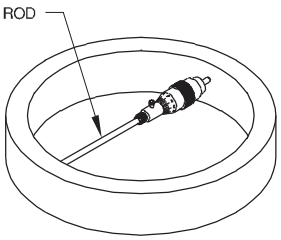
Parts (Fig 3)

The following are the parts of an inside micrometer.

Micrometer head

It consists a sleeve, a thimble, an anvil and locking screw for extension rods.

Fig 1



MEASURING A LARGE BORE USING AN INSIDE MICROMETER WITH AN EXTENSION ROD FITTED

TW20N110661

Fig 2

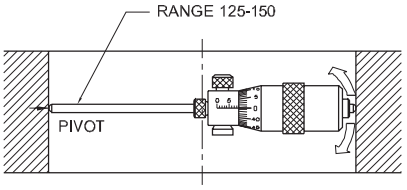


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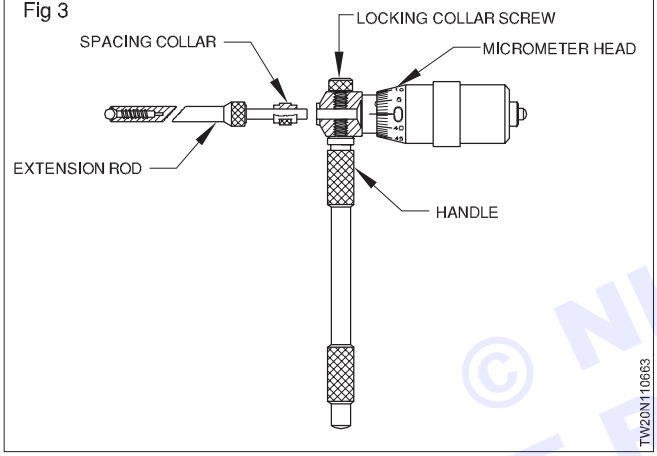
Fig 3



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Extension rod

This is fitted in the hole provided in the barrel of the micrometer head. It provides another measuring surface. It is available in different sizes.

Locking screw

It is used to lock the extension rods.

Handle: It is fitted in the threaded hole provided in the micrometer head. It is used to hold the micrometer assembly while measuring deep bores.

Spacing collar: It is added to the extension rod for additional length. It is available in different sizes.

The range of inside micrometer: Using the different sizes of extension rods and spacing collars the following ranges of measurement can be taken

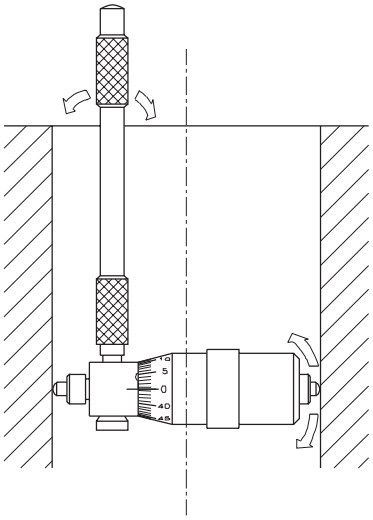
25-50mm, 50-200mm, 50-300mm, 200-500mm,200-1000mm

Inside micrometer

Ranges of extension rod for (50 - 200mm) Inside micrometer

Checking parallelism of surfaces of deep bores: An extended handle can be used while measuring deep bores. (Fig 4) for checking the parallelism of surfaces of the bore.

Fig 4



USING AN EXTENDED HANDLE WHEN MEASURING THE BORE

TW20N110664

Find out the readings at 2 or 3 places i.e. one reading at the top, another reading at the middle and the third reading at the bottom of the bore. If all the three readings are the same, then the surfaces of the bore are parallel. Any variation in the readings shows an error in the bore.

Precautions

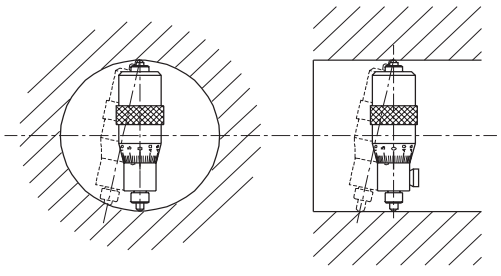
Ensure that the extension rod/spacing collar are fitted correctly.

Check the 'O" setting of the inside micrometer with an outside micrometer.

Ensure that the measuring faces are perpendicular to the axis, and the handle parallel to the axis of the above.

When measuring bores the micrometer must be set for the largest value. While measuring between flat surfaces, the micrometer should be set for the smallest value. (Fig 5 & 6)

Fig 5



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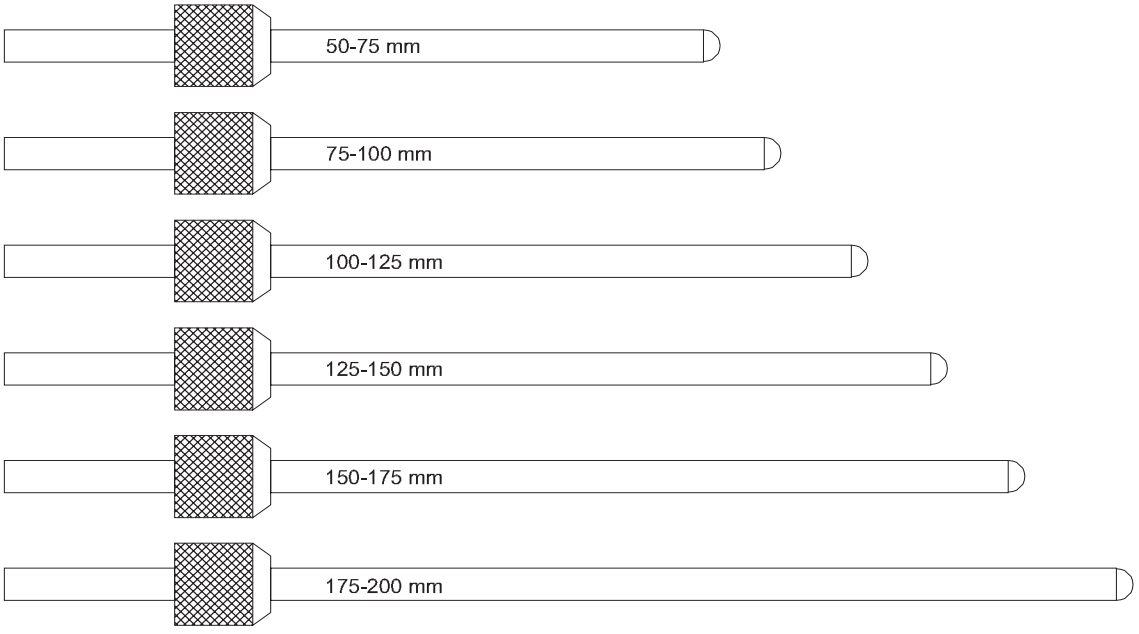
Ensure that the wall surfaces of the bore are free from burrs, oil etc. before using an inside micrometer. Set the inside micrometer in the bore to the correct FEEL. Do not drag or force the inside micrometer in the bore.

Fig 6



EXTENSION RODS

Depth micrometer

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

- **name the parts of a depth micrometer**
- **state the constructional features of a depth micrometer**
- **read depth micrometer measurements.**

Constructional features

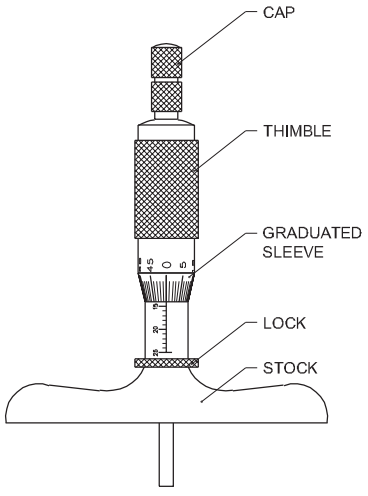
The depth micrometer consists of a stock on which a graduated sleeve is fitted.

The other end of the sleeve is threaded with a 0.5 mm pitch `V' thread.

A thimble which is internally threaded to the same pitch and form, mates with the threaded sleeve and slides over it.

The other end of the thimble has an external step machined and threaded to accommodate a thimble cap. (Fig 1)

Fig 1



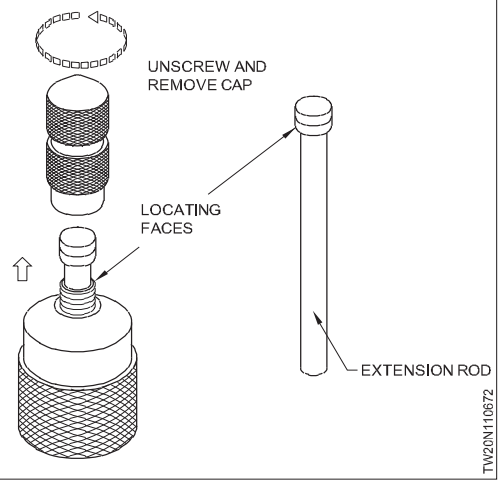
DEPTH MICROMETER

A set of extension rods is generally supplied. On each of them the range of sizes that can be measured with that rod, is engraved as 0-25, 25-50, 50-75, 75-100, 100-125 and 125-150.

These extension rods can be inserted inside the thimble and the sleeve.

The extension rods have a collar-head which helps the rod to be held firmly. (Fig 2)

Fig 2



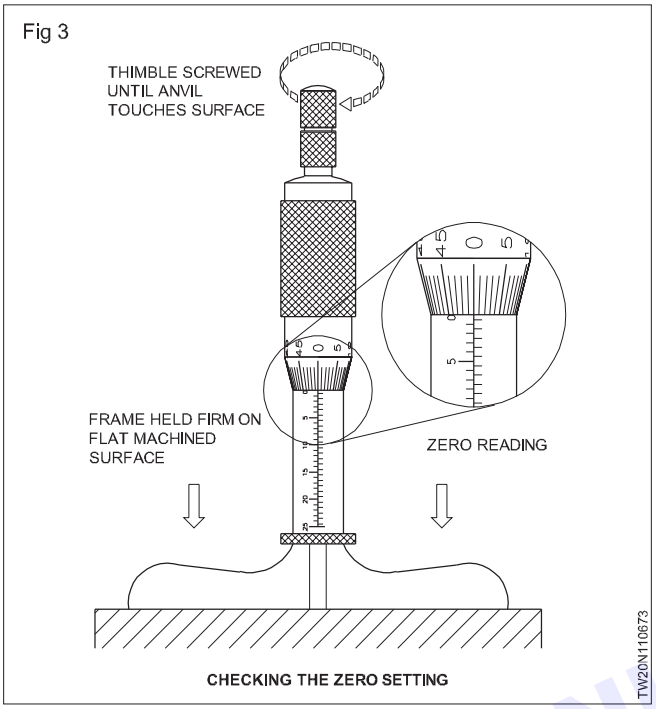
The measuring faces of the stock and the rods are hardened, tempered and ground. The measuring face of the stock is perfectly machined flat.

The extension rods may be removed and replaced according to the size of depth to be measured.

Graduation and least count

On the sleeve a datum line is marked for a length of 25 mm. This is divided into 25 equal parts and graduated, each line representing one millimetre. Each fifth line is drawn a little longer and numbered. Each line representing 1 mm is further subdivided into two equal parts. Hence each sub-division represents 0.5 mm. (Fig 3)

Fig 3



CHECKING THE ZERO SETTING

The graduations are numbered in the reverse direction, to that marked on an outside micrometer.

The zero graduation of the sleeve is on the top and the 25 mm graduation near the stock.

The bevel edge of the thimble is also graduated. The circumference is equally divided into 50 equal parts and every 5th division line is drawn a little longer and numbered. The numbering is in the reverse direction and increases from 0, 5,10,15, 25, 30, 35, 40,45 and 50 (0). (Fig 4)

The advancement of the extension rod for one full turn of the thimble is one pitch which is 0.5 mm.

Therefore, the advancement of the extension rod for one division movement of the thimble will be equal to 0.5 / 50 = 0.01 mm.

This will be the smallest measurement that can be taken with this instrument, and so, this is the accuracy of this instrument.

Fig 4

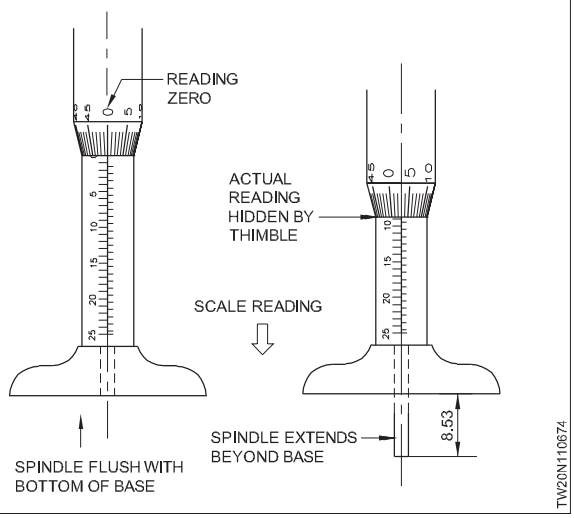
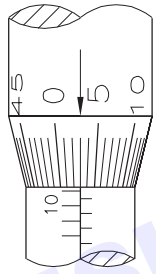


Fig 5



Reading of depth micrometer

Barrel reading (1 mm division)	=	8 x 1 mm	= 8.00 mm
Sub division (0.5 mm division)	=	1 x 0.5 mm	= 0.50 mm
Thimble reading	=	3 x 0.01 mm	= 0.03 mm
(Thimble division x L.C) Total reading			= 8.53 mm

In barrel reading main division and sub division have been hidden covered by thimble

Uses of depth micrometer

- Depth micrometers are special micrometers used to measure
- The depth of holes.
- The depth of grooves and recesses
- The heights of shoulders or projections.

Vernier calipers

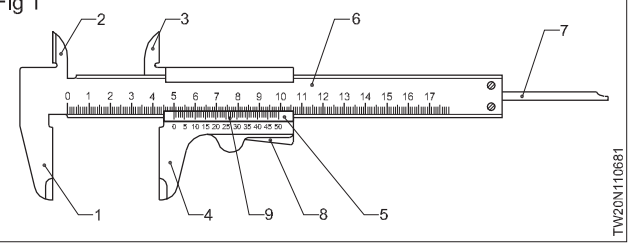
Objectives : At the end of this lesson you shall be able to
- **name the parts of a vernier caliper**
- **describe the parts of a vernier calipers**
- **state the uses of a vernier caliper.**

A vernier caliper is a precision measuring instrument. It is used to measure up to an accuracy of 0.02 mm. (Fig 1)

Parts of a vernier caliper

(Numbers as per Fig 1)

Fig 1



Fixed jaws (1 and 2): Fixed jaws are part of the beam scale. One jaw is used for taking external measurements, and the other for taking internal measurements.

Movable jaws (3 and 4): Movable jaws are part of the vernier slide. One jaw is used for external measurements, and the other for internal measurements. (Fig 2 & 3)

Fig 2

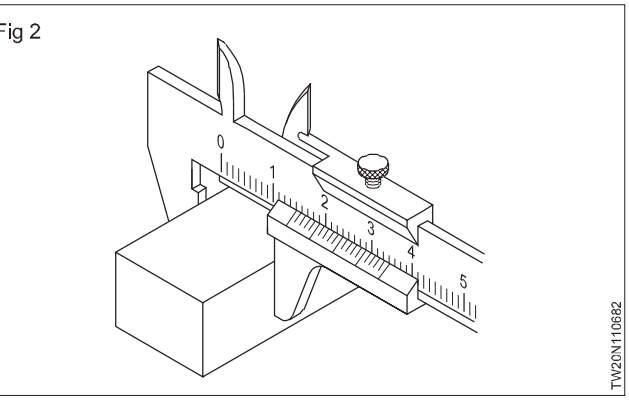
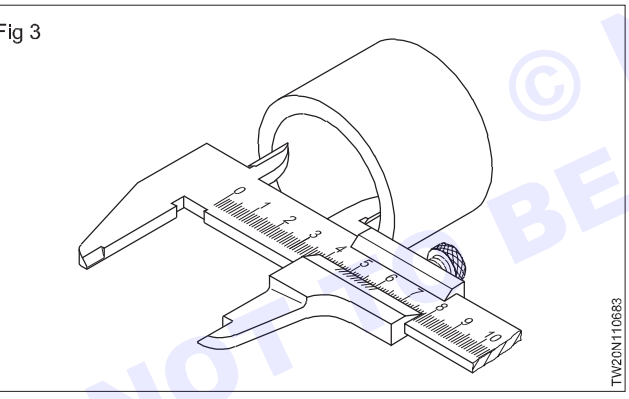


Fig 3

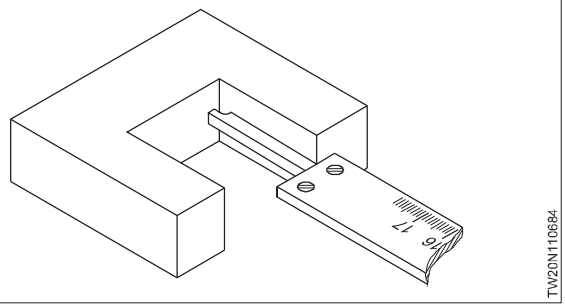


Vernier slide (5): A vernier slide moves over the beam and can be set in any position by means of a spring-loaded thumb lever.

Beam (6): The vernier slide and the depth bar attached to it, slide over the beam. The graduations on the beam are called the main scale divisions.

Depth bar (7) (Fig 4): The depth bar is attached to the vernier slide and is used for measurement of depth.

Fig 4



Thumb lever (8): The thumb lever is spring-loaded which helps to set the vernier slide in any position on the beam scale.

Vernier scale (9): The vernier scale is the graduation marked on the vernier slide. The divisions of this scale are called vernier divisions.

Main scale: The main scale graduations or divisions are marked on the beam.

Sizes: Vernier calipers are available in sizes of 150 mm, 200, 250, 300 and 600 mm. The selection of the size depends on the measurements to be taken. Vernier calipers are precision instruments, and therefore, 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 a vernier caliper**
- **state how graduations are made on a vernier caliper with 0.02 mm 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 sizes of the job to be measured.

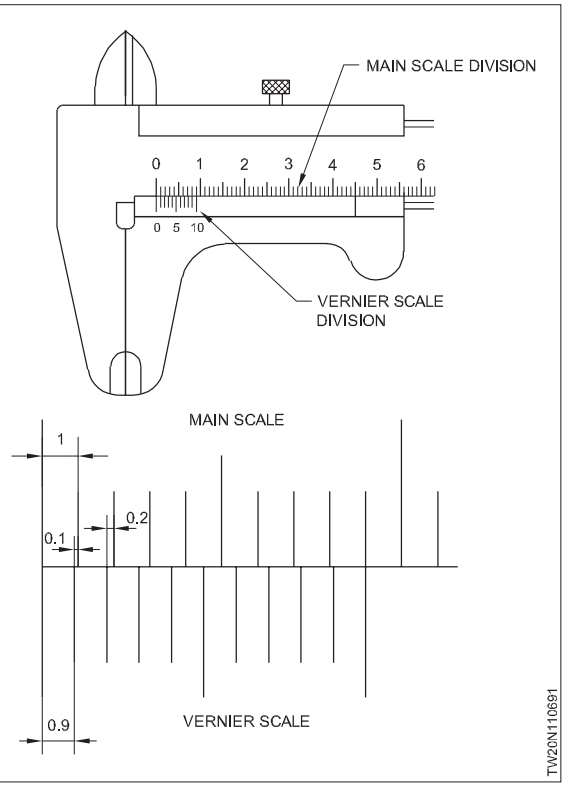
This accuracy/least count is determined by the graduations of the main scale and the vernier scale divisions.

Vernier principle: The vernier principle states that two different scales are constructed on a single known length of line and the difference between them is taken for fine measurements.

Determining the least count of vernier calipers: In the vernier caliper shown in Fig 1 the main scale divisions (9 mm) are divided into 10 equal parts in the vernier scale.

i.e. One main scale division (MSD) = 1 mm

Fig 1



One vernier scale division (VSD) = 9/10 mm

Least count = 1 MSD - 1 VSD

= 1 mm - 9/10 mm

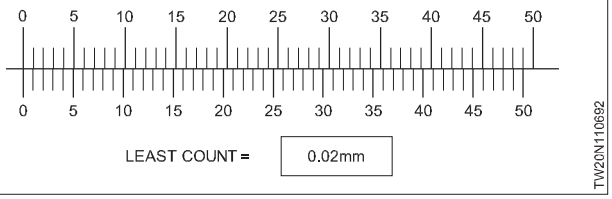
= 0.1 mm

The difference between one MSD and one VSD = 0.1 mm

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)

Fig 2 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



Example

Calculate the least count of the vernier given in Fig 2.

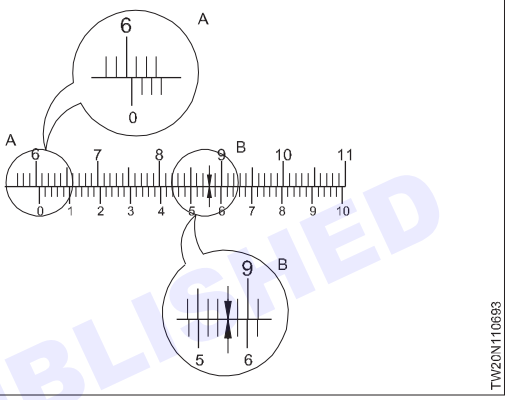
Least count = 1 mm - 49/50 mm

= 1/50 mm

= 0.02 mm.

Example for reading vernier caliper (Fig 3)

Fig 3



Main scale reading = 60 mm

The vernier division coinciding with the main scale is the 28th division, value = 28 x 0.02mm

= 0.56 mm

Reading = 60 + 0.56

Total Reading = 60.56 mm

Vernier height gauge

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

- **name the parts of a vernier height gauge**
- **state the constructional features of a vernier height gauge**
- **state the functional features of a vernier height gauge**
- **state the various applications of the vernier height gauge in engineering.**

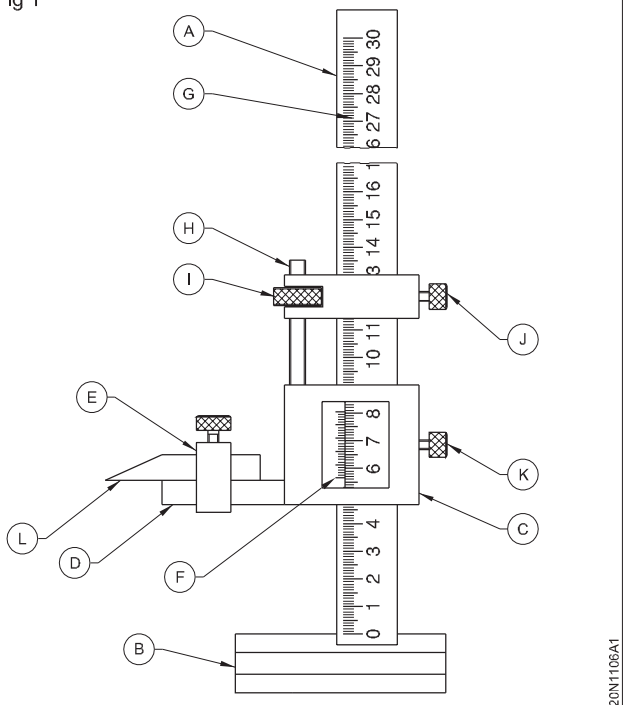
Parts of a vernier height gauge (Fig 1)

A	Beam
B	Base
C	Main slide
D	Jaw
E	Jaw clamp
F	Vernier scale
G	Main scale
H	Finer adjusting slide
I	Finer adjusting nut
J&K	Locking screws
L	Scriber blade

Constructional features of a vernier height gauge: The construction of a vernier height gauge is similar to that of the vernier caliper that it is vertical with a rigid base. It is graduated on the same vernier principle which is applied to the vernier caliper.

The beam is graduated with the main scale in mm as well as in inches. The main slide carries a jaw upon which various attachments may be clamped. The jaw is an integral part of the main slide.

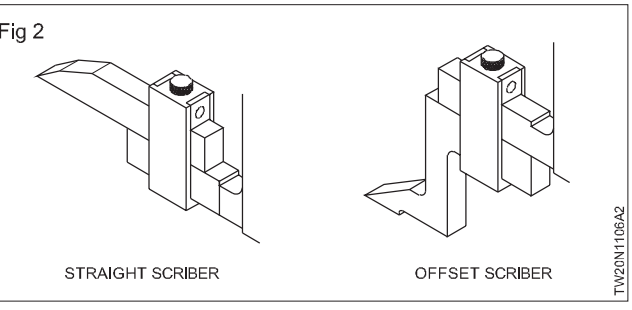
Fig 1



The vernier scale is attached to the main slide which has been graduated, to read metric dimensions as well as the inch dimensions. The main slide is attached with the finer adjusting slide. The movable jaw is most widely used with the chisel pointed scriber blade for accurate marking out as well as for checking the height, steps etc. Care should be taken to allow for the thickness of the jaw depending on whether the attachment is clamped on the top or under the jaw for this purpose.

The thickness of the jaw is marked on the instrument. As like in a vernier caliper, the least count of this instrument is also 0.02 mm. An offset scriber is also used on the movable jaw when it is required to take measurement from the lower planes. (Fig 2) The complete sliding attachment along with the jaw can be arrested on the beam to the desired height with the help of the locking screws. The vernier height gauges are available in ranges of capacities reading from zero to 1000 mm.

Fig 2



Functional features of the vernier height gauge: Vernier height gauges are used in conjunction with the surface plate. In order to move the main slide, both the locking screws of the slide and the finer adjusting slide have to be loosened. The main slide along with the chisel pointed scriber has to be set by hand, for an approximate height as required.

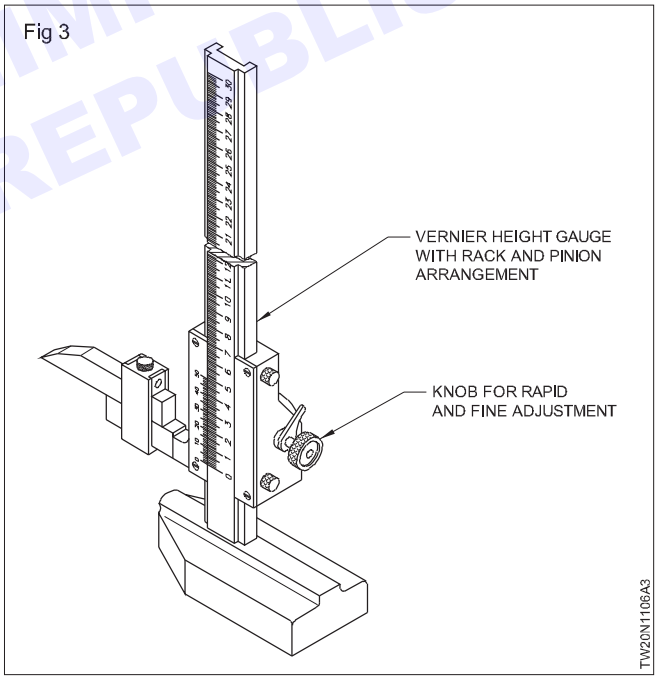
The finer adjusting slide has to be locked in position, for an approximate height as required. To get an exact markable height, the finer adjustments have to be carried on the slider with the help of the adjusting nut. After obtaining the exact markable dimension, the main slide is also to be locked in position.

Modern vernier height gauges are designed on the screw rod principle. In these height gauges, the screw rod may be operated with the help of the thumb screw at the base. In order to have a quick setting of the main slide, it is designed with a quick releasing manual mechanism. With the help of this, it is possible to bring the slide to a desired approximate height without wastage of time. For all other purposes, these height gauges work as ordinary height gauges. In order to set the 'zero' graduation of the main scale for the initial reading.

Some vernier height gauges are equipped with a sliding main scale which may be set immediately for the initial reading. This minimises the possible errors in reading the various sizes in the same setting.

Another kind of modern vernier height gauge has a rack and pinion set up for operating the sliding unit. This is shown in Fig 3.

Fig 3



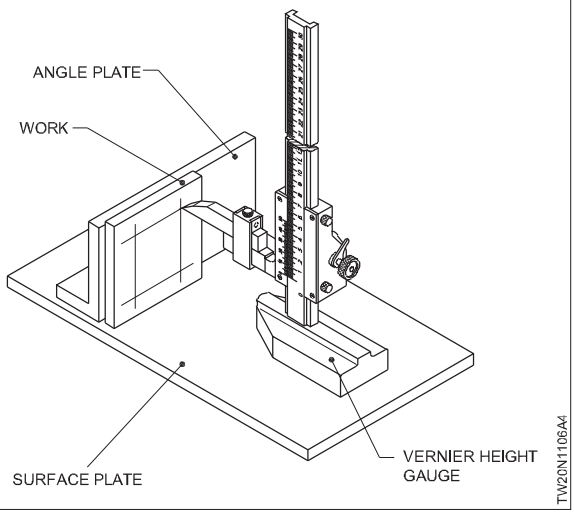
Various applications of a vernier height gauge: The vernier height gauge is mainly used for layout work. (Fig 4)

It is used for measuring the width of the slot and external dimension.

The vernier height gauge is used with the dial indicator to check hole location, pitch dimensions, concentricity and eccentricity.

It is also used for measuring depth, with a depth attachment.

Fig 4



It is used to measure sizes from the lower plane with the help of an offset scriber.

Care and Maintenance

Store after use in room with controlled temperature

Care and maintenance

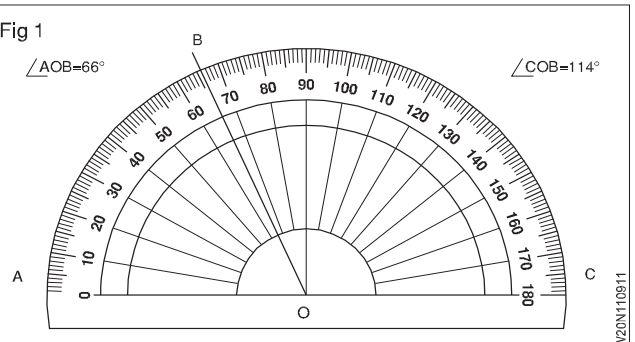
- Store after use in room with controlled temperature
- Do not drop (or) knock it
- Clean tool before and after use
- Do not take measurement on rotating specimen.
- Do not keep with other working tools.

Measurement of angles, vernier bevel protractor graduation on universal bevel protractor - reading of universal bevel protractor

Objectives: At the end of this lesson you shall be able to
- **state the units and fractional units of angles**
- **express degrees, minutes and seconds using symbols.**

The unit of an angle: For angular measurements a complete circle is divided into 360 equal parts. Each division is called a degree. (A half circle will have 180°. (Fig 1)

Fig 1



Subdivisions of an angle: For more precise angular measurements, one degree is further divided into 60 equal parts. This division is one MINUTE (‘). The minute is used to represent a fractional part of a degree and is written as 30° 15’.

One minute is further divided into smaller units known as seconds (“). There are 60 seconds in a minute.

An angular measurement written in degrees, minutes and seconds would read as 30° 15' 20".

Examples for angular divisions

1	complete circle	360°
1/2	circle	180°
1/4	of a circle (right angle)	90°

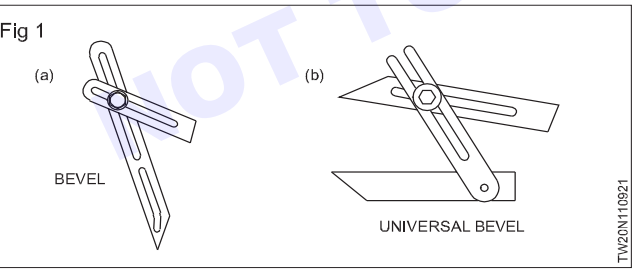
Sub divisions 1 degree or 1° = 60 mts or 60'
1 min or 1' = 60 secs or 60"

Angular measuring instruments (Semi-precision)

Objectives: At the end of this lesson you shall be able to
- **state the names of semi-precision angular measuring instruments**
- **differentiate between bevel and universal bevel gauges**
- **state the features of bevel protractors.**

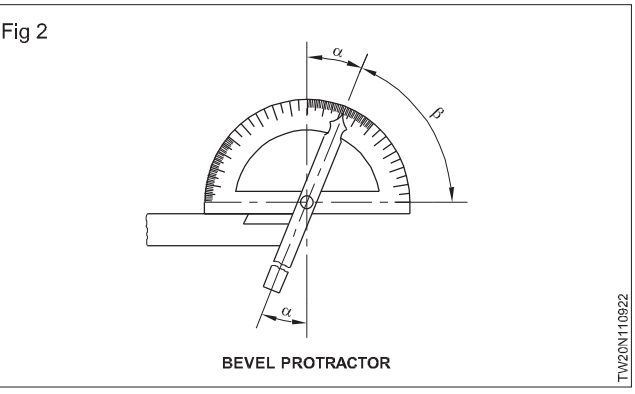
The most common instruments used to check angles are the bevel or bevel gauge (Fig 1)

Fig 1



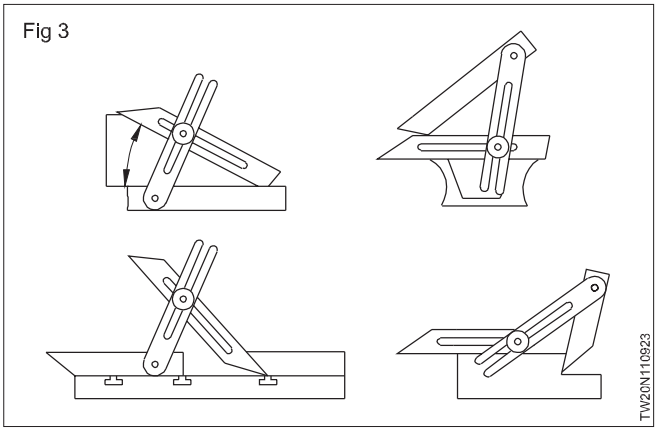
universal bevel gauge (Fig 2)

Fig 2



bevel protractor. (Fig 3)

Fig 3



Bevel gauges: The bevel gauges cannot measure angles directly. They are, therefore, indirect angular measuring instruments. The angles can be set and measured with bevel protractors.

Universal bevel gauges: The universal bevel gauge has an additional blade. This helps in measuring angles which cannot be checked with an ordinary bevel gauge.

Bevel protractor (Fig 3): The bevel protractor is a direct angular measuring instrument, and has graduation marked from 0° to 180°. Angles can be measured within an accuracy of 1° using this instrument. (Fig 3)

Vernier bevel protractor

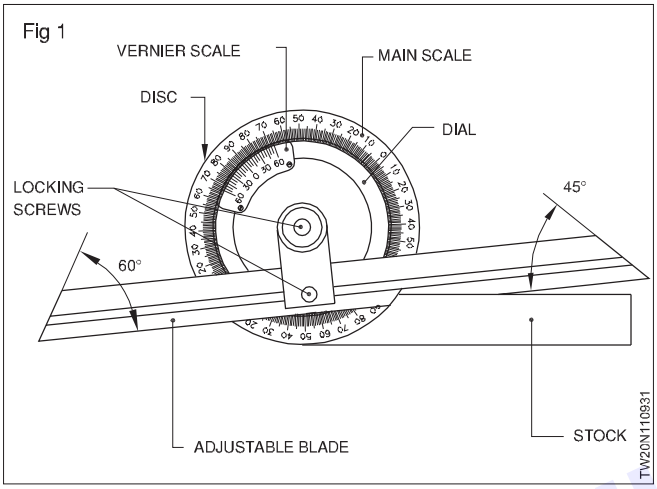
Objectives : At the end of this lesson you shall be able to
- **name the parts of a vernier bevel protractor**
- **state the functions of each part**
- **list out the uses of a vernier bevel protractor.**

The vernier bevel protractor is a precision instrument meant for measuring angles to an accuracy of 5 minutes. (5')

Parts of a vernier bevel protractor

The following are the parts of a vernier bevel protractor. (Fig 1)

Fig 1



Stock: This is one of the contacting surfaces during the measurement of an angle. Preferably it should be kept in contact with the datum surface from which the angle is measured.

Dial: The dial is an integrated part of the stock. It is circular in shape, and the edge is graduated in degrees.

Blade: This is the other surface of the instrument that contacts the work during measurement. It is fixed to the dial with the help of the clamping lever. A parallel groove is provided in the centre of the blade to enable it to be longitudinally positioned whenever necessary.

Locking screws: Two knurled locking screws are provided, one to lock the dial to the disc, and the other to lock the blade to the dial.

All parts are made of good quality steel, properly heat-treated and highly finished. A magnifying glass is sometimes fitted for clear reading of the graduations.

U**ses of a vernier bevel protractor:** Apart from being used for measuring angles a vernier bevel protractor is also used for setting work-holding devices on machine tools, work-tables etc.

The vernier bevel protractor is used to measure acute angles less than 90° (Fig 2) obtuse angles more than 90° (Fig 3).

Fig 2

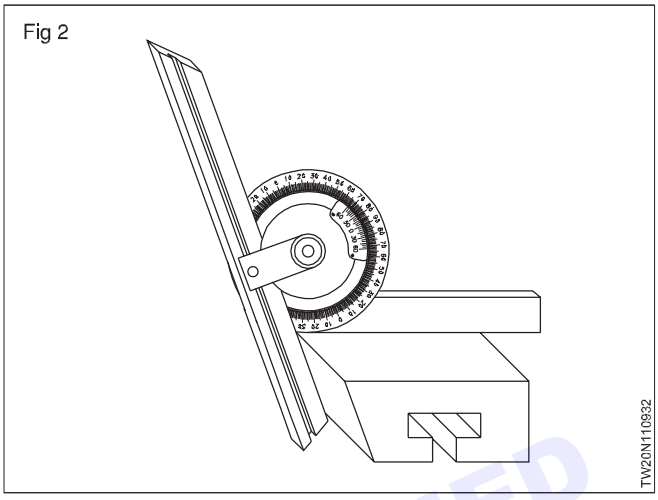
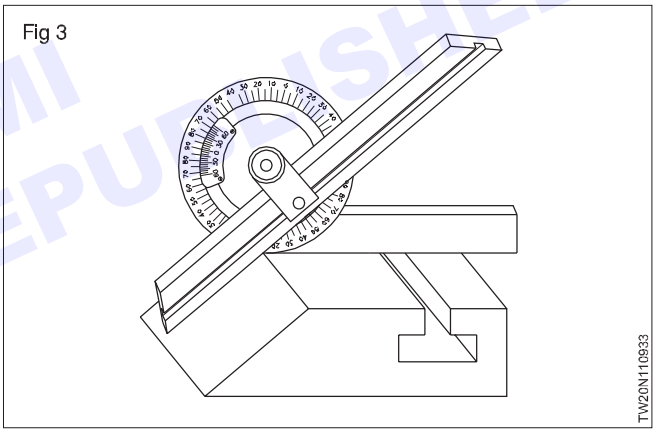
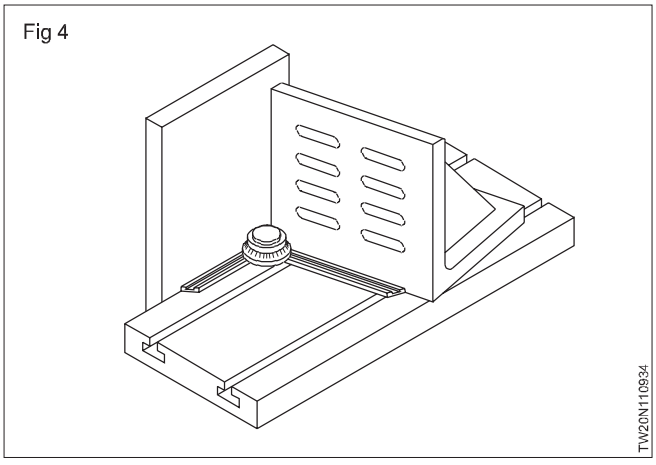


Fig 3



For setting work-holding devices to angles on machine tools, work tables etc., (Fig 4)

Fig 4

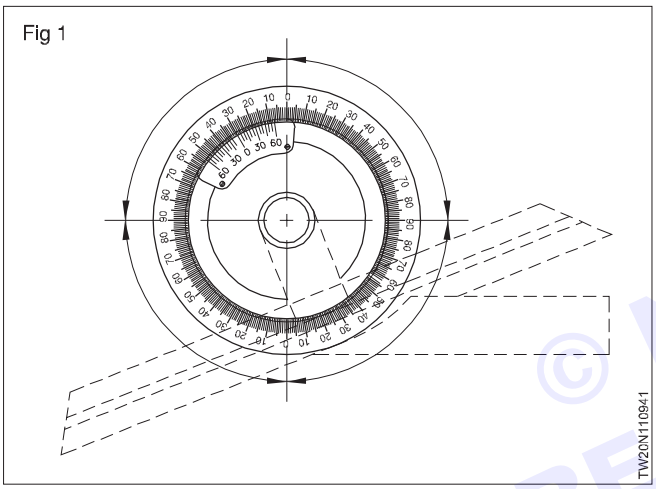


Graduations on universal bevel protractor

Objectives: At the end of this lesson you will be able to
- **state the main scale graduations on the disc**
- **state the vernier scale graduations on the dial**
- **determine the least count of the vernier bevel protractor.**

The main scale graduations (Fig 1 & 2): For purposes of taking angular measurements, the full circumference of the dial is graduated in degrees. The 360° are equally divided and marked in four quadrants, from '0' degree to 90 degrees, 90 degrees to '0' degree. Every tenth division is marked longer and numbered. Each division represents 1 degree. The graduations on the dial are known as the main scale divisions. On the disc, 23 divisions spacing of the main scale is equally divided into 12 equal parts on the vernier. Each 3rd line is marked longer and numbered as 0, 15, 30, 45, 60. This constitutes the vernier scale. Similar graduations are marked to the left of '0' also. (Fig 1)

Fig 1



One vernier scale division VSD (Fig 2)

The least count of the vernier bevel protractor: When the zero of the vernier scale coincides with the zero of the main scale, the first division of the vernier scale will be very close to the 2nd main scale division. (Fig 2)

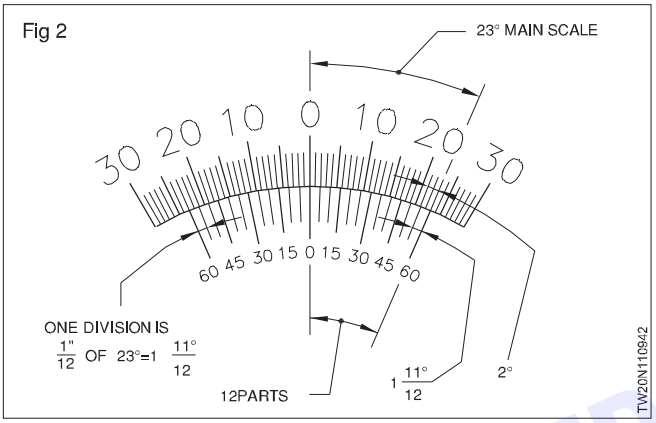
Hence the least count is

2 MSD - 1 VSD

i.e the least count = 2˚

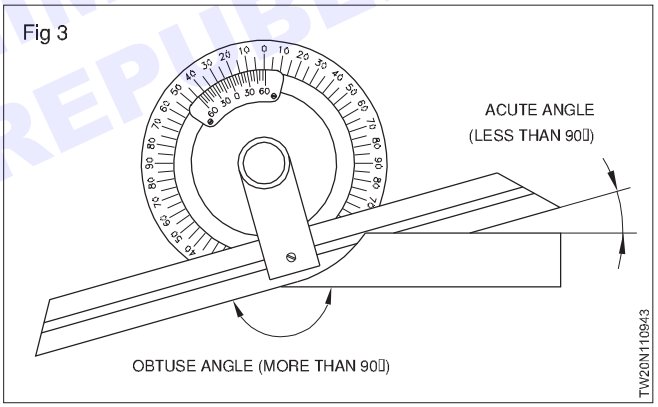
$$= \frac{24}{12} - \frac{23^\circ}{12} = \frac{1^\circ}{12} \text{ or } 5'$$

Fig 2



For any setting of the blade and stock, the reading of the acute angle and the supplementary obtuse angle is possible, and the two sets of the vernier scale graduations on the disc assist to achieve this. (Fig 3)

Fig 3



Reading of universal bevel protractor

Objectives: At the end of this lesson you will be able to
- **read a vernier bevel protractor for acute angle setting**
- **read a vernier bevel protractor for obtuse angle setting.**

For reading acute angle set up (Fig 1): First read the number of whole degrees between zero of the main scale and zero of the vernier scale.

Note the line on the vernier scale that exactly coincides with any one of the main scale divisions and determine its value in minutes. (Fig 2)

To take the vernier scale reading, multiply the coinciding divisions with the least count.

Example

10 x 5' = 50'

Total up both the readings to get the measurements = 41°50'.

If you read the main scale in an anticlockwise direction, read the vernier scale also in an anticlockwise direction from zero.

Fig 1

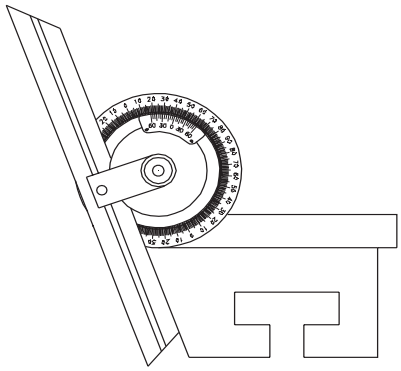


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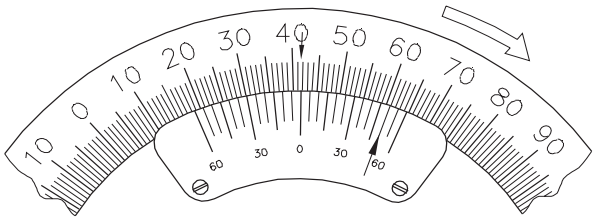
Fig 2



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For obtuse angle set up (Fig 3)

The vernier scale reading up is taken on the left side as indicated by the arrow (Fig 4). The reading value is subtracted from 180° to get the obtuse angle value.

Reading 22° 30'

Measurement 180°-22°30'=157"30'

Fig 3

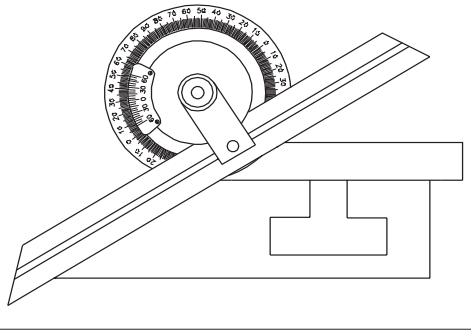

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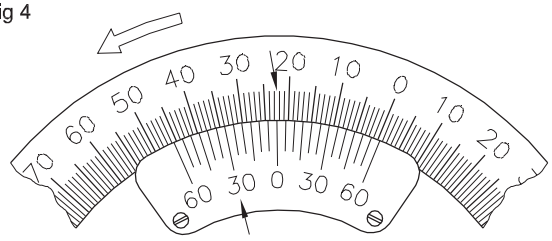
Fig 4



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Care and maintenance of vernier bevel protractor

1 Clean the vernier bevel protractor before use.

2 Loosen the locking screw of dial to move the blade according to the angle measurement.

3 While taking a measurement apply light pressure on vernier bevel protractor

4 Heavy pressure will force the two scales out of parallel and show the false reading.

5 After using vernier bevel protractor wipe it clean and apply a thin coating of oil and keep it in safe place.

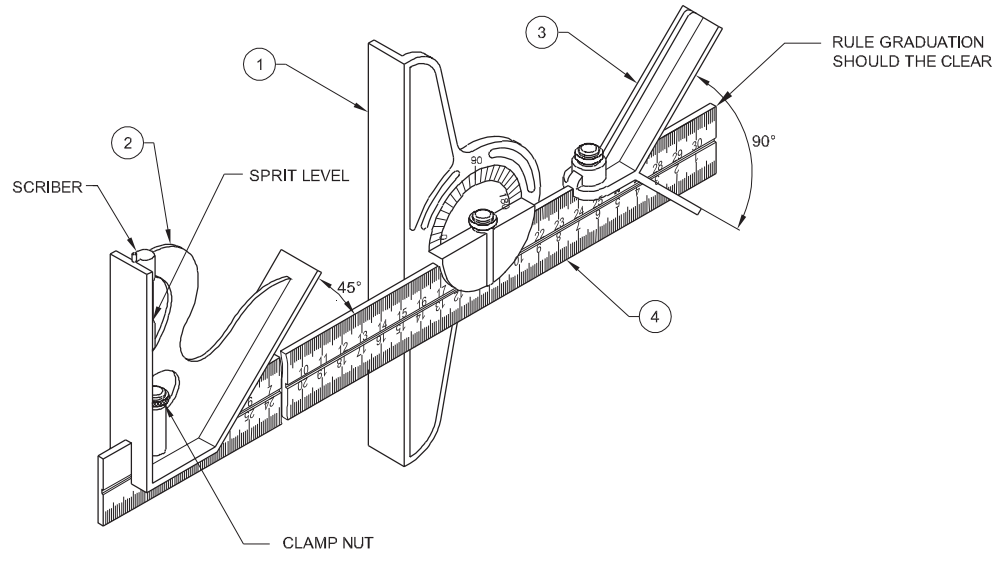
Combination set

Objectives: At the end of this lesson you shall be able to
- **name the parts of a combination set**
- **state the uses of each attachment in a combination set.**

Combination sets can be used for different types of work, like layout work, measurement and checking of angles.

The combination set (Fig 1) has a

Fig 1



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Protractor head (1)

Square Head (2)

Centre head, and a (3)

Rule (4)

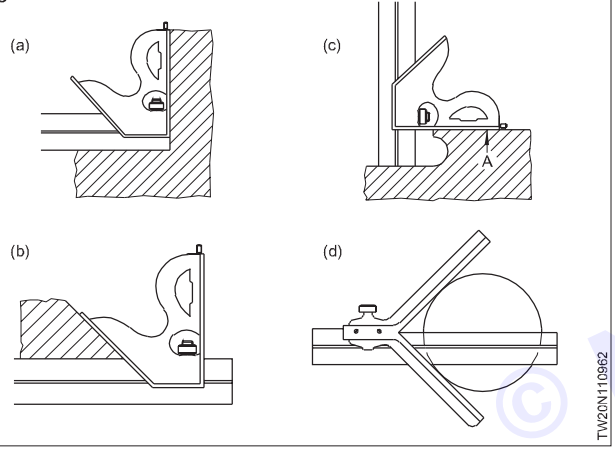
Protractor head: The protractor head can be rotated and set to any required angle.

The protractor head is used for marking and measuring angles within an accuracy of 1˚. The spirit level attached to this is useful for setting jobs in a horizontal plane. (Fig 3)

Square head: The square head has one measuring face at 90˚ and another at 45˚ to the rule.

It is used to mark and check 90˚ and 45˚ angles. It can also be used to set workpieces on the machines and measure the depth of slots. (Fig 2a,2b,2c & 2d)

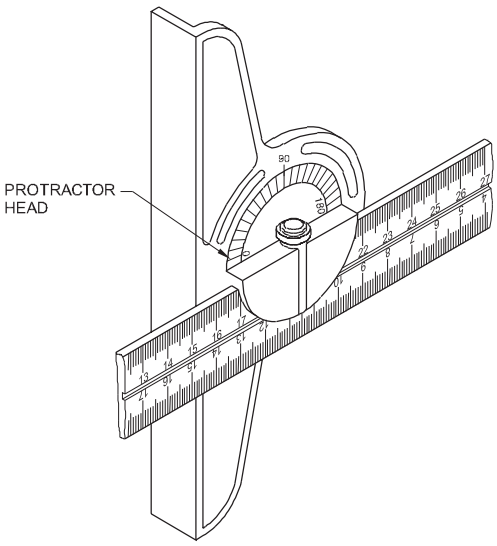
Fig 2



Centre head

This along with the rule is used for locating the centre of cylindrical jobs. (Fig 3)

Fig 3



For ensuring accurate results, the combination set should be cleaned well after use and should not be mixed with cutting tools, either while using or storing.

Types of drilling machine, drill chuck specification, drill types

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

The principle types of drilling machines are

– The sensitive bench drilling machine

– The pillar drilling machine

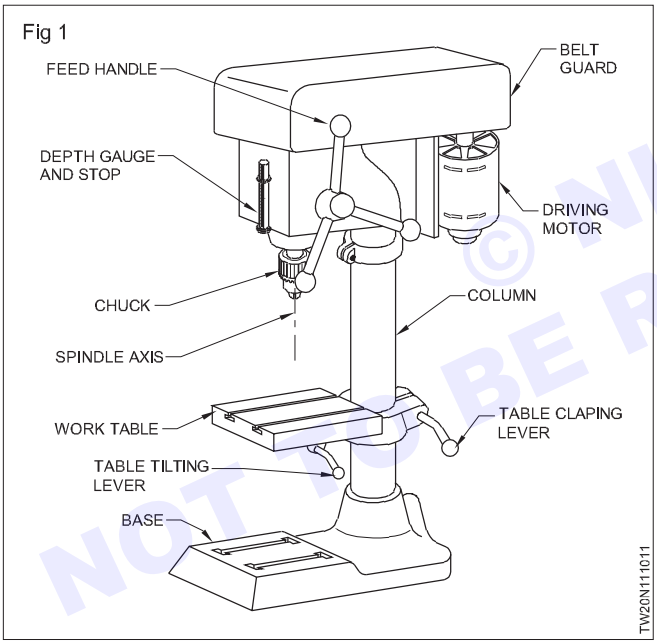
– The column drilling machine

– 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 bench and pillar type machines are explained here)

The sensitive bench drilling machine (Fig 1)

Fig 1



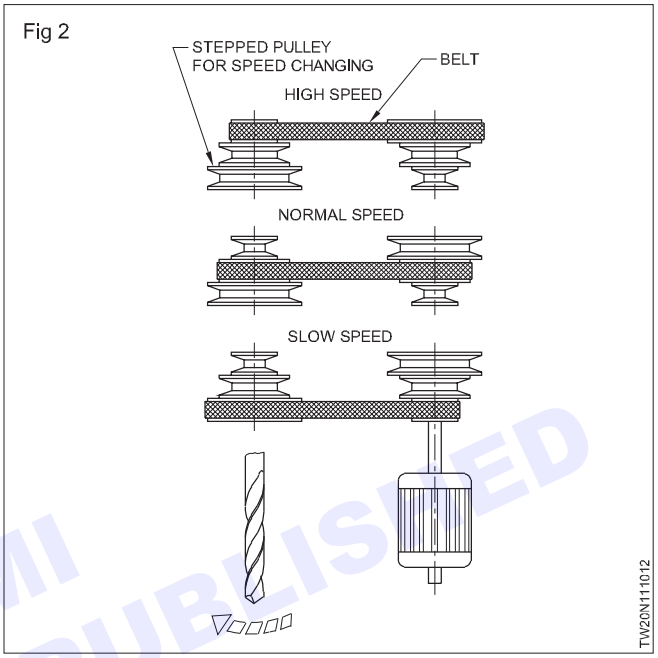
The simplest type of the sensitive drilling machine is shown in the figure with its various parts marked. This is used for light duty work.

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 is shown in Fig 1)

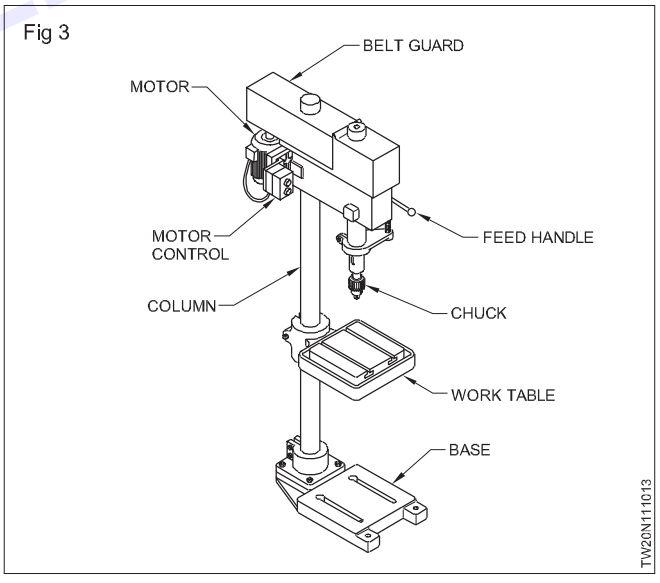
Different spindle speeds are achieved by changing the belt position in the stepped pulleys. (Fig 2)

Fig 2



The pillar drilling machine (Fig 3)

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.

Radial drilling machines

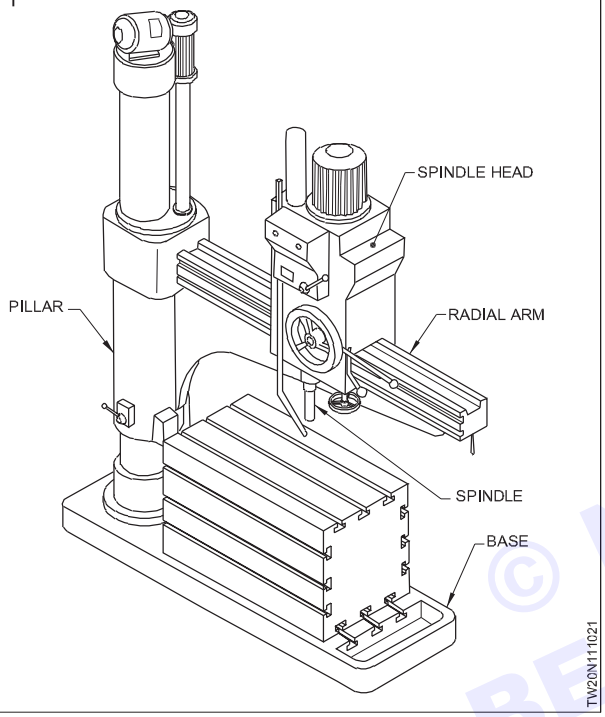
Objectives: At the end of this lesson you shall be able to
- **state the uses of a radial drilling machine**
- **state the features of radial drilling machine.**

Radial drilling machines are used to drill

- Large diameter holes
- Multiple holes in one setting of the work
- Heavy and large workpieces.

Features (Fig 1)

Fig 1



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 gear box provides a large range of R.P.M.

The spindle can be rotated in both clockwise and anticlockwise direction.

Angular holes can be drilled on machines having tilting tables.

A coolant tank is mounted on the base.

Precautions

Ensure that the spindle-head and the arms are locked properly to avoid vibration.

The workpiece and the drill should be rigidly held.

Bring back the spindle head nearer to the pillar after use.

Switch off power when not in use.

Use the drill drift for removing the drills, chucks or sockets.

Use a minimum number of sockets and sleeves to make for the spindle bore size.

Clean and oil the machine after use.

Stop the machine to remove the swarf.

Use a brush to clean the chips and swarf.

Drills

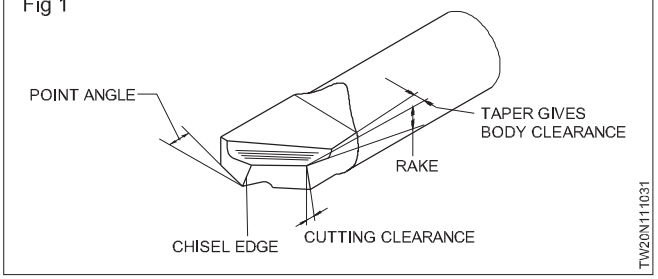
Objectives: At the end of this lesson you shall be able to
- **state drilling and drill material**
- **state the necessity of drilling**
- **name the types of drills used**
- **list the parts of a twist drill.**

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. The fluted part (or) body of a drill is made of either high carbon steel (or) High speed steel.

Types of drills and their specific uses

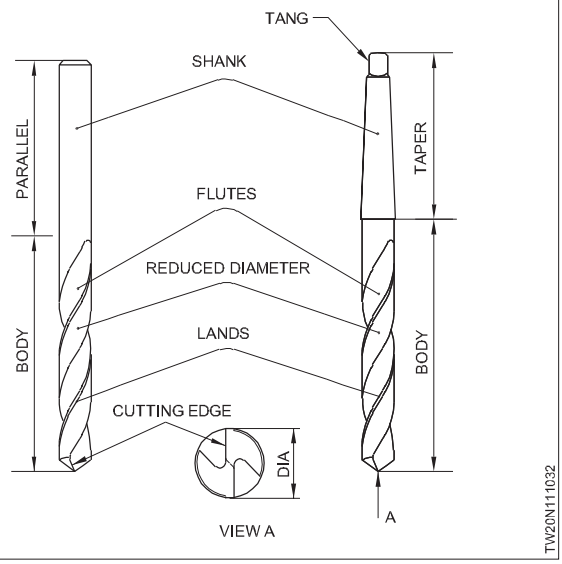
Flat drill (Fig 1) : The earliest form of drill was the flat drill which is easy to operate, besides being inexpensive to produce. The chip removal is poor and its operating efficiency is very low.

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. Parallel shank twist drills are available below 13mm size (Fig 2).

Fig 2



Parts of a twist drill : Drills are made out of high speed steel. The spiral flutes are machined at an angle of 27 1/2° to its axis.

The flutes provide a correct cutting angle which provides an escape path for the chips. It carries the coolant to the cutting edge during drilling. (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 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)

Drills are made of high speed steel.

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 3

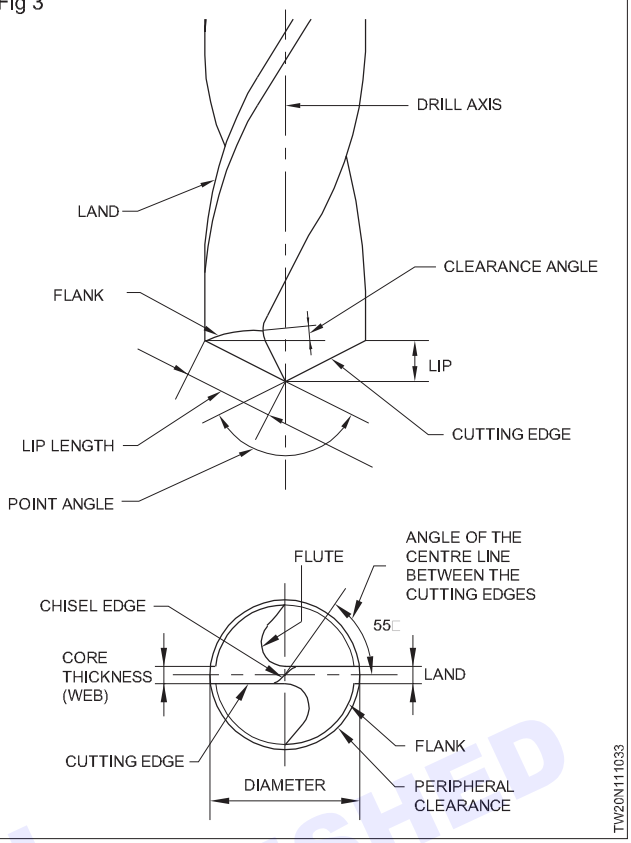


Fig 4

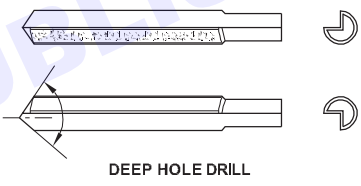
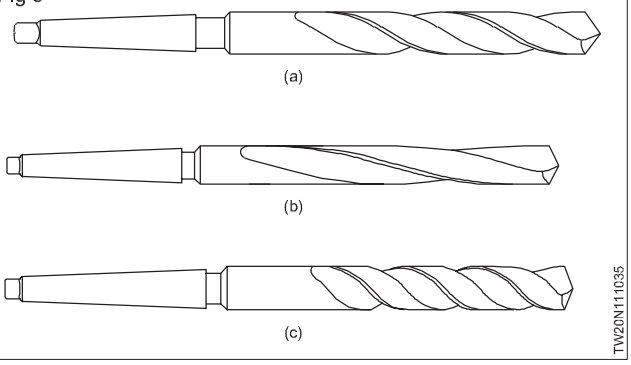


Fig 5



A quick helix drill should never be used on brass as it will 'dig in' and the workpiece may be thrown from the machine table.

Drill-holding devices

Objectives: At the end of this lesson you shall be able to
- **name the different types of drill-holding devices**
- **state the features of drill chucks**
- **state the functions of drill sleeves**
- **state the function of drift.**

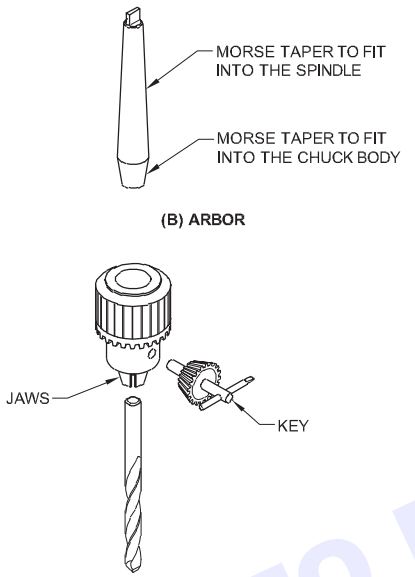
For drilling holes on materials, the drills are to be held accurately and rigidly on the machines.

The common drill-holding devices are drill chucks, sleeves and sockets.

Drill chucks: Straight shank drills are held in drill chucks. (Fig 1A) For fixing and removing drills, the chucks are provided either with a pinion and key or a knurled ring.

The drill chucks are held on the machine spindle by means of an arbor (Fig 1B) fitted on the drill chuck.

Fig 1



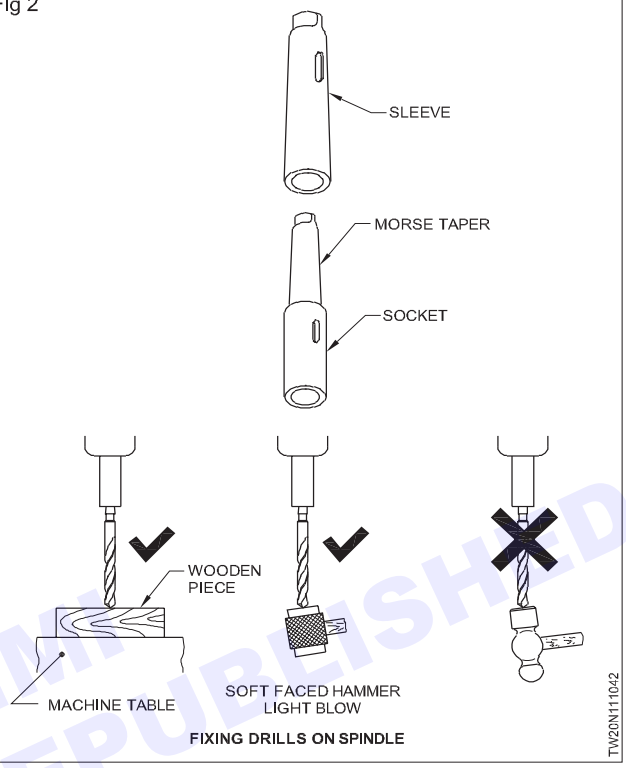
Taper sleeves and sockets (Fig 2): Taper shank drills have a Morse taper.

Sleeves and sockets are made with the same taper so that the taper shank of the drill, when engaged, will give a good wedging action. Due to this reason Morse tapers are called self-holding tapers.

The drills are provided with five different sizes of Morse tapers, and are numbered from MT 1 to MT 5.

In order to make up the difference in sizes between the shanks of the drills and the bore of machine spindles, sleeves of different sizes are used. When the drill taper shank is bigger than the machine spindle, taper sockets are used. (Fig 2)

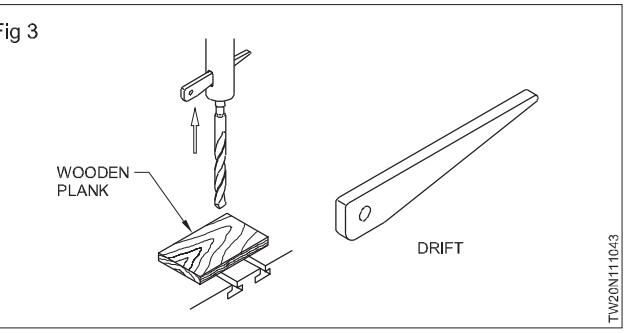
Fig 2



While fixing the drill in a socket or sleeve, the tang portion should align in the slot. This will facilitate the removal of the drill or sleeve from the machine spindle.

Use a drift to remove drills and sockets from the machine spindle. (Fig 3)

Fig 3



While removing the drill from the sockets/sleeves don't allow it to fall on the table or jobs.

Drill chucks are made from special alloy steel

Drill sleeves are made from case hardened steel

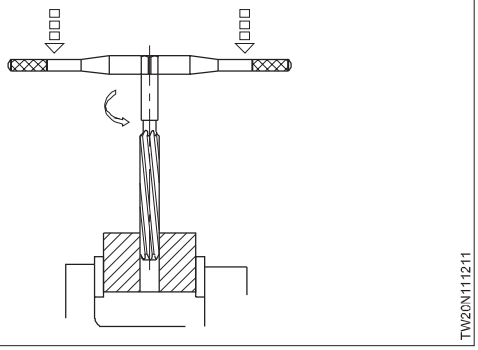
Reamers types - various cutting angles

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 multipoint cutting tool used for enlarging by finishing previously drilled holes to accurate sizes. (Fig 1)

Fig 1



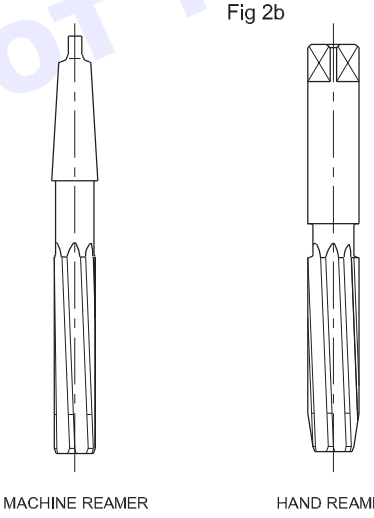
Advantages of 'reaming'

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 2a & 2b)

Fig 2a Fig 2b



Reaming by using hand reamers is done manually for which great skill is needed.

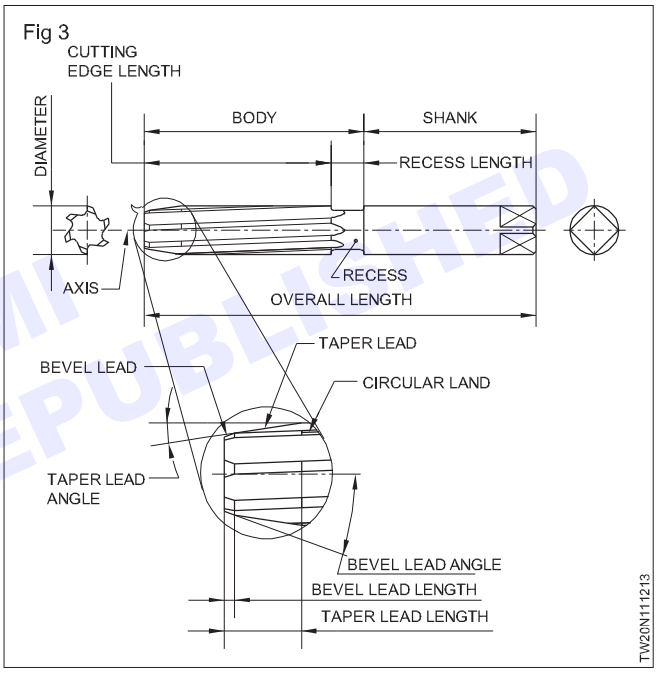
Machine reamers are fitted on spindles of machine tools and rotated for reaming.

Machine reamers are provided with mores taper shanks for holding on machine spindles.

Hand reamers have straight shanks with 'square' at the end, for holding with tap wrenches. (Fig 2a & 2b)

Parts of a hand reamer: The parts of a hand reamer are listed hereunder. Refer to Fig 3.

Fig 3



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 of the shank.

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 taper.

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 hole. 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.

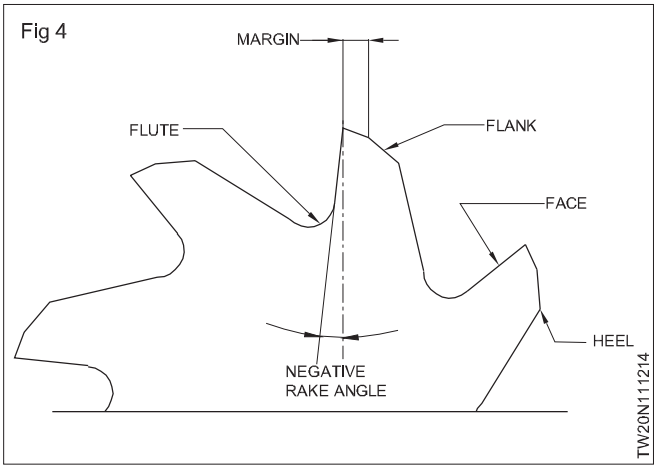
Bevel lead angle: The angle formed by the cutting edges of the bevel lead and the reamer axis.

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 4)

Fig 4



Heel: The edge formed by the intersection of the surface left by the provision of a secondary clearance and the flute. (Fig 4)

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 4)

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 4)

Rake angles: The angles in a diametric plane formed by the face and a radial line from the cutting edge. (Fig 5)

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 6)

Fig 5

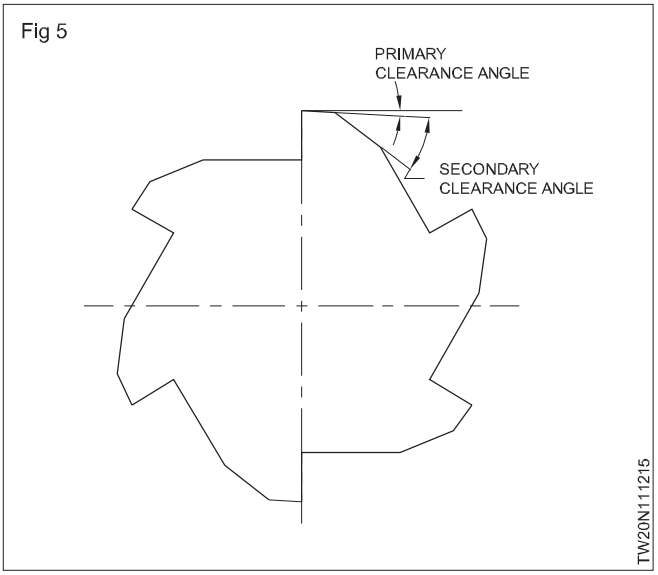
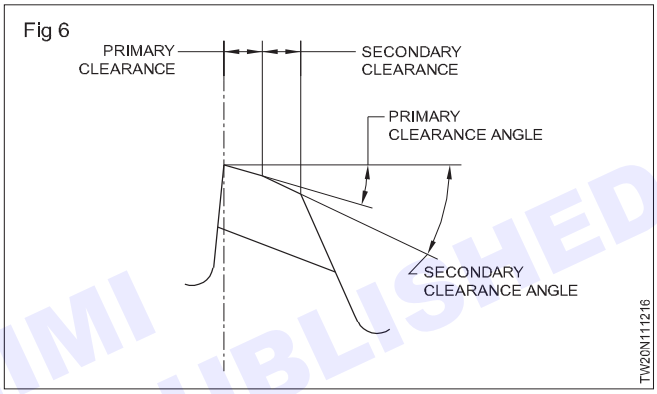
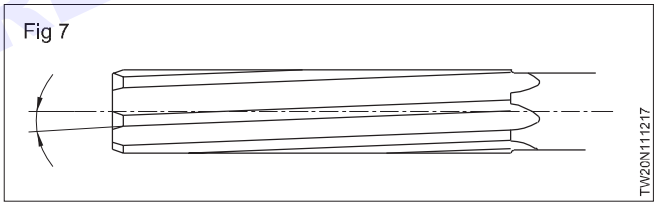


Fig 6



Helix angle: The angle between the edge and the reamer axis. (Fig 7)

Fig 7



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): 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)

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 4a): 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 turn 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.

Fig 1

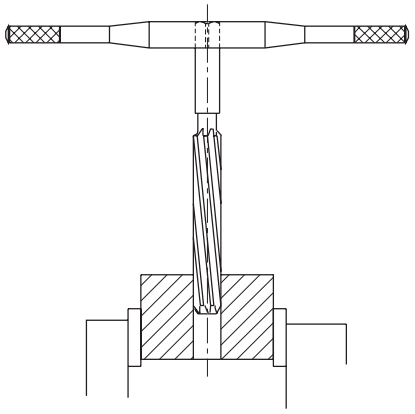


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Fig 2

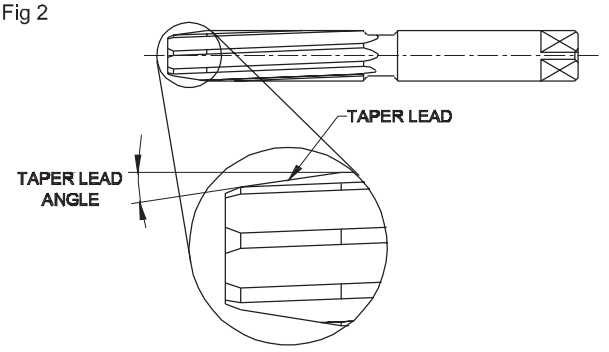

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Fig 3

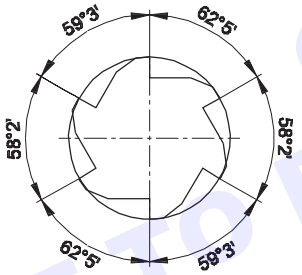

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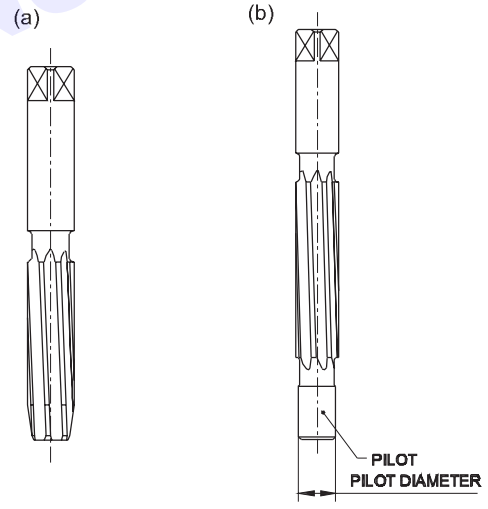
Fig 4



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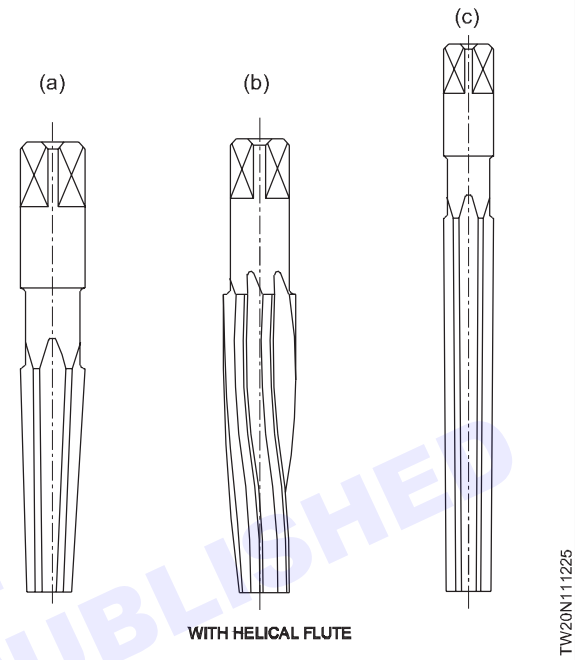
Reamers commonly used in workshop produce H7 holes.

Hand reamer with pilot (Fig 4b): 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.

Socket reamer with parallel shank (Figs 5a and 5b): 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.

Fig 5



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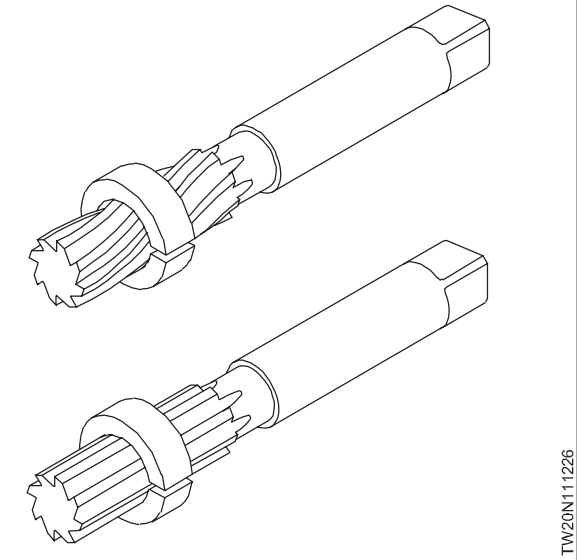
The socket reamer is used for reaming internal morse tapered holes.

Taper pin hand reamer (Fig 5c): This reamer has tapered cutting edges for reaming taper holes to suit taper pins. A taper pin reamer is made with a taper of 1 in 50. These reamers are available with straight or helical flutes.

Use of straight and helical fluted reamers (Fig 6)

Fig 6



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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.

Taps and dies types, uses, tap drills and dies calculation

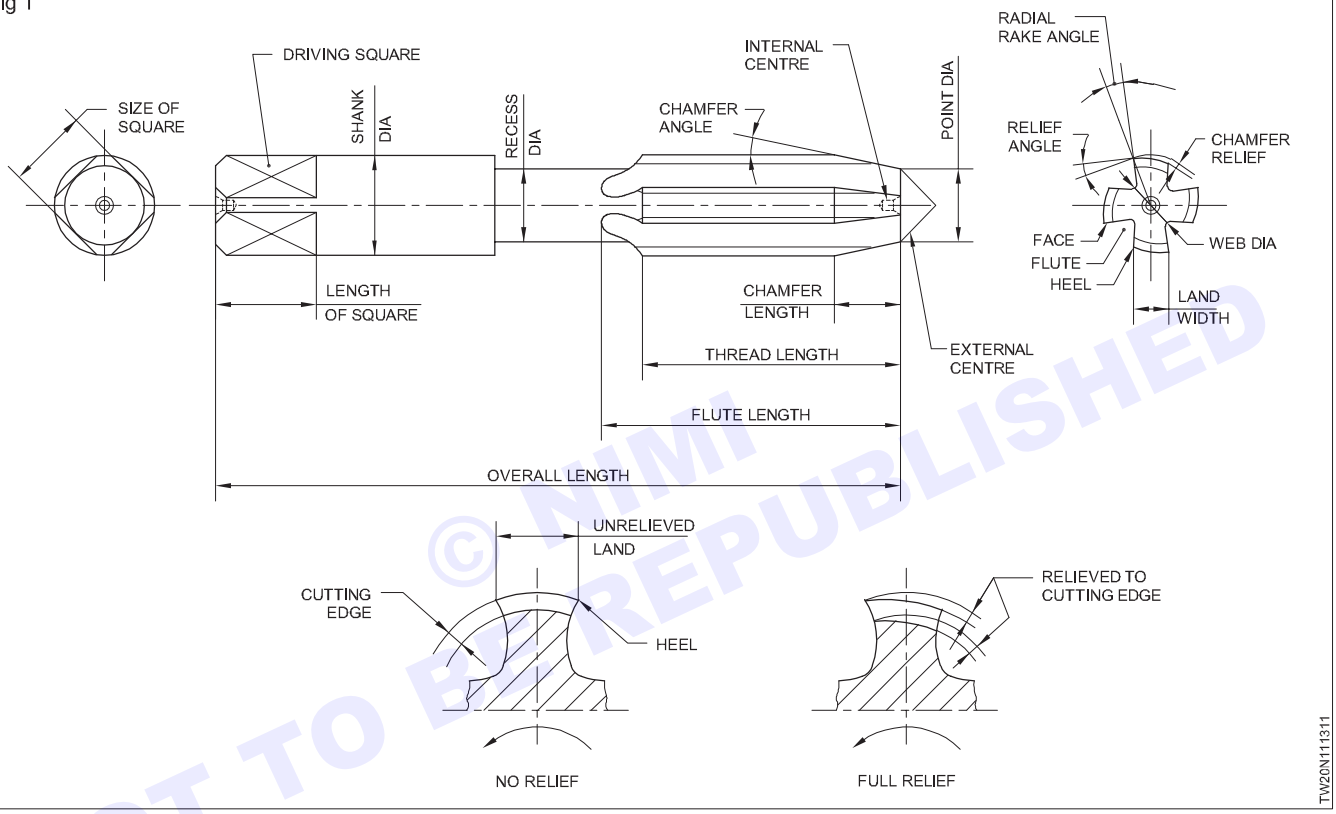
Objectives: At the end of this lesson you shall be able to

- **state the use of hand taps and its feature**
- **distinguish between the different taps in a set**
- **name the different types of tap wrenches and its uses**
- **calculate the drill size for tapping.**

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.

Fig 1



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.

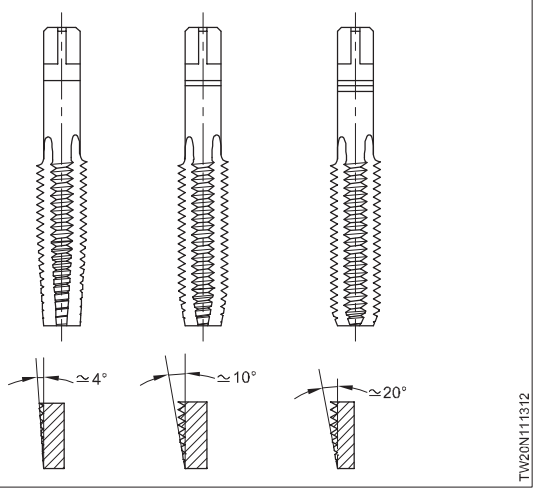
The end of the taps are chamfered (taper lead) for assisting, aligning and starting of the thread.

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.

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

Fig 2



External threading using dies

Objective: At the end of this lesson you shall be able to
- **cut external threads using dies.**

Check blank size.

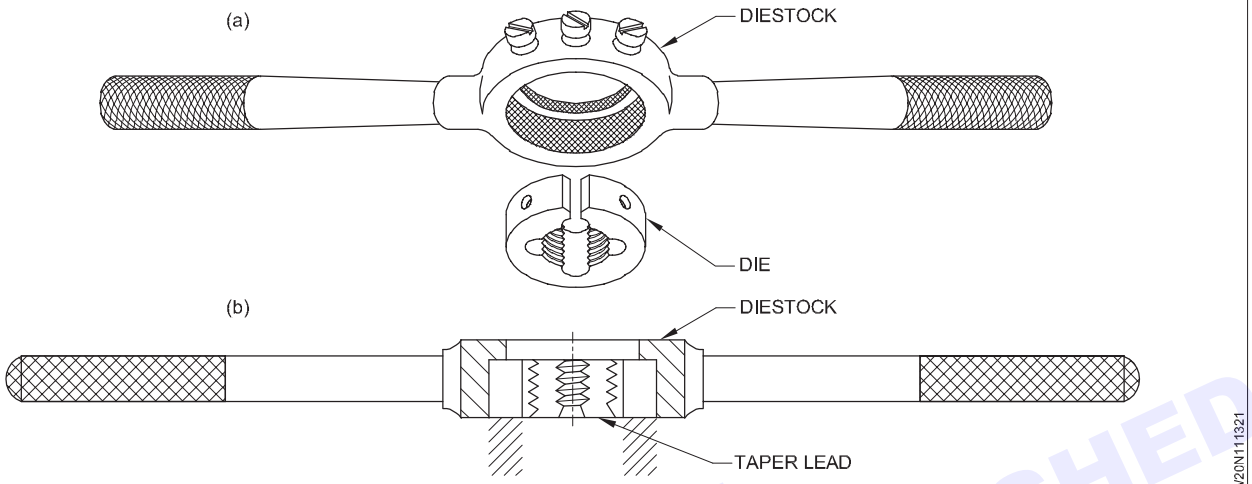
Blank size = Threads size -0.1 x pitch of thread

Procedure: Fix the die in the diestock and place the leading side of the die opposite to the step of the diestock. (Figs 1a & 1b)

Use false jaws for ensuring a good grip in the vice.

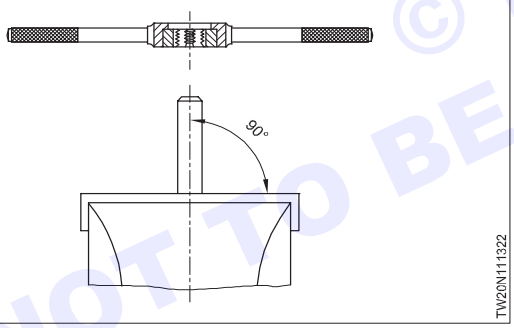
Project the blank above the vice - just the required thread length only.

Fig 1



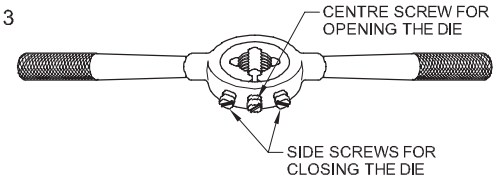
Place the leading side of the die on the chamfer of the work (Fig 2)

Fig 2



Make sure that the die is fully open by tightening the centre screw of the diestock. (Fig 3)

Fig 3



Start the die, square to the bolt centre line. (Fig 4)

Apply pressure on the diestock evenly and turn clockwise direction to advance the die on the bolt blank. (Fig 5)

Cut slowly and reverse the die for a short distance in order to break the chips

Use a cutting lubricant.

Increase the depth of the cut gradually by adjusting the outer screws.

Fig 4

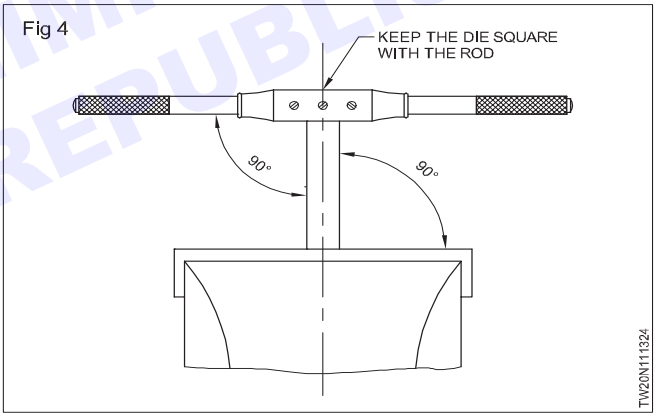
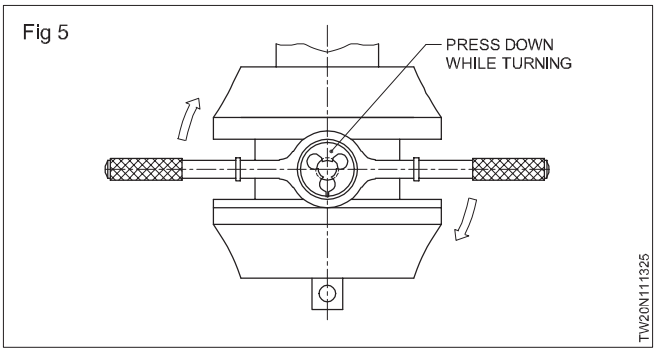


Fig 5



Check the thread with a matching nut.

Repeat the cutting until the nut matches.

Too much depth of cut at one time will spoil the threads. It can also spoil the die.

Clean the die frequently to prevent the chips from clogging and spoiling the thread.

Blank size for external threading

Objective: At the end of this lesson you shall be able to
• determine 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 blank**s** show a slight increase in diameter. such increase in the diameter will make assembly of external and internal threaded components very difficult. To overcome this, the diameter of the blank is slightly reduced before commencing the threading.

What should be the blank size?

The diameter of the blank should be less by 1/10th of the pitch of the thread.

Example

For cutting the thread of M12 with 1.75mm pitch the diameter of the blank is 11.80.

Formula, D = d - p/10

= 12mm - 0.175mm

= 11.825 or 11.8 mm.

d = diameter of bolt

D = the blank diameter

p = pitch of thread

Grinding machine practice types, method of drill bit and chisel grinding

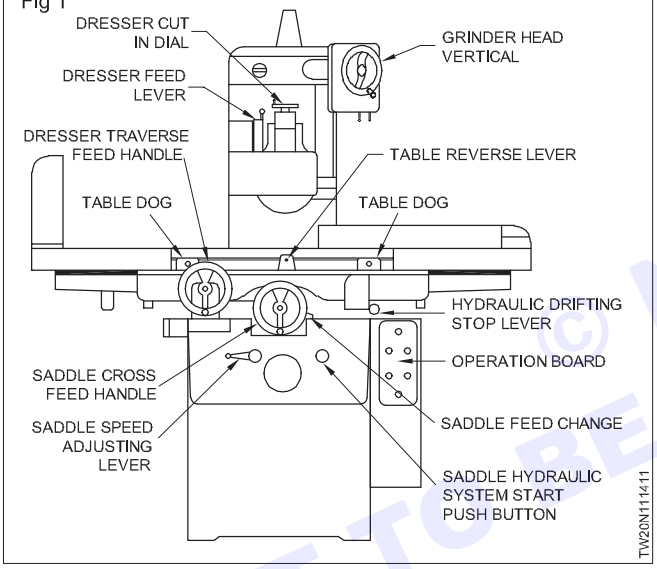
Objectives: At the end of this lesson you shall be able to
- **preparing the surface grinding machine**
- **setting the speed and feed**
- **operating the surface grinding dry/idle run.**

Preparing wheel spindle: It is very essential to check the different controls of the machine before actually starting the grinding operation. This will help the preparation of the machine for work. Check the following before the grinding operation.

Checking and oiling before start: Supply oil to all the lubricating points.(Consult your instructor)

Check that the button on the operation board is at the stop position. (Fig 1)

Fig 1



Check that the clutch of the table traverse feed handle is cut.

Check that the table dog is fixed.

Manual feed of table: Set the table reverse lever at the neutral position (Fig.1) Engage the clutch of the table traverse feed handle.

Move the table to the right and left by turning the handle clockwise and anticlockwise respectively.

Manual and automatic feed of saddle: Move the saddle forward by turning the saddle cross-feed handle clockwise. (Fig 1)

Move the saddle backward by turning the saddle cross-feed handle anticlockwise.

Set in the automatic feed by turning the saddle feed change lever upward and downward. (Fig 2) (when the lever is pushed up or down, the saddle moves forward or backward respectively)

Raise and lower the grinding wheel.

Disengage the fine feed knob. (Fig 3)

Fig 2

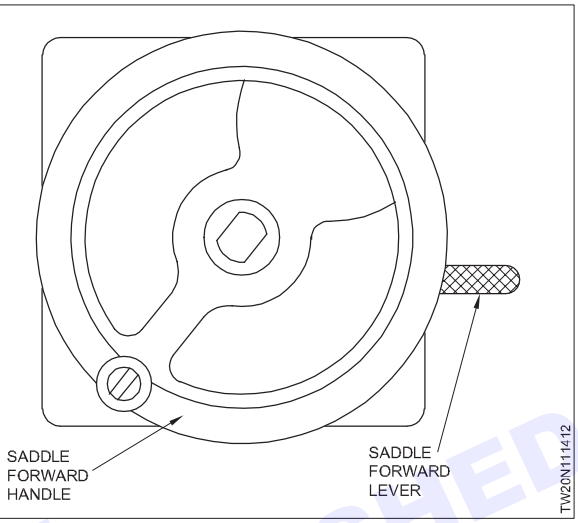
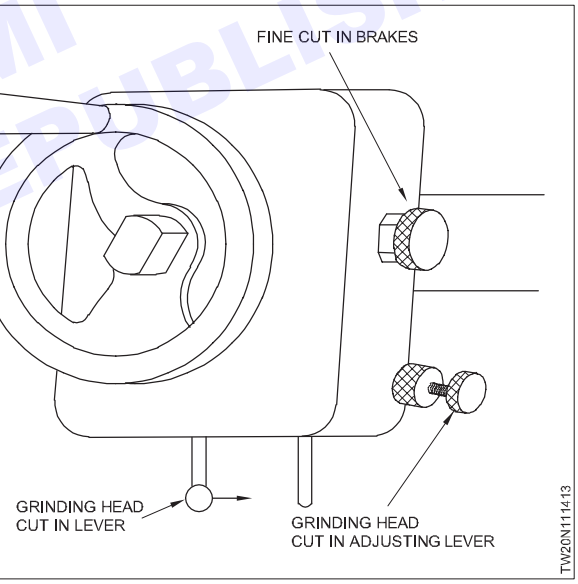


Fig 3



Turn the grinding wheel elevation handle anticlockwise to lower the grinding wheel. (Fig 1)

Turn the grinding wheel elevation handle clockwise to raise the grinding wheel.

Hydraulic operation of table: Pull the table traverse feed handle to the front side to disengage the clutch.

Push the hydraulic driving push-button to drive the table hydraulically. (Fig 1)

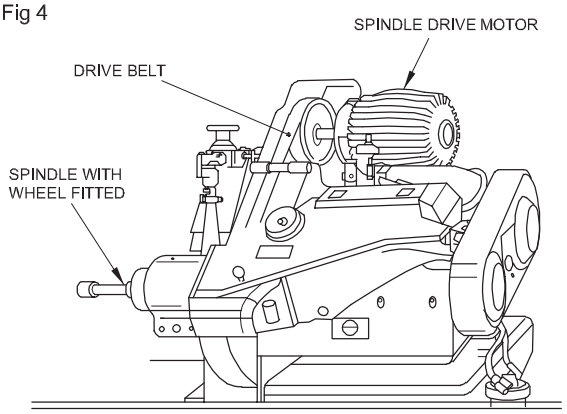
Adjust the table speed by the use of the table speed adjusting lever. (When the lever is pushed up, the table speed is increased. The speed is decreased by lowering the lever and the hydraulic drive is stopped at the lowest position of the lever)

Stop the hydraulic drive by pushing or pulling the hydraulic drive stop lever. (The table is stopped at the right end position)

Mounting the spindle (Fig 4): For setting up the internal grinding spindle of a universal grinding machine, the general procedure is as follows

- Position the internal grinding attachment, including the spindle on the wheel head and fix securely. Refer to the operators handbook for the particular machine.
- Mount the flat drive belt between the internal grinding drive motor and the pulley on the internal grinding attachment and adjust to proper tension.
- If a machine motor selector control is provided turn it to the 'internal' position.
- Disengage the power operated cross - feed.
- Replace any guards removed to set the attachment in place.

Fig 4



INTERNAL GRINDING SPINDLE MOUNTED ON WHEELHEAD OF UNIVERSAL GRINDING MACHINE

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Off - hand grinding with bench and pedestal grinders

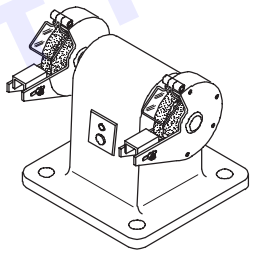
Objectives: At the end of this lesson you shall be able to
- **state the purposes of off-hand grinding**
- **name the machines with which off-hand grinding is done**
- **state the features of bench and pedestal grinders.**

Off-hand grinding is the operation of removing material which does not require great accuracy in size or shape. This is carried out by pressing the workpiece by hand against a rotating grinding wheel.

Off-hand grinding is performed for rough grinding of jobs and resharpening of scribers, punches, chisels, twist drills, single point cutting tools etc.

Off-hand grinders are fitted to a bench and pedestal (Fig 1 & 2)

Fig 1



BENCH GRINDER

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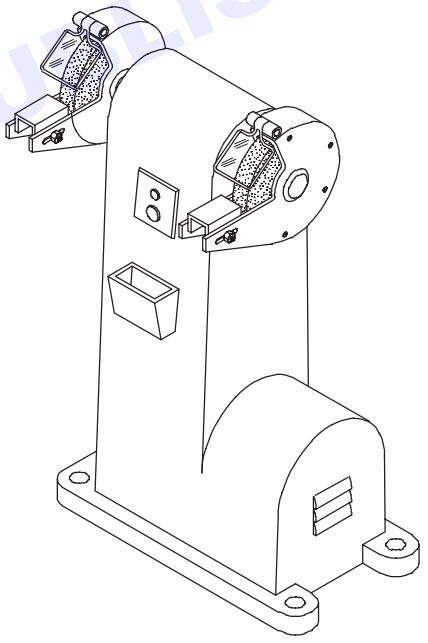
Bench grinders: Bench grinders are fitted on a bench or table, and are useful for light duty work.

Pedestal grinders: Pedestal grinders are mounted on a base (pedestal), which is fastened to the floor. They are used for heavy duty work.

These grinders consist of an electric motor and the spindle for mounting the grinding wheels. On one end of the spindle a coarse-grained wheel is fitted, and on the other end, a fine-grained wheel. For safety while working, wheel guards are provided.

Fig 2



PEDESTAL GRINDER

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A coolant container (Fig 3) is provided for frequent cooling of the work.

Adjustable work-rests are provided for both the wheels to support the work while grinding. These work-rests must be set very close to the wheels. (Fig 4)

Extra eye shields are also provided for the protection of the eyes. (Fig 4)

Fig 3

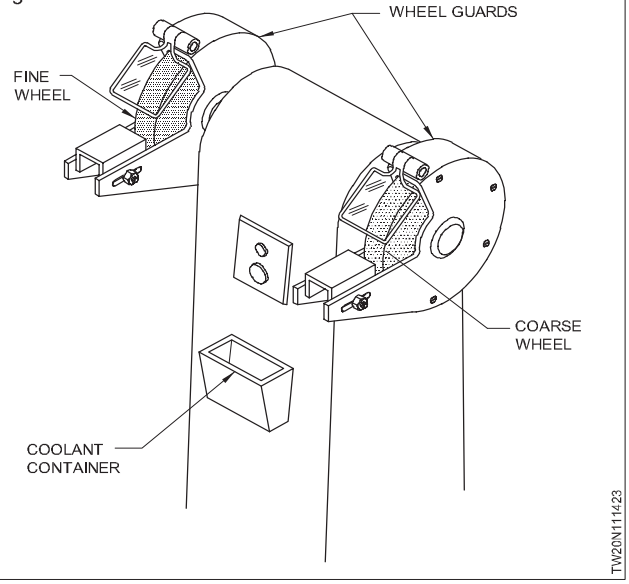
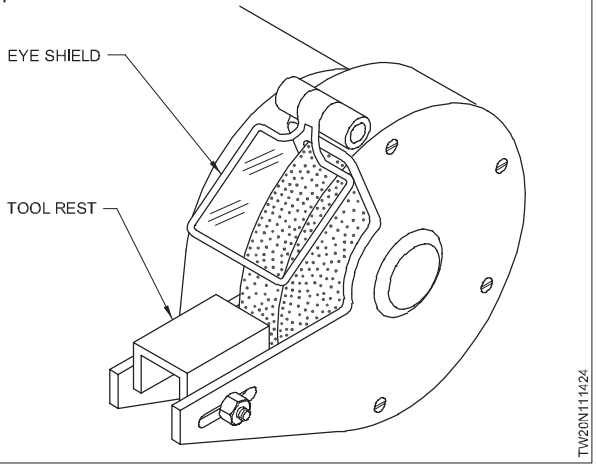


Fig 4



Sharpening of drills

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

- **sharpen drills on an off hand grinder.**

A drill will loose the sharpness of its cutting edges due to continuous use, and improper use of drills will also spoil the cutting edges.

Spoiled or blunt cutting edges of the drills must be sharpened on a grinder.

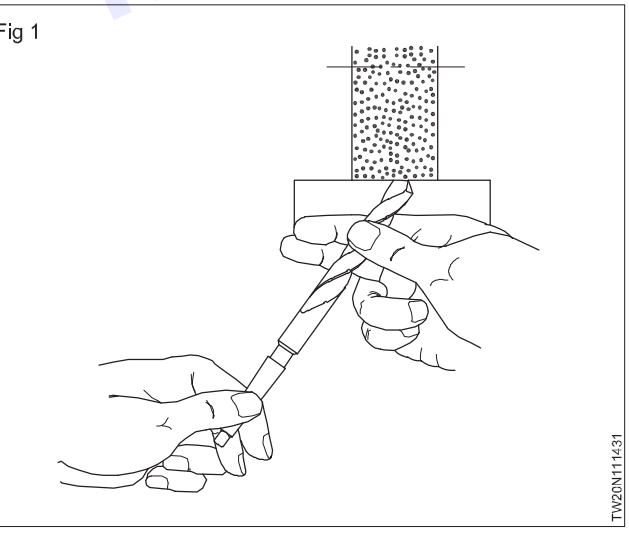
Check the grinding wheel for loading, glazing, trueness and cracks. Call your instructor for advice. Dress and true the wheel if necessary.

Protect your eyes either with goggles or by lowering the eye protecting shield near the tool rest and adjust the tool rest 2 mm closer to the wheel, if necessary.

Switch on the grinder.

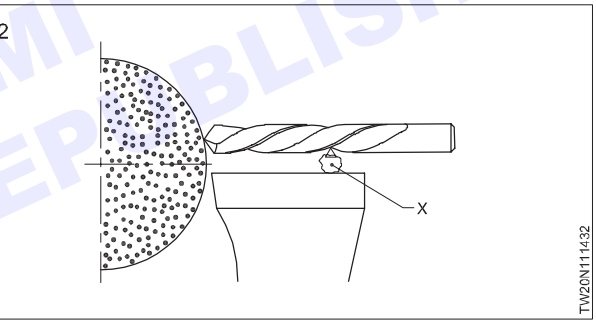
Hold the shank of the drill lightly between the thumb and the forefinger, and with the other hand hold the portion near the point. (Fig 1)

Fig 1



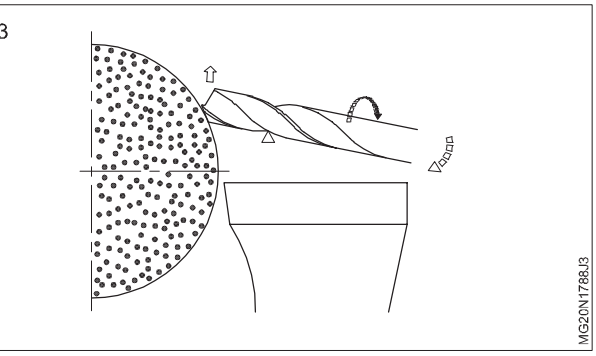
The hand near the point of the drill should be pivoted lightly on the tool rest at “X’ for easy manipulation (Fig 2)

Fig 2



Hold the drill level (Fig 1) and turn it to 59° to the face of the wheel and swing the drill slightly downward and towards left. (Fig 3 & 4)

Fig 3

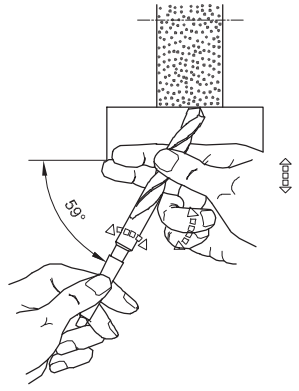


Rotate the drill to the right by turning it between the thumb and the forefinger (Fig 4)

This turning movement is not necessary for smaller dia. drills

While swinging down, apply a slight forward motion. This will help to form the clearance angle

Fig 4



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While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to resharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths.

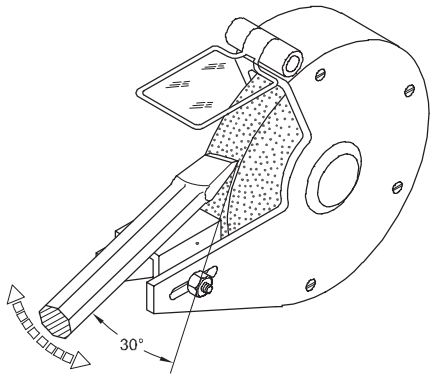
Check the lip clearance angle in Fig visually. The angle should be between 8° to 12°.

When you are satisfied with correct equal angle and equal tip length, drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m) use cutting fluid

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could cause by to much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check lips lengths for uneven or the lip angle for uneven.

Chisel grinding

Fig 5



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- Check the grinding machine and check whether safety guards are properly fitted.
- Switch on the grinding machine.
- Rest the body of the chisel on the tool rest.

The body of the chisel must be at an angle of 30° in such a way as to get 60°.

- Give the minimum pressure to create the cutting point.
- Check angle with help of bevel protractor.

Ensure that there is enough coolant in the container.

Types of gauges, uses , care & maintenance, tolerance limits, fits, definitions & applications

Objectives: At the end of this lesson you shall be able to
- **define template with its uses and advantages**
- **define gauges their necessity and types.**

Gauge: Gauge is an inspection tool used to check product dimension with reference to its maximum and minimum acceptable limits. It is, generally, used to segregate acceptable and non-acceptable products in mass production, without the exact dimensions. It is made of tool steel and is heat treated.

Advantages of gauging

Faster checking of the product is within the specified limits.

Less dependence on operator skill and getting affected by operator judgement.

Gauges are economical when compared to measuring instruments.

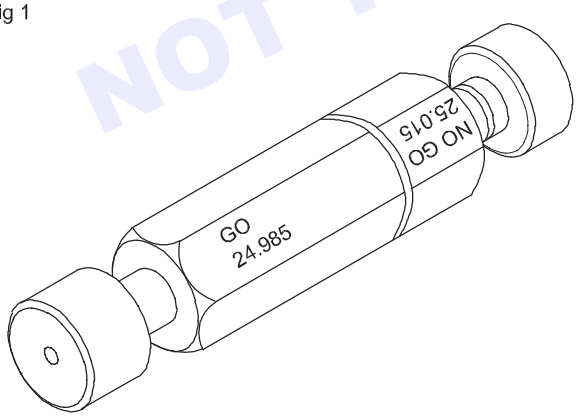
Instrument used for gauging

1 Snap and ring gauge
2 Combined gauge
3 Plug gauge
4 Screw pitch gauge
5 Template and form gauge
6 Taper gauge

Types of cylindrical plug gauges

Double-ended plug gauge (Fig 1 & 2)

Fig 1



DOUBLE ENDED PLUG GAUGE

Progressive plug gauge (Fig 3)

Plain cylindrical gauges are used for checking the inside diameter of a straight hole. The 'Go' gauge checks the lower limit of the hole and the 'No- Go' gauge checks the upper limit. The plugs are ground and lapped. (Fig 3)

Fig 2

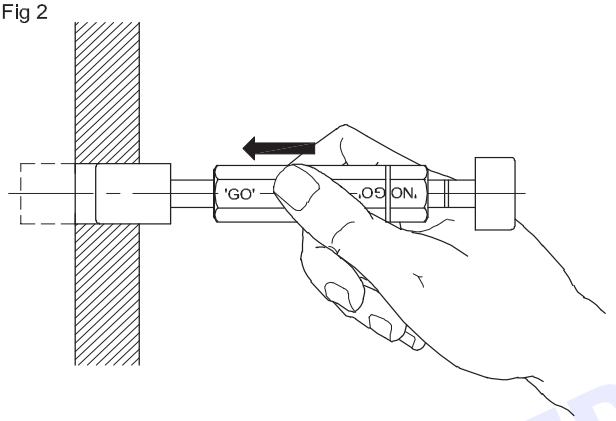
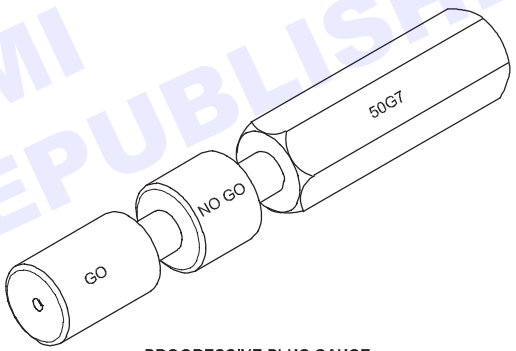


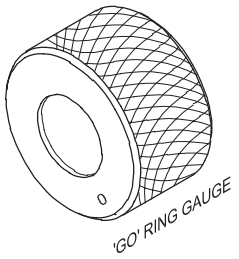
Fig 3



PROGRESSIVE PLUG GAUGE

Plain ring gauge (Fig 4)

Fig 4

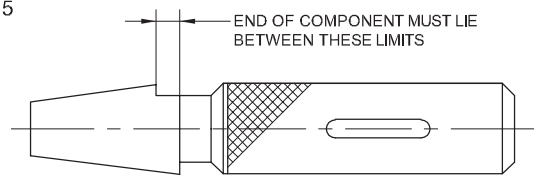


Plain ring gauges are used to check the outside diameter of pieces. Separate gauges are used for checking 'Go' and 'No- Go' sizes. A `No-Go' gauge is identified by an annular groove on the knurled surface.

Taper plug gauges (Fig 5)

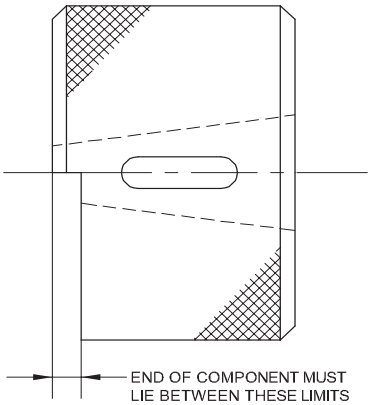
These gauges made with standard or special tapers are used to check the size of the hole and the accuracy of the taper. The gauge must slide into the hole for a prescribed depth and fit perfectly. An incorrect taper is evidenced by a wobble between the plug gauge and the hole.

Fig 5



Taper ring gauges (Fig 6)

Fig 6



They are used to check both the accuracy and the outside diameter of a taper. Ring gauges often have scribed lines or a step ground on the small end to indicate the 'Go' and 'No-Go' dimensions.

Thread plug gauges (Fig 7 & 8)

Fig 7

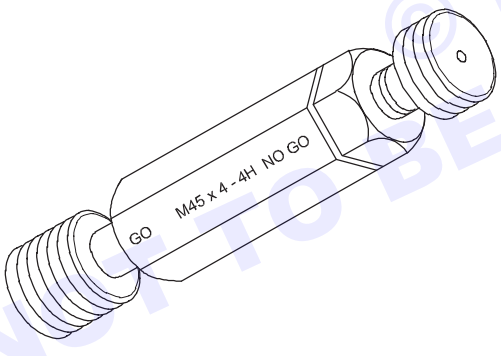
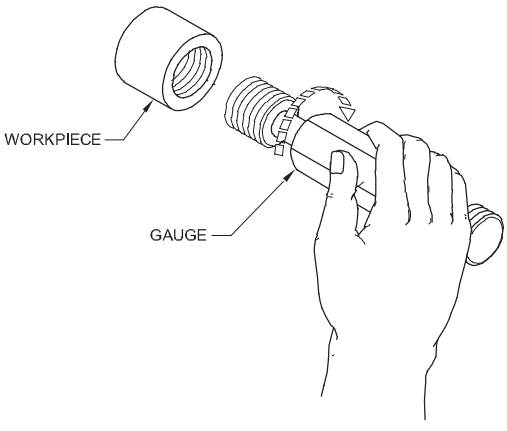


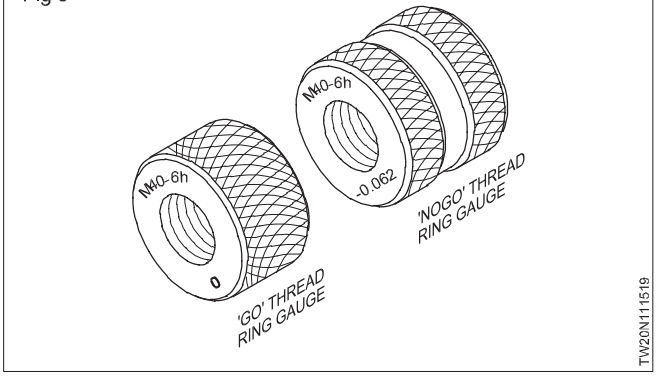
Fig 8



Internal threads are checked with thread plug gauges of 'Go' and `No-Go' variety which employ the same principle as cylindrical plug gauges.

Thread ring gauges (Fig 9)

Fig 9



These gauges are used to check the accuracy of an external thread. They have a threaded hole in the centre with three radial slots and a set screw to permit small adjustments.

Snap gauges (Figs 10, 11, 12 & 13)

Fig 10

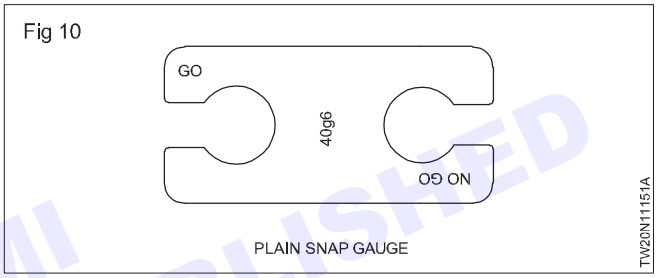
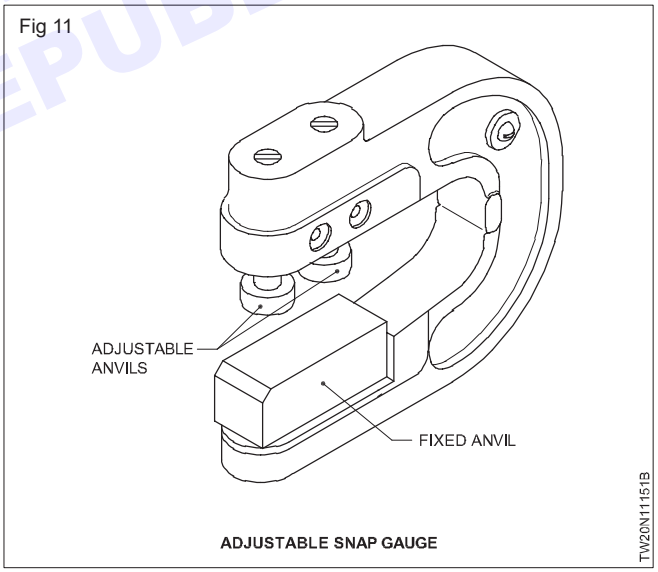


Fig 11



Snap gauges are a quick means of checking diameters and threads to within certain limits by comparing the part's size to the present dimension of the snap gauge.

Snap gauges are generally C-shaped and are adjustable to the maximum and minimum limits of the part being checked. When in use, the work should slide into the 'Go' gauge but not into the 'No-Go' gauging end.

Fig 12

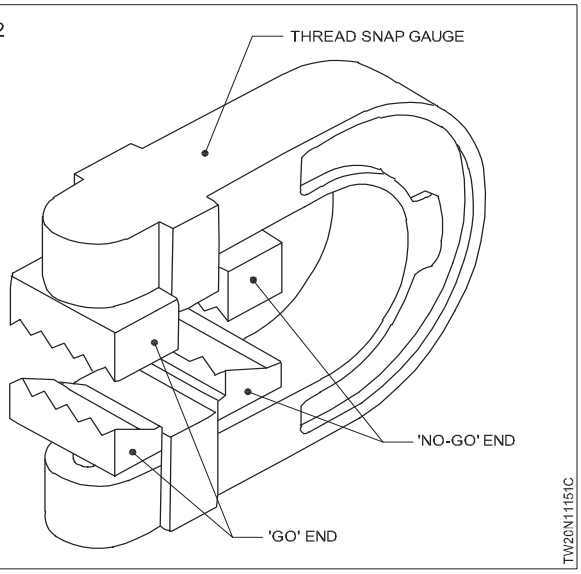


Fig 13

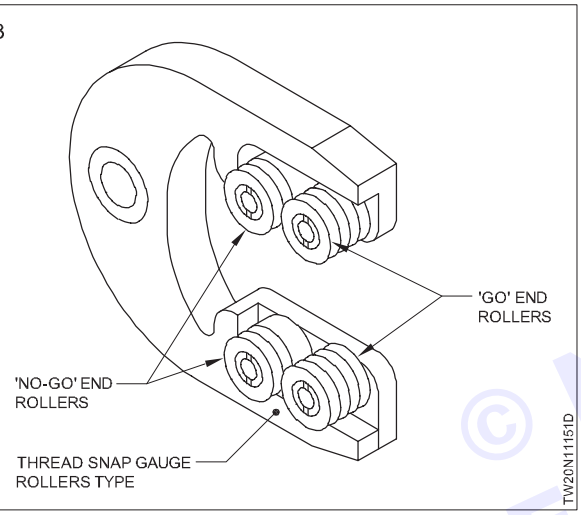


Fig 14

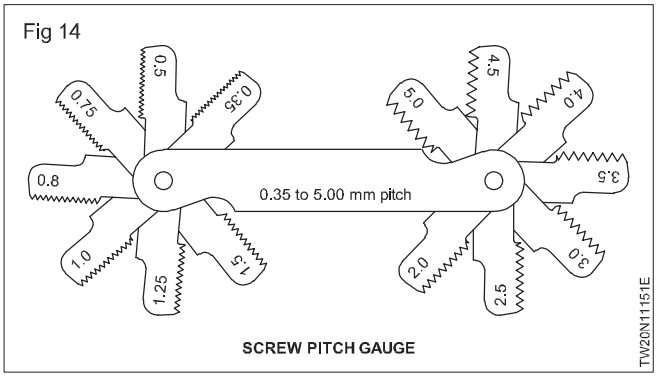
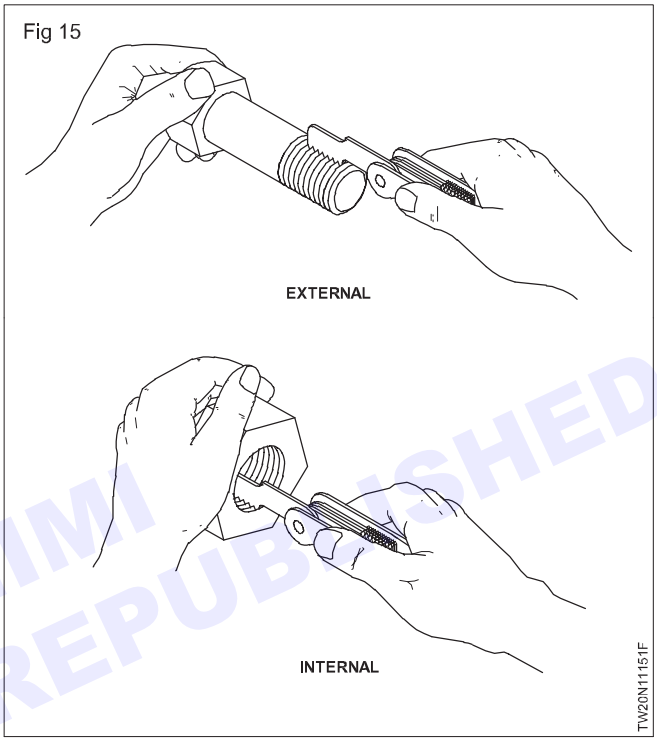


Fig 15



Screw pitch gauge

Purpose

A screw pitch gauge is used to determine the pitch of a thread.

It is also used to compare the profile of threads.

Constructional features

Pitch gauges are available with a number of blades assembled as a set. Each blade is meant for checking a particular standard thread pitch. The blades are made of thin spring steel sheets, and are hardened.

Some screw pitch gauge sets will have blades provided for checking British Standards threads (BSW, BSF etc.) at one end and the metric standard at the other end.

The thread profile on each blade is cut for about 25 mm to 30 mm. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 14)

For obtaining accurate results while using the screw pitch gauge, the full length of the blade should be placed on the threads. (Fig 15)

Simple and standard workshop gauges

Radius and fillet gauges: Components are machined to have curved formation on the edges or at the junction of two steps. Accordingly they are called radius and fillets. The size of the radius and radius is normally provided on a drawing. The gauges used to check the radius formed on the edges of diameters are fillet and the gauges used to check the fillets are called fillets gauges.

They are made of hardened sheet metal each to a precise radius. They are used to check the radii by comparing the radius on a part with the radius of the gauges.

Fig 16 shows the application of radius gauge to check the radius formed externally. Fig 17 shows the application of a fillet gauge to check the fillet formed on a turned component. The other typical applications are:

Some sets have provisions to check the radius and fillet on each blade. (Fig 18)

And some sets have separate sets of blades to check the radius and fillet. (Fig 19)

Each blade can be swung out of the holder separately, and has its size engraved on it. (Fig 20)

Fig 16

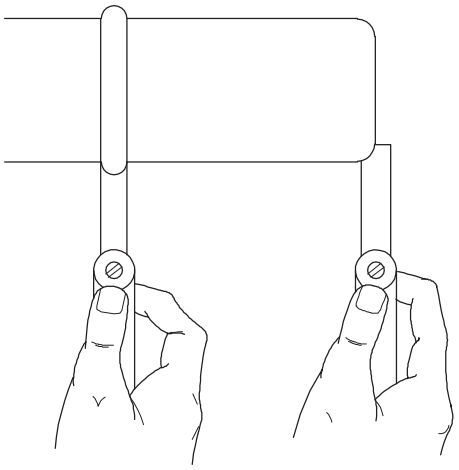


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Fig 17

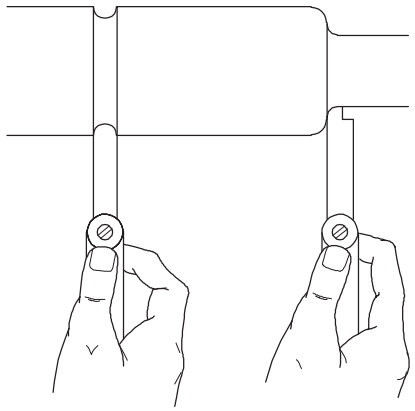

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Fig 18

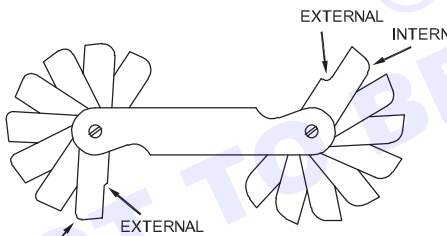

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Fig 19

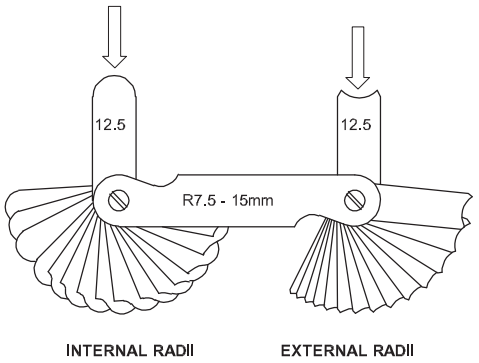

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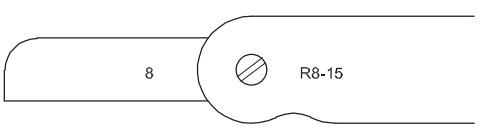
Fig 20



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Fillet gauges are available in sets to check the radii and fillets from

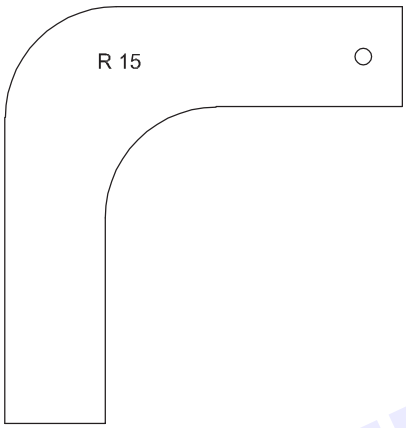
1 to 7 mm in steps of 0.5 mm

7.5 to 15 mm in steps of 0.5 mm

15.5 to 25 mm in steps 0.5 mm.

Individual gauges are also available. They usually have internal and external radii on each gauge and are made in sizes from 1 to 100 mm in steps of 1 mm. (Fig 21)

Fig 21



TW20N11151L

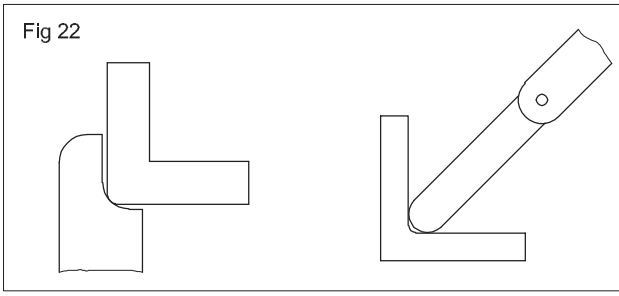
Before using the radius gauge, check that it is clean and undamaged.

Remove burrs from the workpiece.

Select the leaf of the gauge from the set corresponding to the radius to be checked.

Fig 22 shows that the radius of the fillet and that of the external radius are smaller than the gauge.

Fig 22

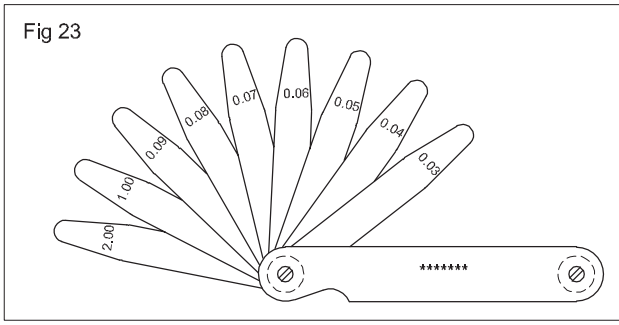


TW20N11151M

Feeler gauge and uses

Features: A feeler gauge consists of a number of hardened and tempered steel blades of various thicknesses mounted in a steel case. (Fig 23)

Fig 23



TW20N11151N

The thickness of individual leaves is marked on it. (Fig 23)

B.I.S. Set: The Indian Standard establishes four sets of feeler gauges Nos.1,2,3 and 4 which differ by the number of blades in each and by the range of thickness (minimum is 0.03 mm to 1 mm in steps of 0.01 mm). The length of the blade is usually 100 mm.

Example

Set No.4 of Indian Standard consist of 13 blades of different thicknesses.

0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50.

The sizes of the feeler gauges in a set are carefully chosen in order that a maximum number of dimensions can be formed by building up from a minimum number of leaves.

The dimension being tested is judged to be equal to the thickness of the leaves used, when a slight pull is felt while withdrawing them. Accuracy in using these gauge requires a good sense of feel.

Feeler gauges are used

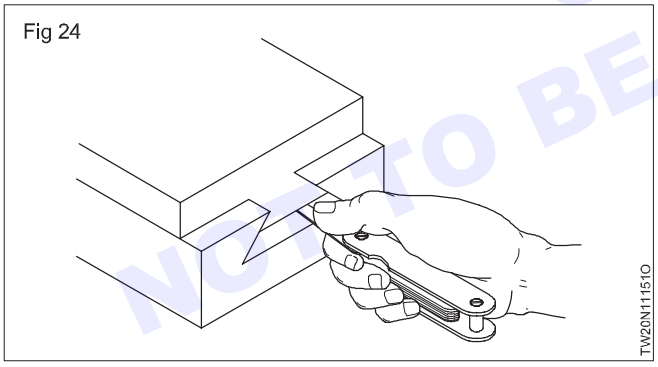
– To check the gap between the mating parts

– To check and set the spark plug gaps

– To set the clearance between the fixture (setting block) and the cutter/tool for machining the jobs

– To check and measure the bearing clearance, and for many other purposes where a specified clearance must be maintained. (Fig 24)

Fig 24



Drill gauge: A drill gauge is a rectangular or square shaped metal piece containing a number of different diameter holes. The size of the hole is stamped against each hole. (Fig 25)

In the number drill and letter drill series, the diameter of the drill is gauged with the help of the respective drill gauge.

Standard Wire Gauge (SWG): It is used to measure the size of a wire and thickness of sheet shown in Fig 26

Fig 25

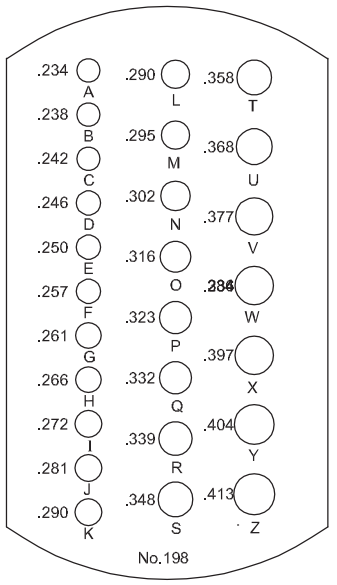
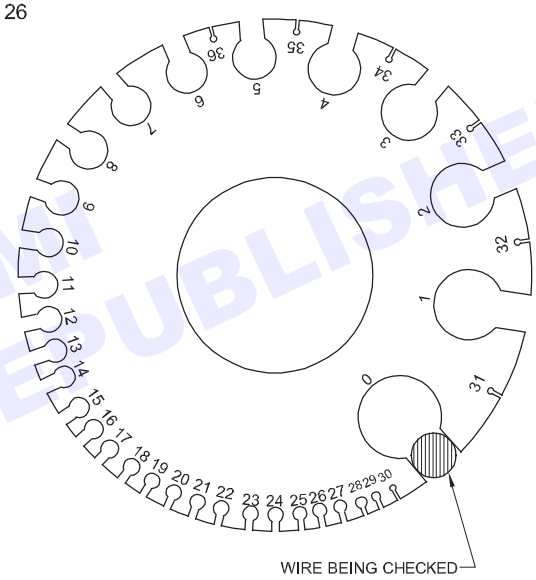


Fig 26



The standard wire gauge is a circular metal disc with varying hole and slot size on its circumference. Each slot size corresponds to a gauge number which is written just below the hole.

The gauge numbers specify the size of a round wire in terms of its diameter.

As the gauge number increase from 0 to 36, the dia size decrease.

The thickness of sheet metal and the diameter of wires confirm to various gauging numbers and the following Table 1 give the decimal equivalents of the different gauge numbers for the diameter of wires, and the thickness of sheets.

System of limits & fits - Terminology

Objectives: At the end of this lesson you shall be able to
- **state the terms under the BIS system of limits and fits**
- **define each term under the BIS system of limits and fits**.

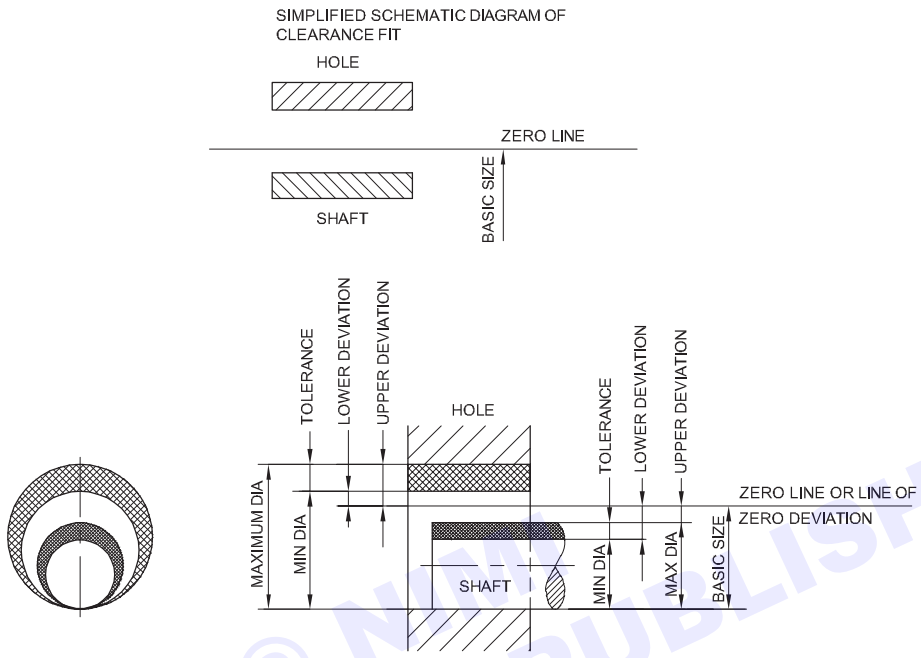
Size

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)

Fig 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)

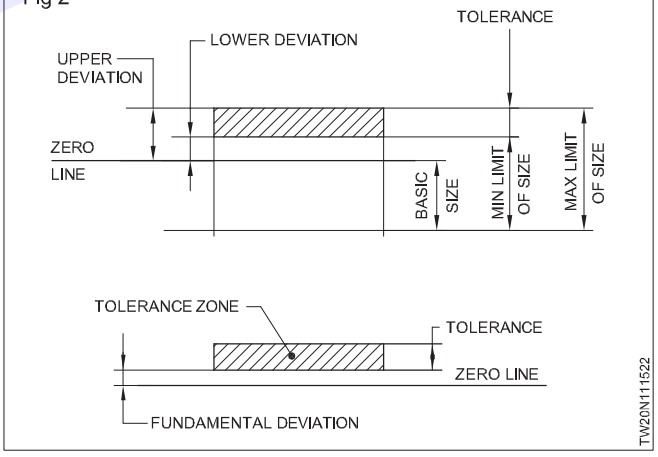
Maximum limit of size

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)

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

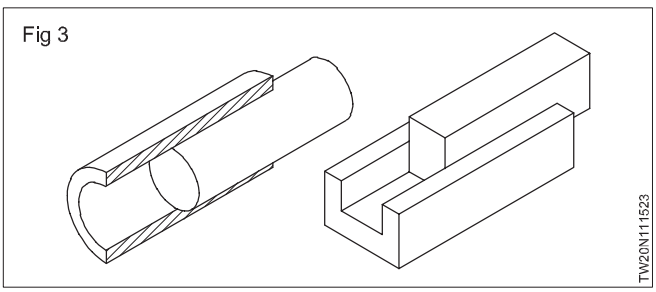


Table 1 (Examples)

SL. NO.	Size of component	Upper deviation	Lower deviation	Max-limit of size	Min-limit of size
1	$20^{+.008}_{-.005}$	+ 0.008	- 0.005	20.008	19.995
2	$20^{+.028}_{+.007}$	+ 0.028	+ 0.007	20.028	20.007
3	$20^{-.012}_{-.021}$	- 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)

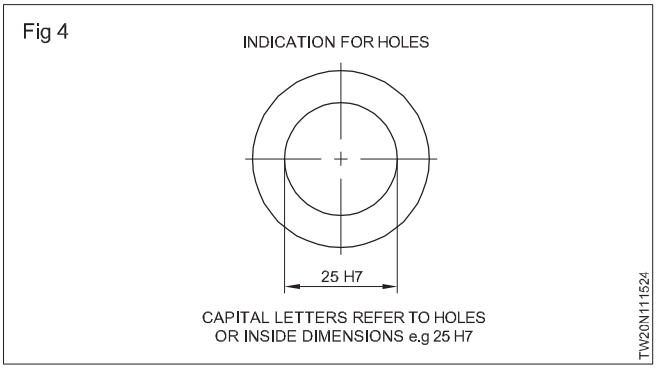
Zero line

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. (Fig 1 & 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 & 7.

Fig 5

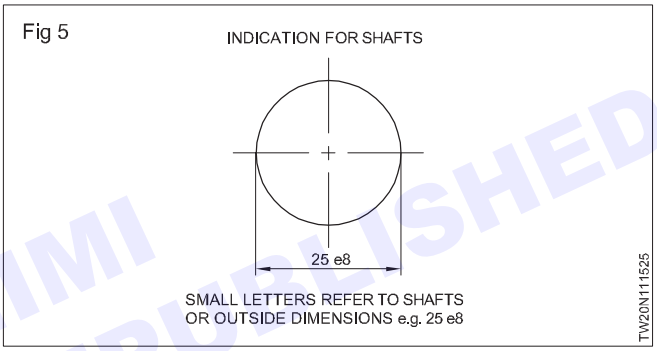


Fig 6

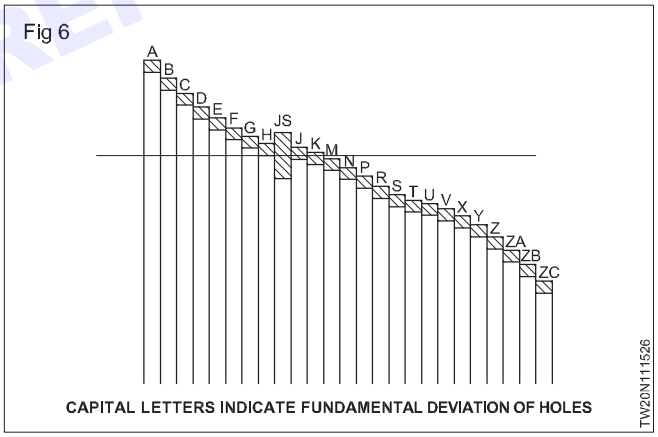
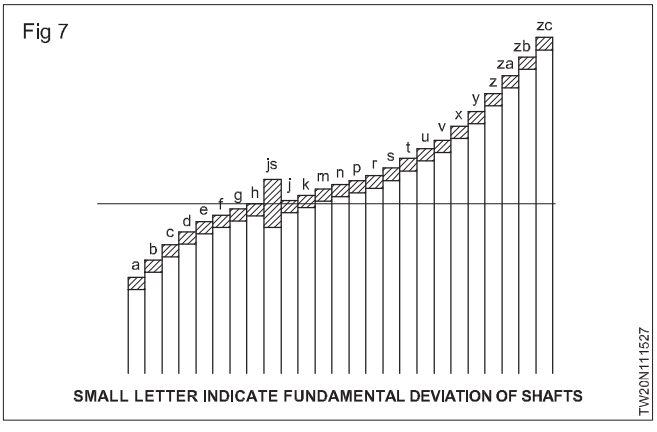


Fig 7



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 $30\ \frac{H7}{g6}$

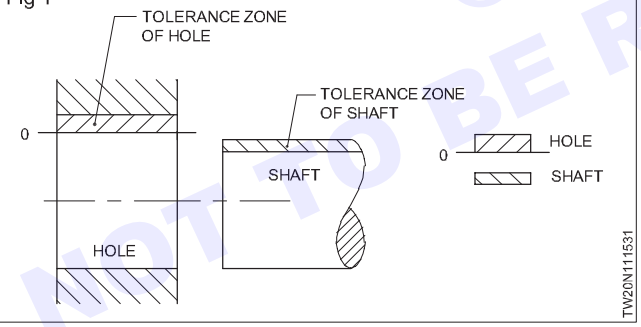
Clearance

In a fit the clearance is the difference 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 + 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

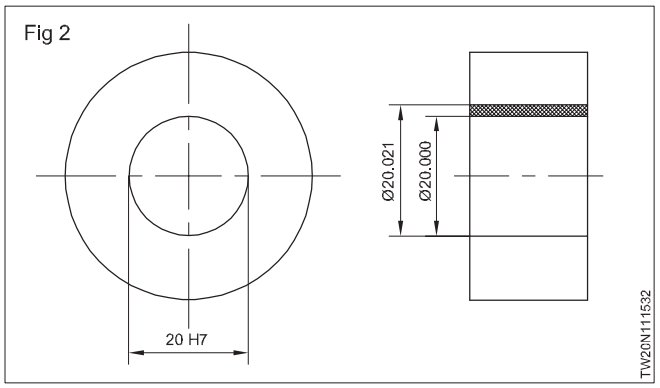
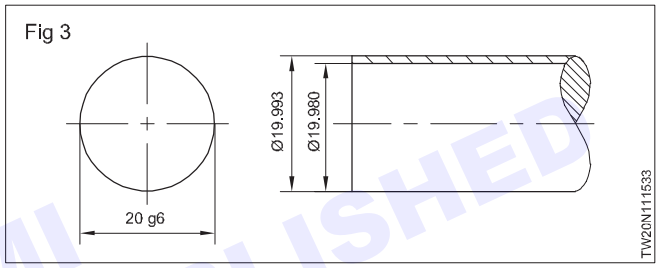


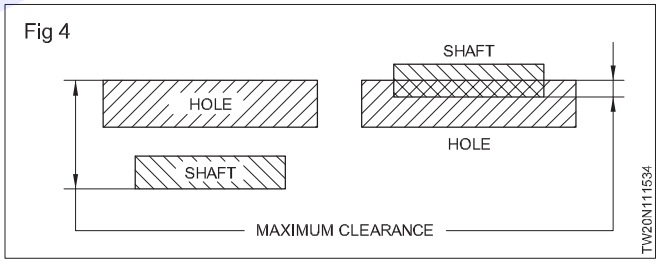
Fig 3



Maximum clearance

In a clearance fit or transition fit, it is the difference between the maximum hole and minimum shaft. (Fig 4)

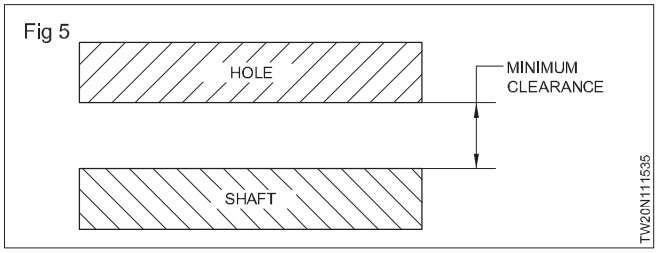
Fig 4



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)

There is always a clearance between the hole and the shaft. This is the clearance fit.

Fig 6

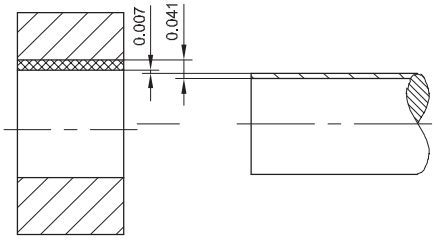


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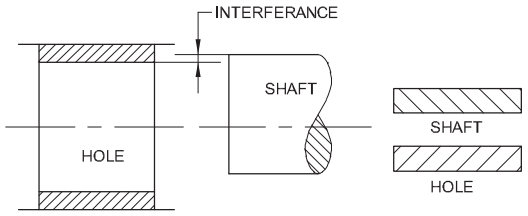
Fig 7



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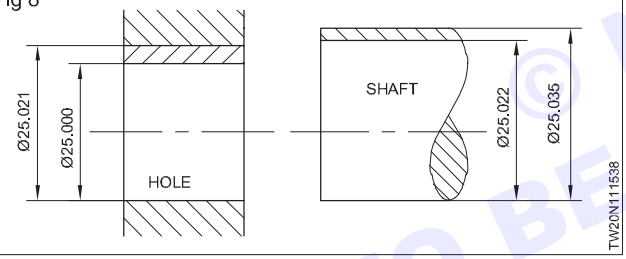
Interference

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)

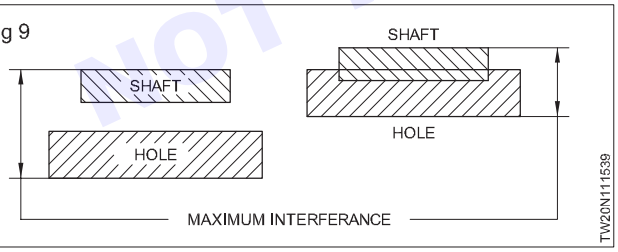
Fig 8



TW20N111538

Example: Fit 25 H7/p6 (Fig 9)

Fig 9



TW20N111539

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.

Maximum interference

In an interference fit or transition fit, it is the algebraic difference between the minimum hole and the maximum shaft. (Fig 10)

Minimum interference

In an interference fit, it is the algebraic difference between the maximum hole and the minimum shaft. (Fig 11)

Fig 10

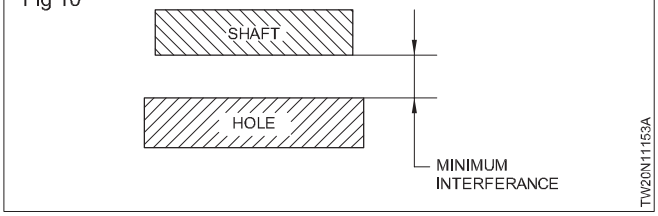


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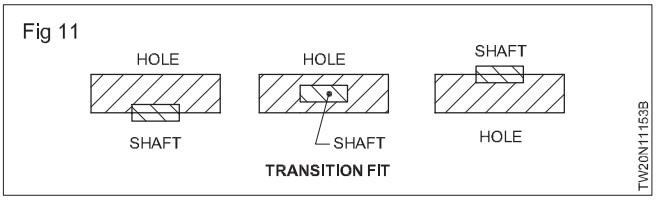
Fig 11



TW20N111153B

In the example shown in figure 9

The maximum interference is = 25.035 – 25.000

= **0.035**

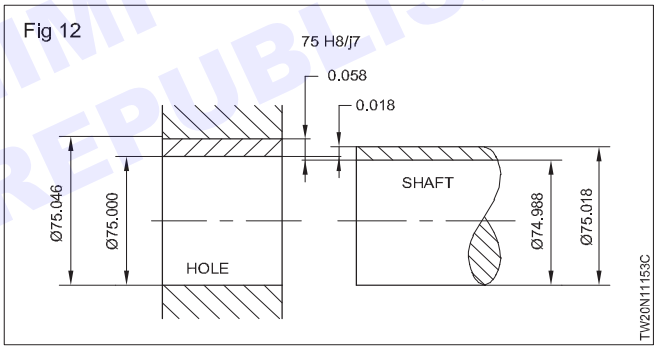
The minimum interference is = 25.022 – 25.021

= 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)

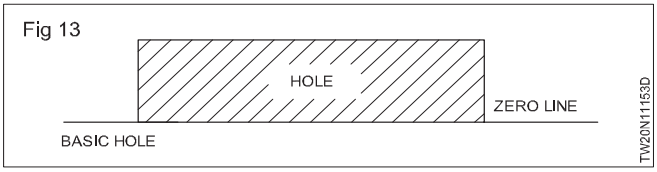
Fig 12



TW20N111153C

Example Fit 75 H8/j7 (Fig 13)

Fig 13



TW20N111153D

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.

British standard limits and fits BS 4500: 1969

International Tolerance Grades (IT)

The specific tolerance for a particular IT grade is calculated via the following formula:

$$T = 10^{0.2 \times (ITG - 1)} (0.45 \times \sqrt[3]{D} + 0.001 \times D)$$

T is the tolerance in micrometres [μm]

D is the geometric mean dimension in millimeters [mm]

ITG is the IT Grade, a positive integer.

NOMINAL (BASIC) SIZES (INCHES)		INTERNATIONAL TOLERANCE GRADES OVER UP TO INCL.									
OVER	UP TO INCL	IT4	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13
0	0.12	0.12	0.15	0.25	0.4	0.6	1.0	1.6	2.5	4	6
0.12	0.24	0.15	0.20	0.3	0.5	0.7	1.2	1.8	3.0	5	7
0.24	0.40	0.15	0.25	0.4	0.6	0.9	1.4	2.2	3.5	6	9
0.40	0.71	0.2	0.3	0.4	0.7	1.0	1.6	2.8	4.0	7	10
0.71	1.19	0.25	0.4	0.5	0.8	1.2	2.0	3.5	5.0	8	12
1.19	1.97	0.3	0.4	0.6	1.0	1.6	2.5	4.0	6	10	16
1.97	3.15	0.3	0.5	0.7	1.2	1.8	3.0	4.5	7	12	18
3.15	4.73	0.4	0.6	0.9	1.4	2.2	3.5	5	9	14	22
4.73	7.09	0.5	0.7	1.0	1.6	2.5	4.0	6	10	16	25
7.09	9.85	0.6	0.8	1.2	1.8	2.8	4.5	7	12	18	28
9.85	12.41	0.6	0.9	1.2	2.0	3.0	5.0	8	12	20	30
12.41	15.75	0.7	1.0	1.4	2.2	3.5	6	9	14	22	35
15.75	19.69	0.8	1.0	1.63	2.5	4	6	10	16	25	40
19.69	30.09	0.9	1.2	2.0	3	5	8	12	20	30	50
30.09	41.49	1.0	1.6	2.5	4	6	10	16	25	40	60
41.49	56.19	1.2	2.0	3	5	8	12	20	30	50	80
56.19	76.39	1.6	2.5	4	6	10	16	25	40	60	100
76.39	100.9	2.0	3	5	8	12	20	30	50	80	125
100.9	131.9	2.5	4	6	10	16	25	40	60	100	160
131.9	171.9	3	5	8	12	20	30	50	80	125	200
171.9	200	4	6	10	16	25	40	60	100	160	250

Tolerances in Thousandths of an Inch (0.001)

Table 1 for Tolerance Zones & Limits (Dimensions in μm)

NOMINAL SIZE RANGE mm	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 1 up to 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 3 up to 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 −38	−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 6 up to 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 10 up to 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 14 up to 18	+28	+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	+6	+16	+32	+50	+95	+150	+290
Over 18 up to 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 24 up to 30	+35	+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 30 up to 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 40 up to 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 50 up to 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 65 up to 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 80 up to 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 100 up to 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 120 up to 140	+117 +92	+88 +63													−200 −450	−260 −510	−460 −710	−77 −117	−48 −88													+450 +200	+510 +260	+710 +460
Over 140 up to 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 160 up to 180	+133 +108	+93 +68													−230 −480	−310 −560	−580 −830	−93 −133	−53 −93													+480 +230	+560 +310	+830 +580
Over 180 up to 200	+151 +122	+106 +77													−240 −530	−340 −630	−660 −950	−105 −151	−60 −106													+530 +240	+630 +340	+950 +660
Over 200 up to 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 +15	+122 +50	+215 +100	+355 +170	+550 +260	+670 +380	+1030 +740
Over 225 up to 250	+169 +140	+113 +84													−280 −570	−420 −710	−820 −1110	−123 −169	−67 −113													+570 +280	+710 +420	+1110 +820
Over 250 up to 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 280 up to 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 315 up to 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 355 up to 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	+62	+125	+210	+760 +400	+1040 +680	+1710 +1350
Over 400 up to 450	+272 +232	+166 +126	+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 450 up to 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

Lathe - types, construction, parts of functions and specifications

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

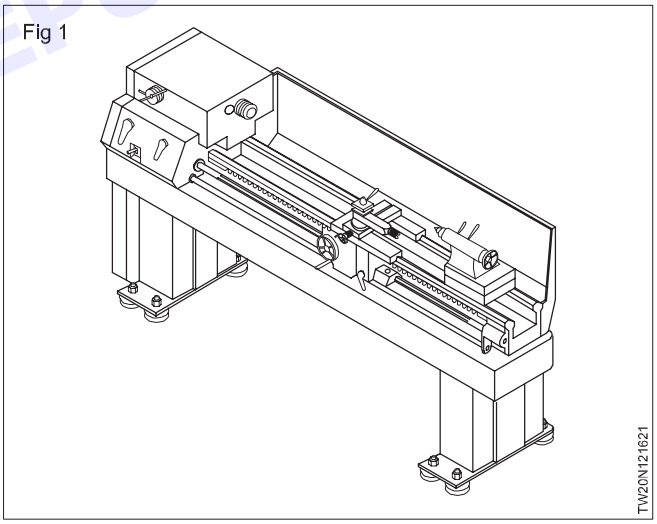
- The term engine is because of that early lathes were driven by steam engine.
- It consists of basic parts like bed, head-stock and tail stock but head-stock is more robust and has additional drive mechanism for multiple speeds.
- Engine lathe can feed cutting tool both in cross and longitudinal directions 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)

Fig 1



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

Lathe - parts and lubrication points

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)

Fig 1

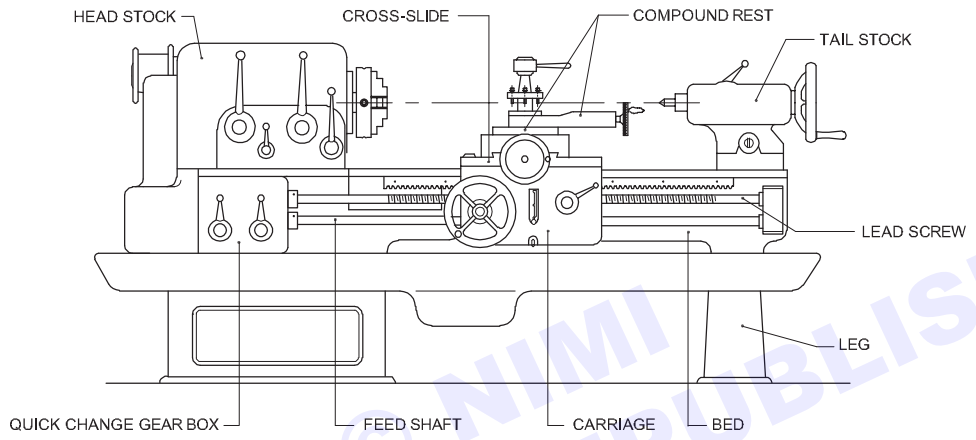
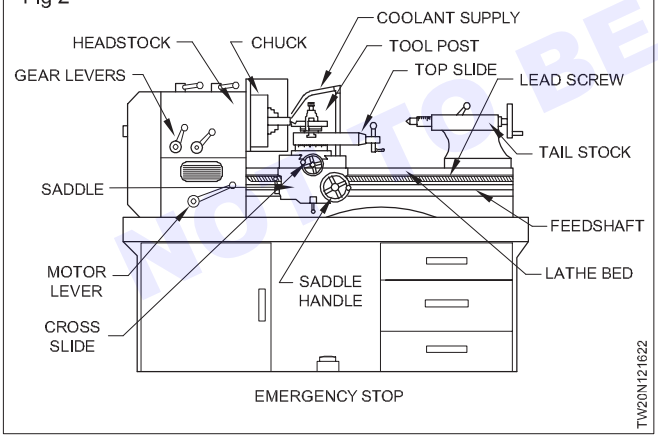


Fig 2



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.

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.

Lathe parts

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.**

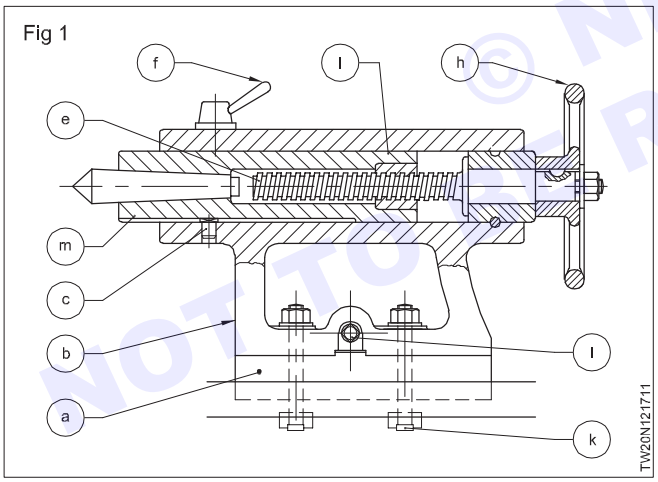
Tailstock

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

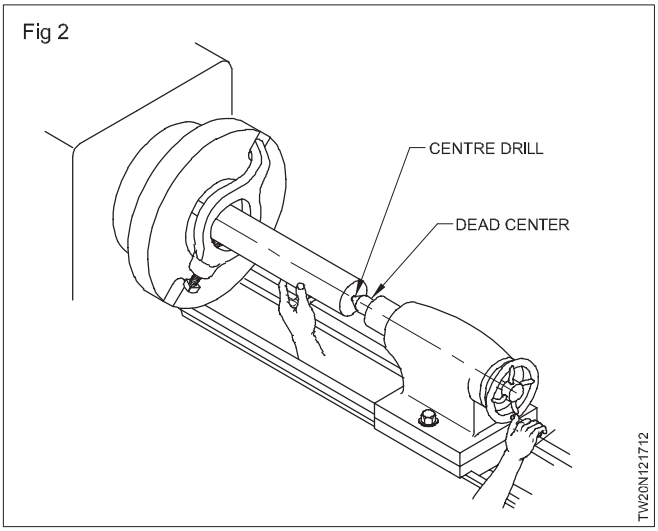
By rotating the hand wheel the screw rod is operated. This causes the barrel, which carries the nut, to move forward and backward according to the direction of rotation. The key, which fits in the keyway milled at the bottom of the barrel, prevents the barrel from rotation. The thread in the screw rod 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)

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

Fig 3

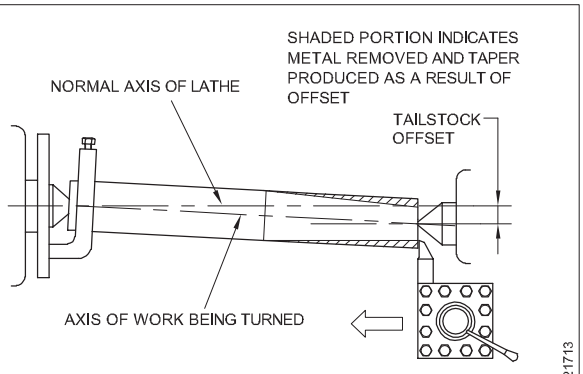
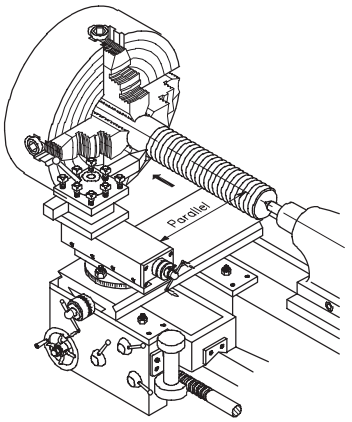


Fig 4



The carriage

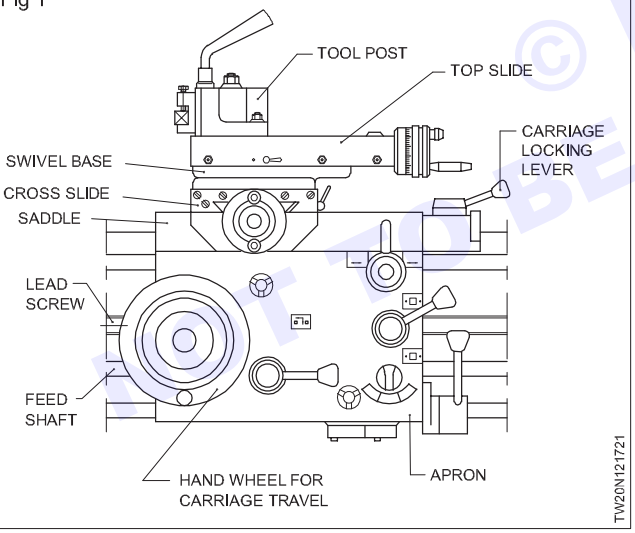
Objectives: At the end of this lesson you shall be able to

- **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 movement (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

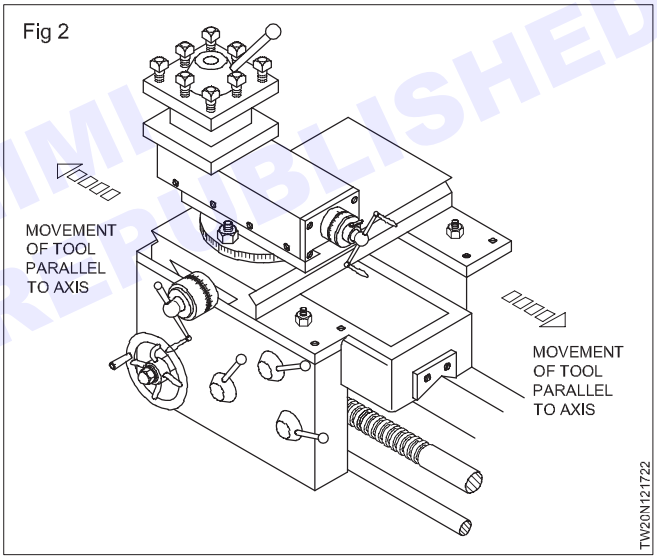
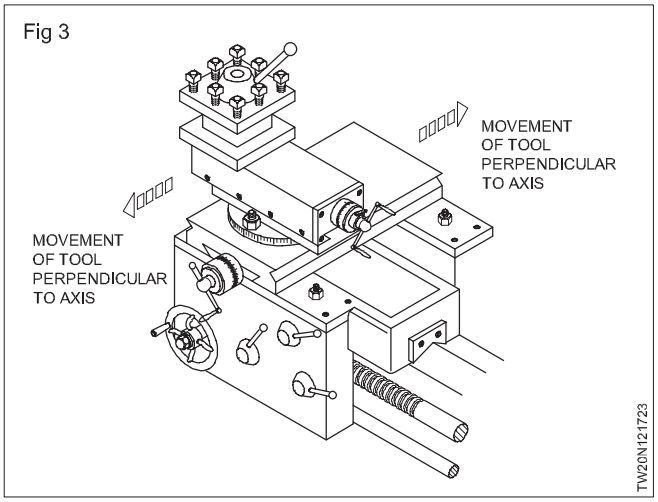
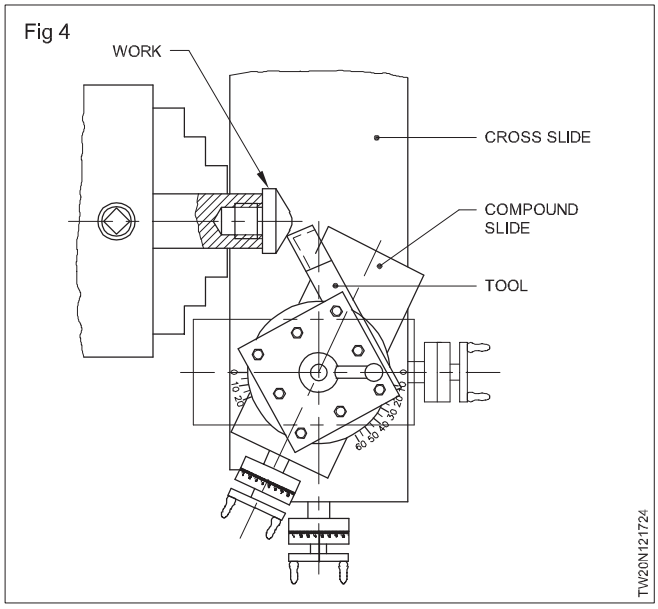


Fig 3



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



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

Saddle

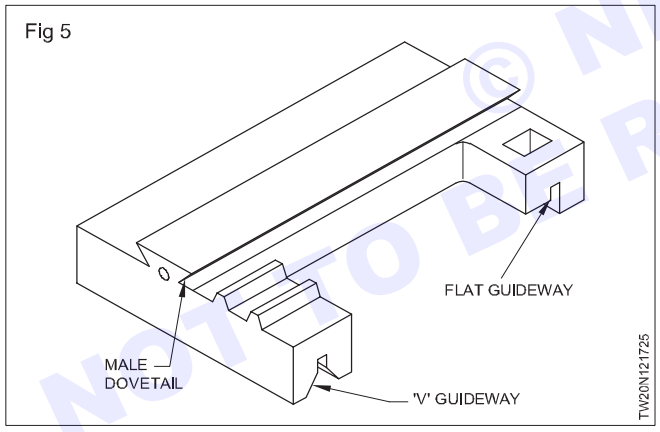
Cross-slide

Compound rest swivel and top slide.

Tool post

Apron

The saddle (Fig 5)



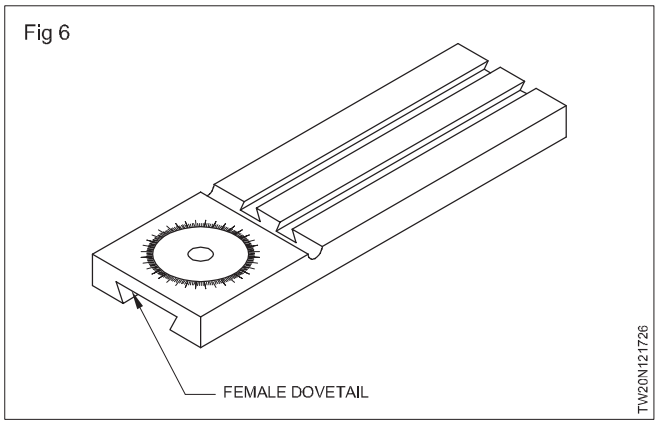
It is 'H' shaped casting and has 'V' guide grooves and flat grooves machined at the bottom face corresponding to the lathe bed-ways for mounting the saddle on the lathe bed and for sliding over the bed by the operation of the hand wheel.

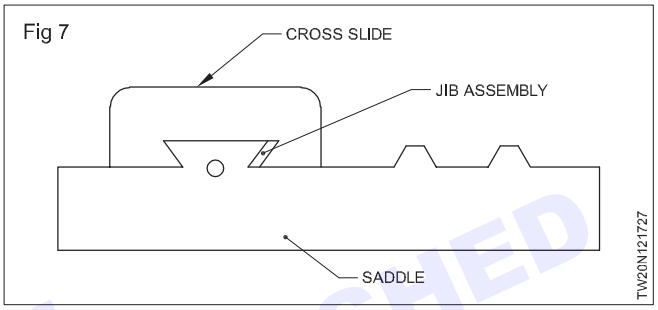
The cross-slide (Fig 6 & 7)

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.

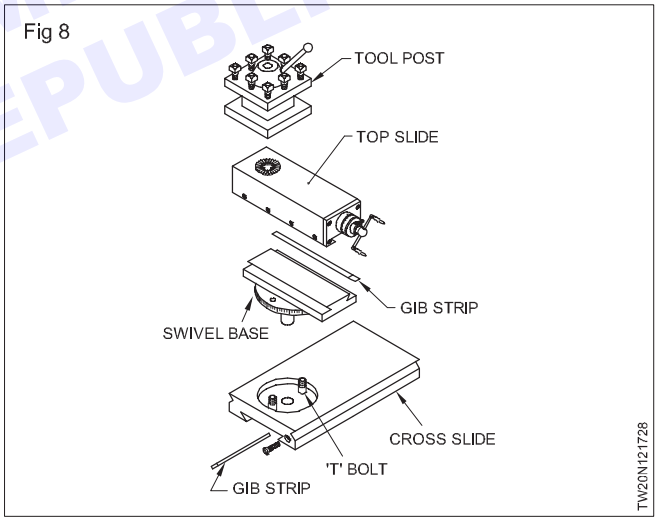
A left hand square or acme thread screw-rod fitted with a hand wheel helps in the manual movement of the cross-slide. The automatic feeding is achieved through gearing.

A graduated collar mounted on the screw-rod along with the hand wheel helps to set the fine, movements of the cross slide.





The compound rest (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 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.

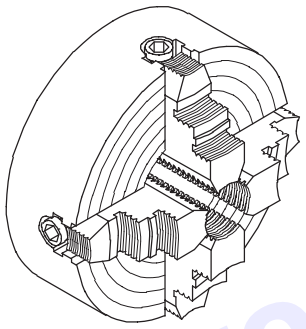
Work-holding accessories

The work can be directly mounted on these accessories and held.

The accessories are

- Four jaw independent chuck (Fig 1)

Fig 1



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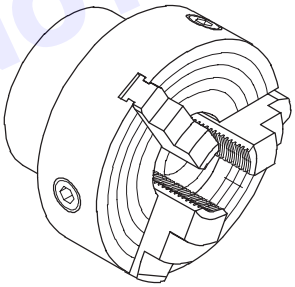
- Three jaw self-centering chuck (Fig 2)

Fig 2



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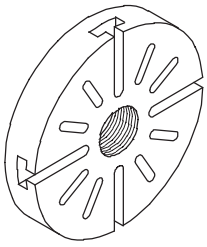
- Face plates (Fig 3)

Fig 3



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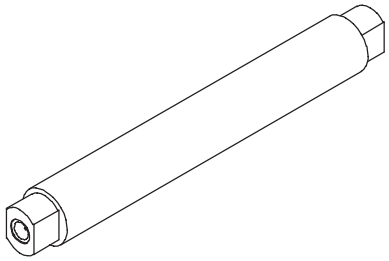
- Lathe mandrels. (Fig 4)

Fig 4



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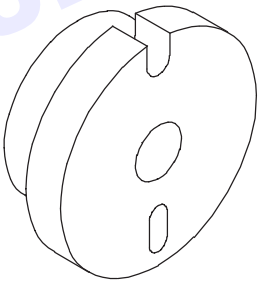
Work-supporting accessories

These accessories do not hold the work themselves. They support the work. The following are the work supporting accessories.

- Catch plate (Fig 5)

Fig 5



CATCH PLATE

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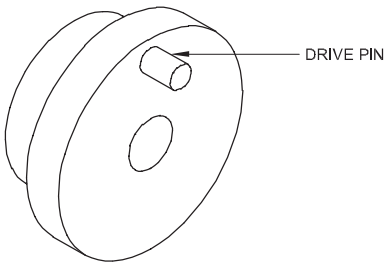
- Driving plate (Fig 6)

Fig 6



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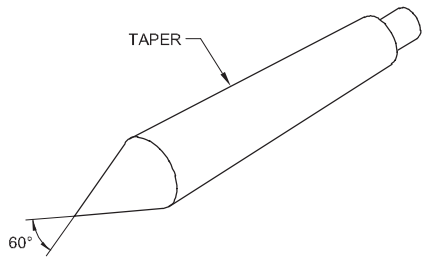
- Lathe centres (Fig 7)
- Lathe carriers (Fig 8)
- Lathe travelling steady (Fig 9)
- Lathe fixed steady (Fig 10)

Fig 7



60° TAILSTOCK CENTRE

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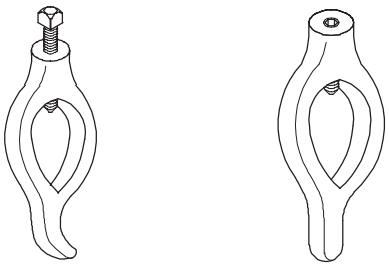
Fig 8



BENT TAIL STRAIGHT TAIL

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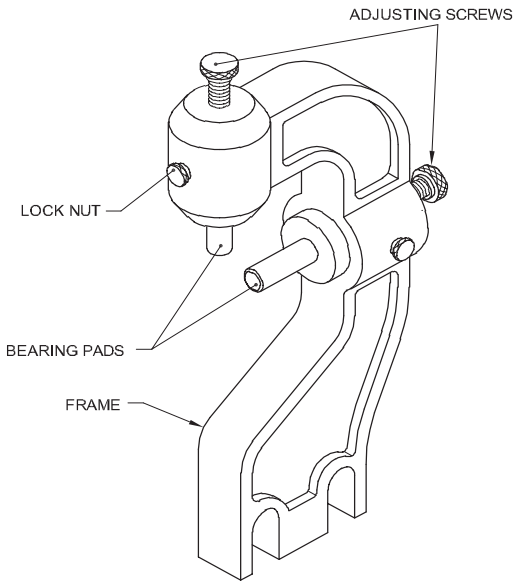
Accessories used for between centre work

The accessories used during turning work held in between centres are

- live centre
- dead centre
- catch plate
- driving plate
- lathe spindle plate
- lathe carriers

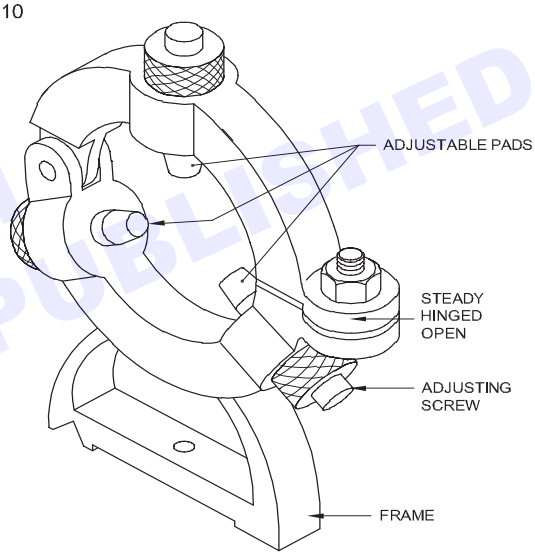
Fig 9



TRAVELLING STEADY

TW20N121819

Fig 10



FIXED STUDY

TW20N121181A

Lathe carrier - Function, types of carrier and uses

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

- **state the functions of lathe carriers**
- **state the features of different types of lathe carriers**
- **name the different types of lathe carriers**
- **distinguish between the uses of different types of 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.

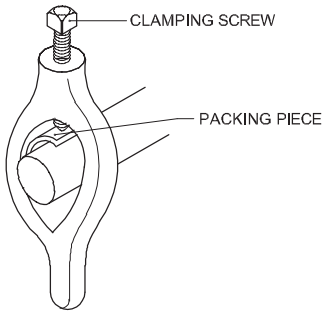
Types of lathe carriers

The following are the four types of lathe carriers.

- Straight tail carrier
- Bent tail carrier
- Clamp type carrier
- Safety clamp type carrier.

The tail of the straight tailed carrier locates against the driving pin of the driving plate and provides a positive drive for the workpiece. (Fig 2)

Fig 1



FITTING CARRIER TO WORK

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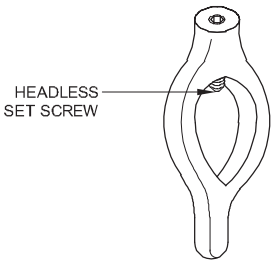
Fig 2



STRAIGHT TAIL

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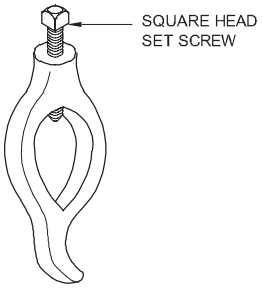
A bent tailed lathe carrier engages into a 'u' slot of the catch plate and drives the workpiece. (Fig 3)

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 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 3



BENT TAIL

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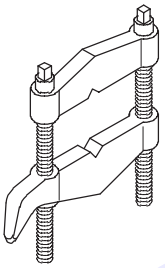
Fig 4



CLAMP TYPE

TW20N121824

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 jobs between centres, driving plates are used. They are

- catch plate
- driving plate
- safety driving plate

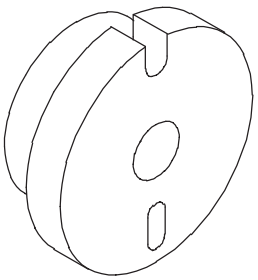
Catch plate: It is designed with a 'U' slot and an elliptical slot to accommodate the bent tail of the lathe carrier. (Fig 1)

Driving plate: It is designed with a projected pin which locates the straight tail of the lathe carrier. (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)

It is made of cast steel and is machined to have its face perfectly at right angles to the bore. It is 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.

Fig 1



CATCH PLATE

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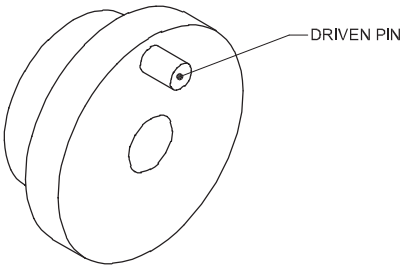
Uses

The driving plate with a straight tail carrier provides a positive drive for the workpiece.

Catch plates with bent tail carriers use a minimum length of the workpiece for clamping purposes.

A safety driving plate protects the operator from likely injuries.

Fig 2



DRIVE PLATE

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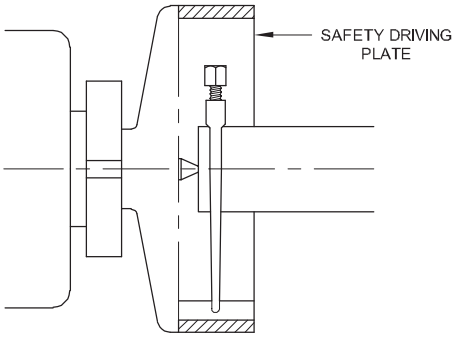
Fig 3



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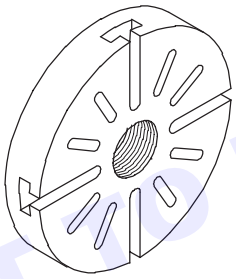
Face plates : They are similar in construction to the lathe catch plates but are larger in diameter.

The different types of face plates are

- Face plates with only elongated radial slots (Fig 4)

Fig 4



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- Face plates with elongated slots and T' slots. (Fig 5)
- Face plates with elongated radial slots and additional parallel slots. (Fig 6)

Fig 5

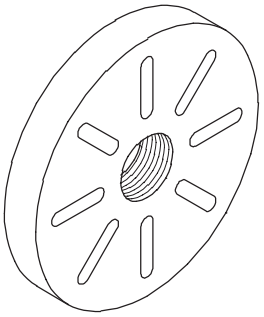

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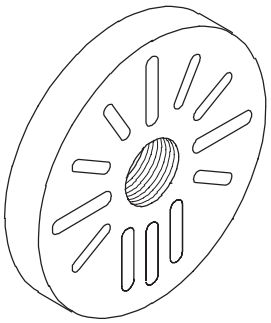
Fig 6



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Face plates are used along with the following accessories.

Clamps, 'T' bolts, Angle plate, Parallels, Counterweight, Stepped block, 'V' Block etc.

Uses

Large, flat, irregular shaped workpieces, castings, jigs and fixtures may be firmly clamped to a face plate for various turning operations.

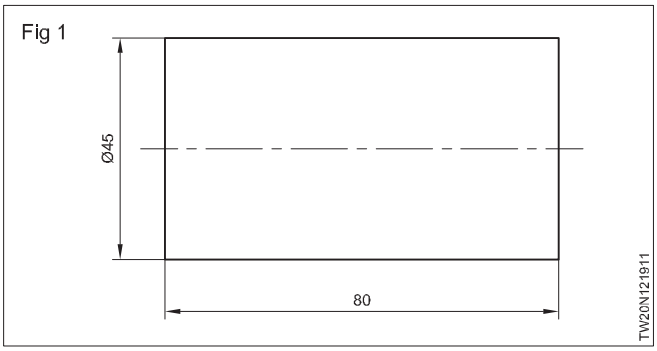
A work can be mounted on a face plate while the face plate is on the lathe spindle or on the workbench. If the workpiece is heavy or awkward to hold, the workpiece is mounted while the face plate is on the workbench. Before mounting the face plate set up to the spindle, it is advantageous to locate the workpiece on the face plate and centre the workpiece. Centre a 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.

Different types of operations performed in lathe

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

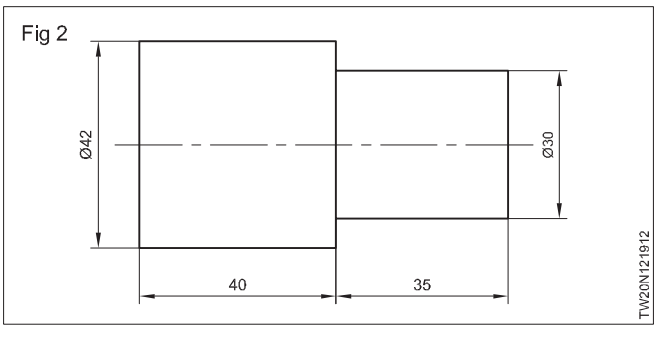
- **parallel turn the work by hand feed method with various depth of cuts**
- **turn step to the required diameter and length**
- **groove by the traverse feed method**
- **chamfer the edges and check with a protractor**
- **set the parting off tool in the machine to the correct centre height**
- **form a 'V' groove and match with the template.**

Parallel turning (Fig 1)



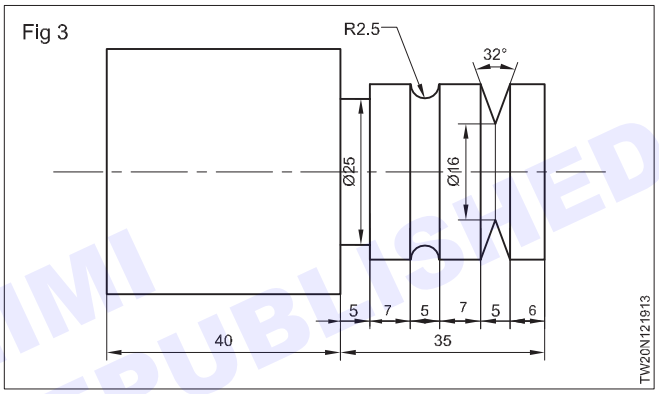
- Check the raw material size.
- Hold the job in a 4 jaw chuck and true it by keeping about 50mm outside the chuck.
- Set the tool to the correct centre height.
- Select and set the correct spindle rpm.
- Face one side first and turn the outer diameter to Ø45mm for the maximum possible length.
- Reverse and hold the job.
- Face the other end to a total length of 80mm.
- Turn Ø 45mm to remaining length.
- Remove the sharp edge.

Step turning (Fig 2)



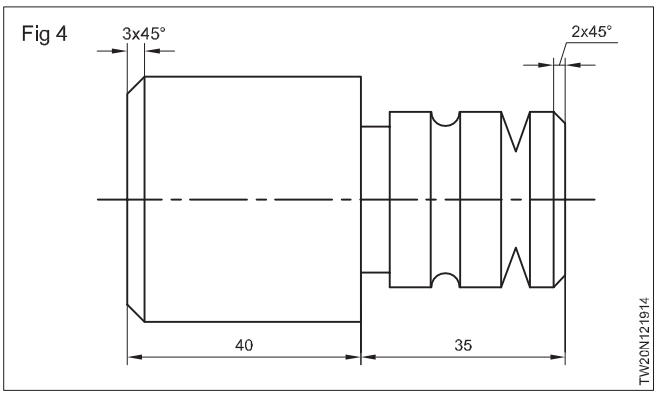
- Hold the job in a 4 jaw chuck keeping about 45 mm outside and true it.
- Face one end.
- Turn Ø30mm x 35 mm length.
- Reverse the job and reset it.
- Face the other end to maintain a 75mm total length.
- Turn Ø42mm x 40mm length.
- Remove the sharp corners.

Grooving (Fig 3)



- Set the u/c tool, radius tool, 'V' groove tool to the correct centre height and hold it rigidly.
- Form a square groove 2.5mm depth x 5mm width at 30mm from the end face.
- Form a radius groove 2.5mm depth x 5mm width at 18mm from the end face.
- Plunge the 'V' groove tool to form a 'V' groove 5mm width at 6mm from the end face.
- Remove the burrs.
- Check the dimensions.

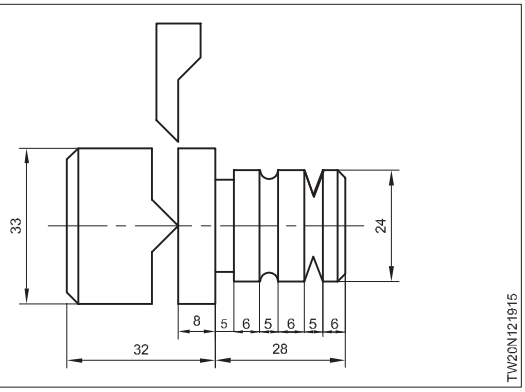
Chamfering (Fig 4)



- Set the chamfering tool to correct centre height.
- Chamfer the Ø42 step to 3 x 45°.
- Reverse the job and reset it.
- Chamfer the Ø30 step to 2 x 45°.
- Remove the job and check the dimensions.

Parting (Fig 5)

Fig 5

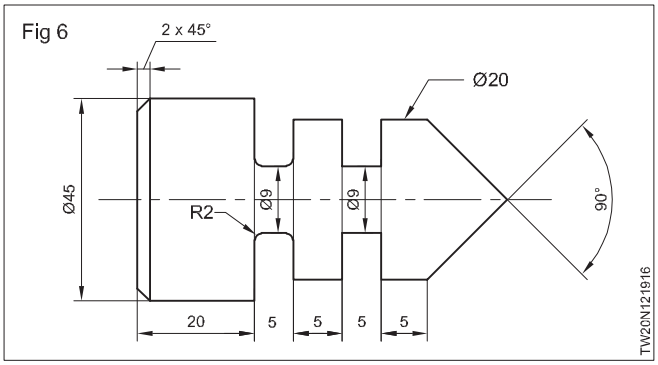


- Hold the job keeping Ø42 inside at 3 jaw chuck by keeping about 50mm outside the chuck and true the job.
- Set the 3 mm width parting tool to correct centre height.
- Select and set the correct spindle speed for parting operation.
- Part the job use plunge cut method at 45 mm from the end face.

Groove turning (Fig 6)

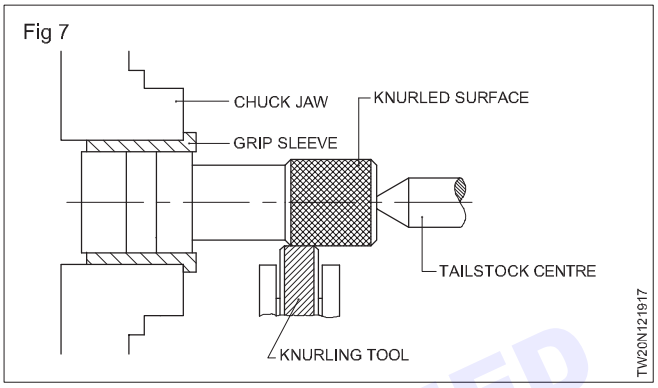
- Write the job sequence.
- Grind the required tool
- Turn the job as per drawing and maintain the dimension
- Part of the job after finishing all turning operations

Fig 6



Knurling (Fig 7)

Fig 7



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.

Cutting tool materials - types of selection various cutting angle, uses and applications

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

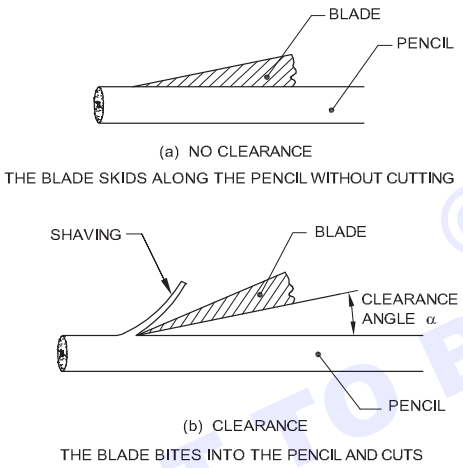
- **state the necessity of providing angles and clearances on cutting tools**
- **name the angles of a lathe cutting tool**
- **state the characteristics of a rake angle**
- **state the characteristics of a clearance angle**
- **determine the recommended rake and clearance angles for turning different 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.

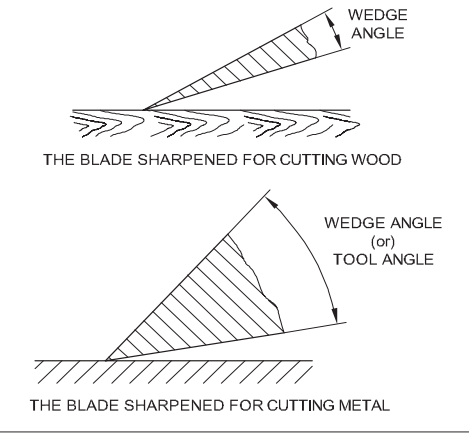
When we sharpen a pencil with a pen knife by trial and error, we find that the knife must penetrate into the wood at a definite angle, if success is to be achieved. (Fig 1)

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.

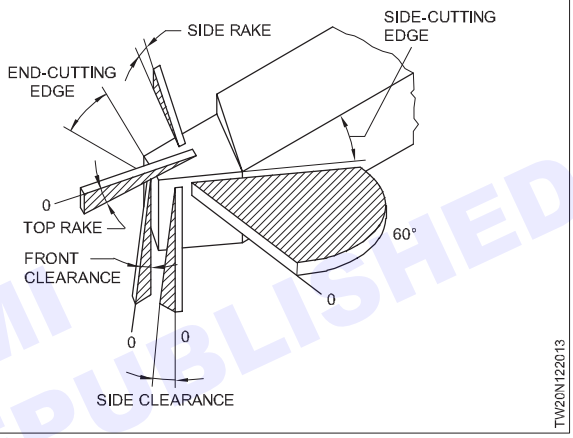
Fig 2



The angle shown in Fig 1 is known as a clearance angle and that shown in Fig 2 is a wedge angle.

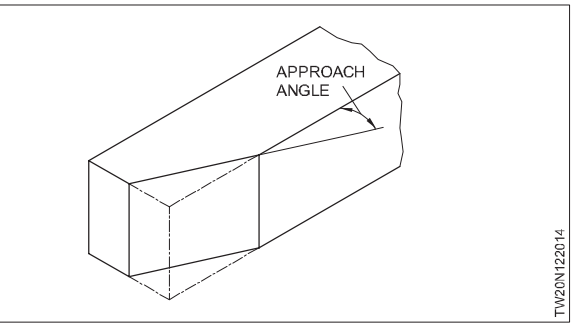
Angles ground on a lathe cutting tool (Fig 3)

Fig 3



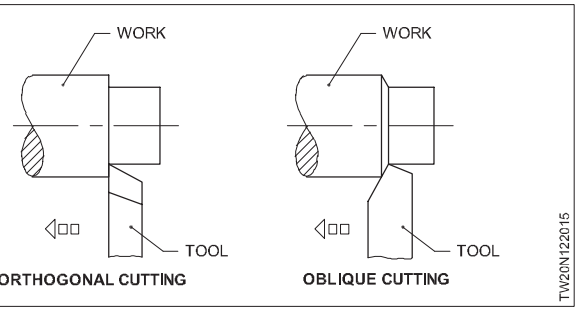
Side cutting edge angle (Approach angle) (Fig 4)

Fig 4



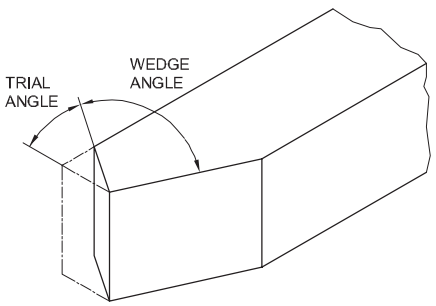
This is ground on the side of the cutting tool. The cutting will be oblique. The angle ground may range from 25°to 40° but as a standard a 30° angle is normally provided. The oblique cutting has certain advantages over an orthogonal cutting, in which the cutting edge is straight. More depth of cut is 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)

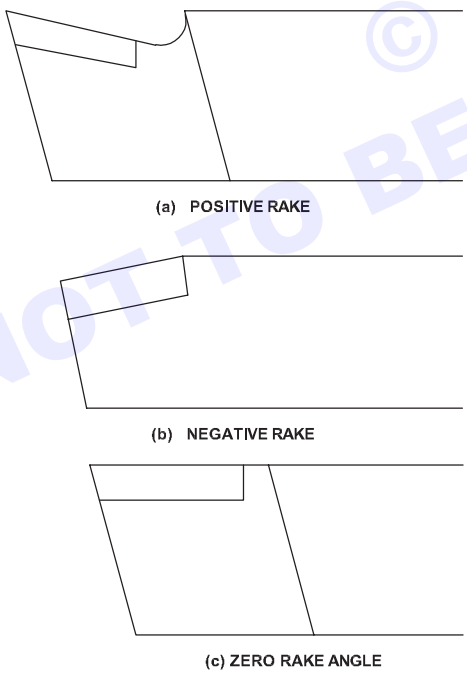
Fig 6



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.

Top or back rake angle (Fig 7)

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): 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 chips 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.

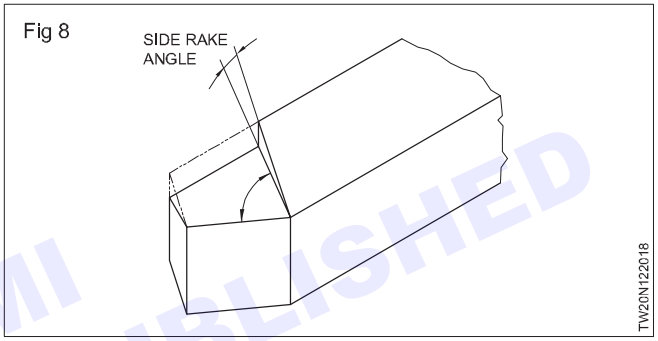
Negative top rake tools have more strong than positive top rake angle tools. Tool life is too long. Chip should be broken and rough surface finish.

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)

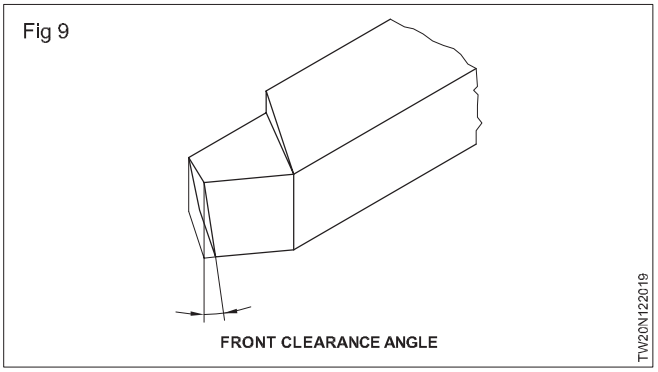
Fig 8



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)

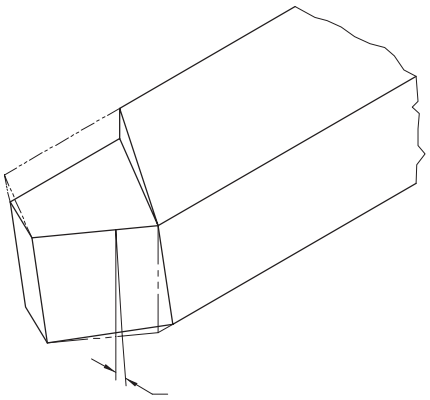
Fig 9



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.

Side clearance angle (Fig 10)

Fig 10

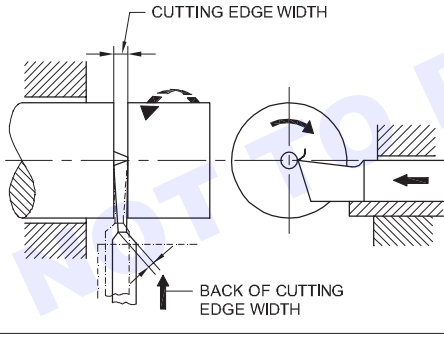


The side clearance angle is the slope formed between the side cutting edge of the tool with a line perpendicular to the tool axis drawn downwards at the side cutting edge of the tool. The slope is from the top of the side cutting edge to the bottom face. This is also ground to prevent the tool from rubbing 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)

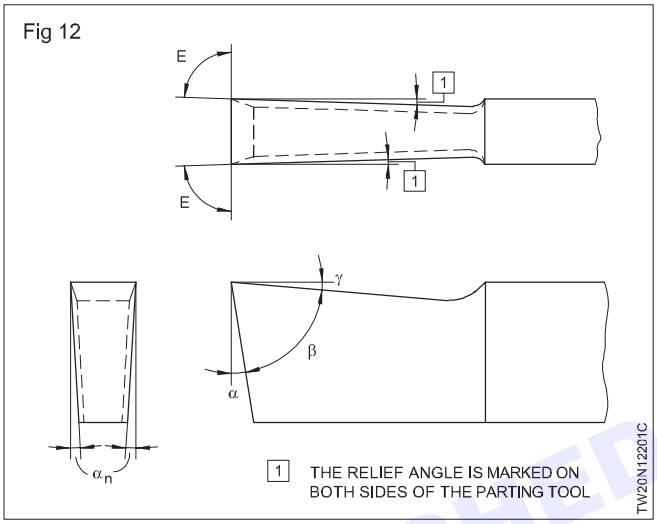
Fig 11



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.

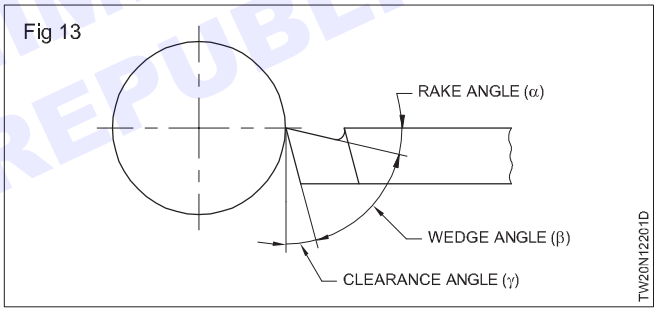
This permits clearance between the sides of the tool and the groove walls formed by the plunging action of the tool, thereby, preventing the tool from getting jammed in the groove and causing breakage. The relief is kept as minimum as possible. Too much of relief will weaken the tool cutting edge, and 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)

Fig 12



Relationship between rake, clearance and wedge angles (Fig 13)

Fig 13



The rake angle (∝), 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.

Lathe cutting tools - Different types

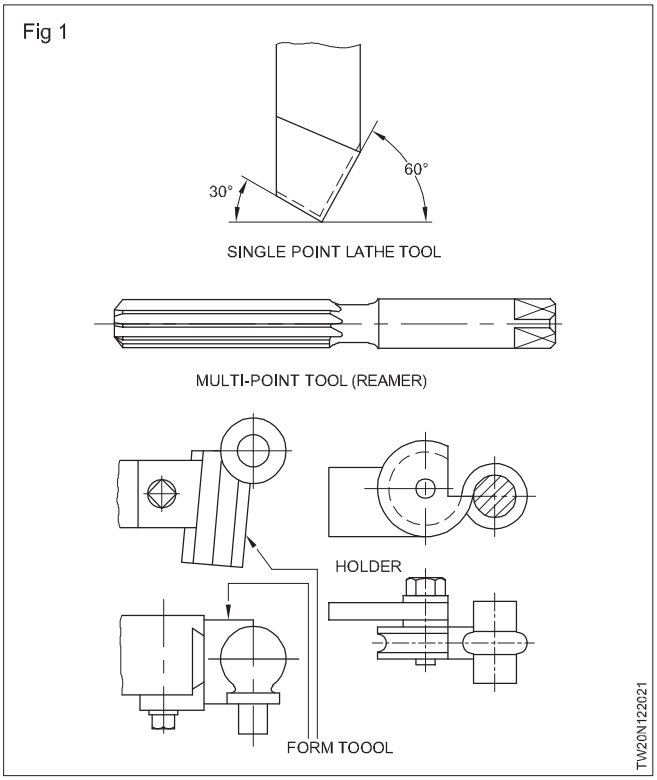
Objectives: At the end of this lesson you shall be able to
- **classify lathe cutting tools**
- **list the types of lathe cutting tools**
- **state the features of each type.**

Cutting tool classification (Fig 1)

Cutting tools are classified as

- single point cutting tools
- multi-point cutting tools
- form tools.

Fig 1

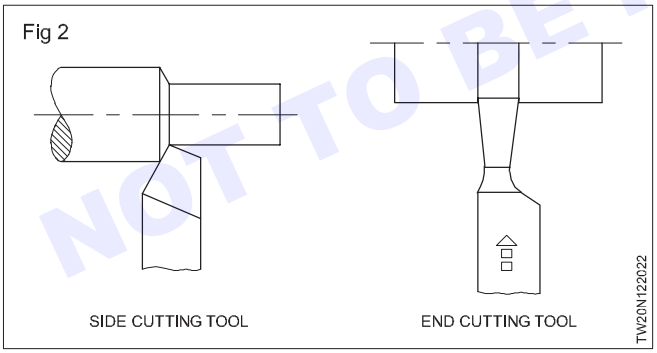


Single point cutting tools: Single point cutting tools have one' cutting edge which performs the cutting action. Most of the lathe cutting tools are single point cutting tools.

Single point cutting tools used on lathes may be grouped into

- side cutting tools
- end cutting tools. (Fig 2)

Fig 2

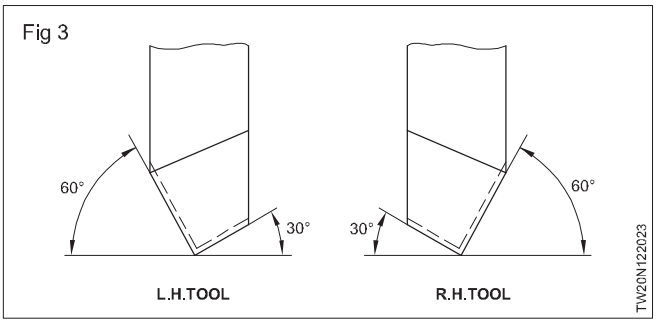


Side cutting tools: Side cutting edge tools have their cutting edges formed on the side of the cutting tool, and are used on lathes for most of the operations. They are again classified as right hand tools and left hand tools. (Fig 3) A right hand tool operates from the tailstock end towards headstock and a left hand tool operates from the headstock end towards the tailstock. The cutting edge is formed accordingly.

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.

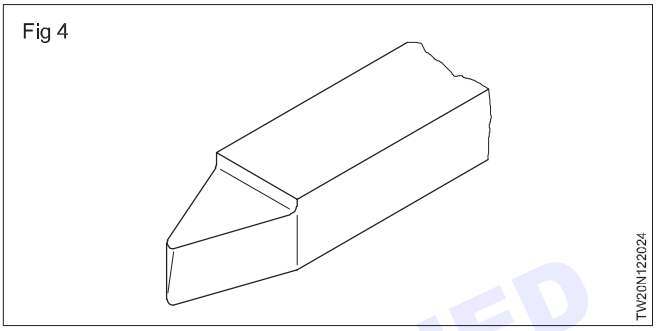
Multi-point cutting tools: These tools have more than one cutting edge, and they remove metal from the work simultaneously by the action of all the cutting edges. The application of the multi-point cutting tools on the lathe is mostly done by holding the tool in the tailstock and feeding it to the work.

Fig 3



Form tools (Fig 4)

Fig 4



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

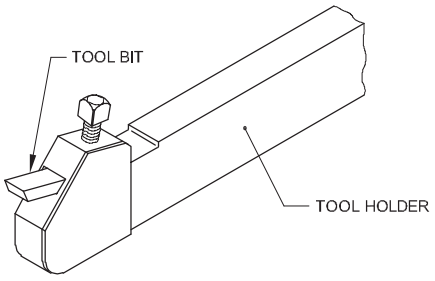
- Solid type tools
- Brazed type tools
- Inserted bits with holders
- Throw-away type tools.

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.

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.

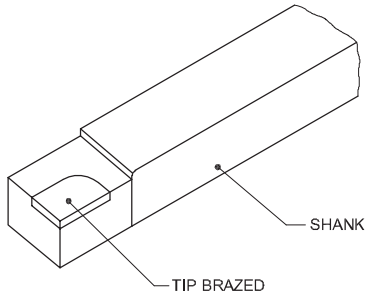
The disadvantage in these types of tools is that the rigidity of the tool is poor in the slot.

Fig 5



Brazed tools (Fig 6)

Fig 6

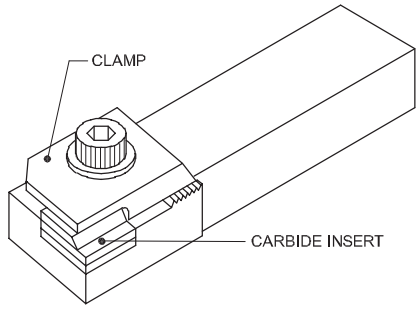


These tools are made of two different metals. The cutting portions of these tools are good cutting tool materials, and the body of the tools does not possess any cutting ability and is tough. Tungsten carbide tools are mostly of the brazed type. Tungsten carbide bits of square, rectangular and triangular 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.

Throw-away type tools (Fig 7)

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.

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.**

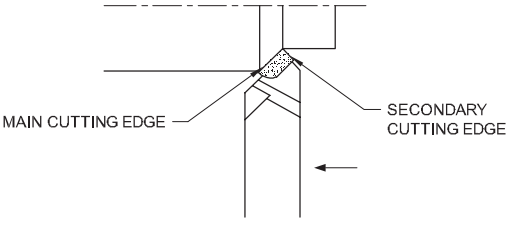
Cemented carbide tools are available as brazed tipped tools and throw away tips held in specially designed tool holders.

Standard 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.

Standard terms for carbide tools as specified in ISO

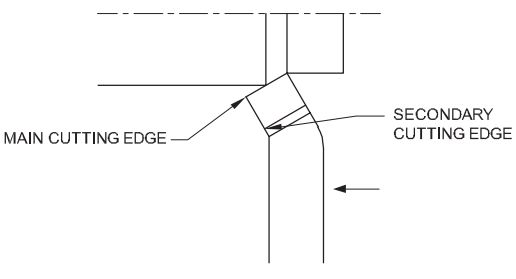
ISO 1 straight turning tool (Fig 1)

Fig 1



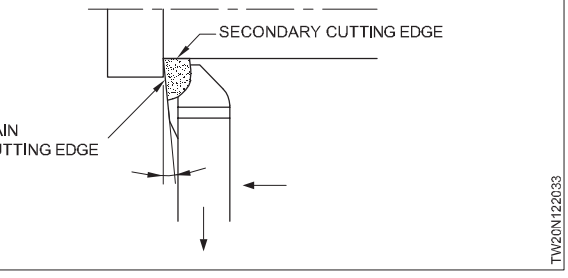
ISO 2 Cranked turning tool (Fig 2)

Fig 2

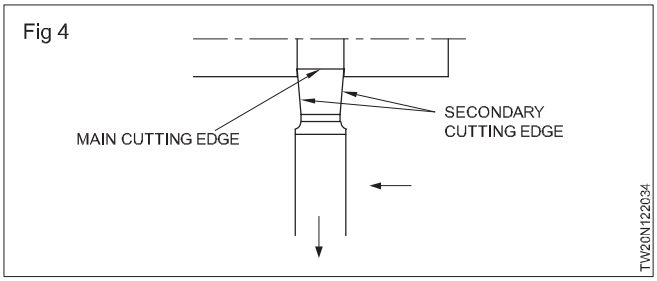


ISO 3 Offset facing tool (Fig 3)

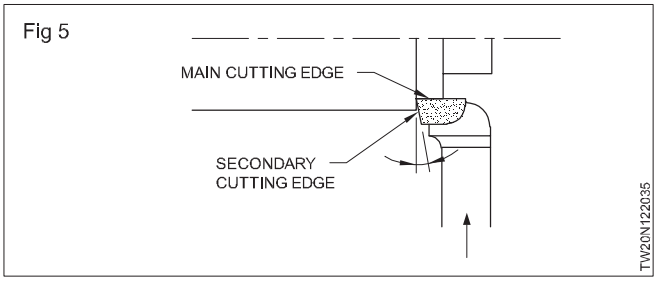
Fig 3



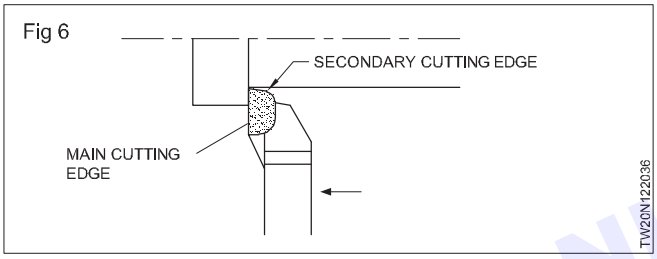
ISO 4 Wide nose square turning tool (Fig 4)



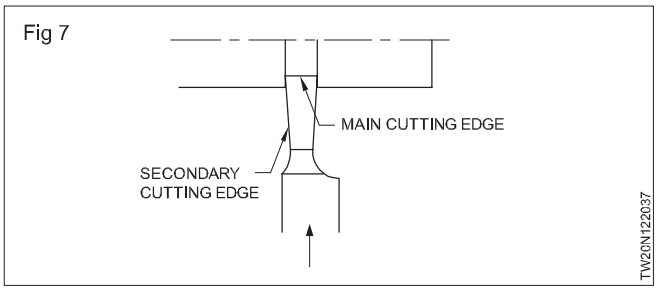
ISO 5 Offset turning and facing tool (Fig 5)



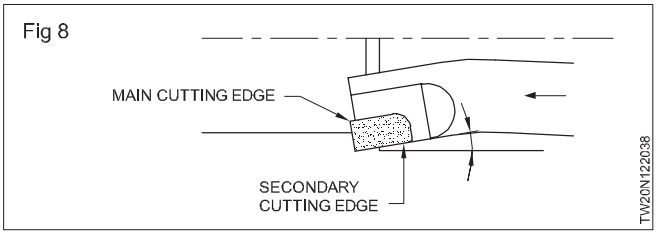
ISO 6 Offset side cutting tool (Offset knife tool) (Fig 6)



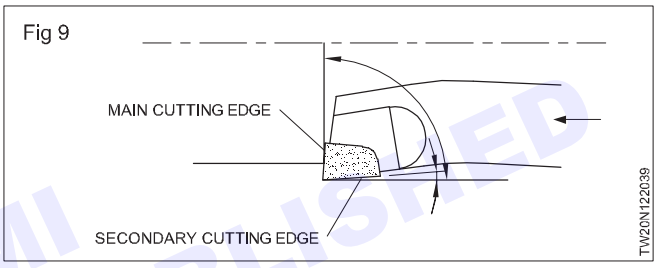
ISO 7 Recessing tool (parting tool) (Fig 7)



ISO 8 Boring tool (Fig 8)



ISO 9 Corner boring tool (finishing) (Fig 9)



The carbide tools are specified according (1) the operation (rough and finish) (2) right hand or left hand (3) material being turned and machining conditions.

Types of thread applications, tapping process

Objectives: At the end of this lesson you shall be able to
- **name different types of screw threads**
- **name the different form of screw threads**
- **illustrate their forms and elements**
- **describe their applications.**

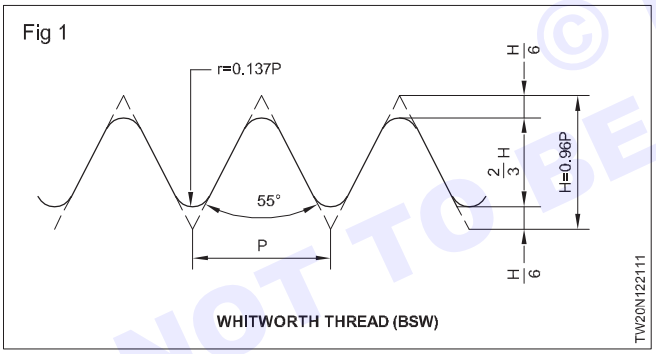
The different types of V threads are

- **BSW Thread:** British Standard Whitworth Thread
- **BSF Thread**: British Standard Fine Thread
- **BSP Thread:** British Standard Pipe Thread
- **B.A. Thread:** British Association Thread
- **I.S.O. Metric thread:** International Standard Organisation metric thread
- American National or sellers 'thread

BIS Metric thread: Bureau of Indian Standard metric thread.

BSW thread (Fig 1): it has an included angle of 55° and depth of the thread is 0.6403xP. The crest and root are rounded off to a definite radius. The figure shows the relationship between the pitch and the other elements of the thread.

Fig 1



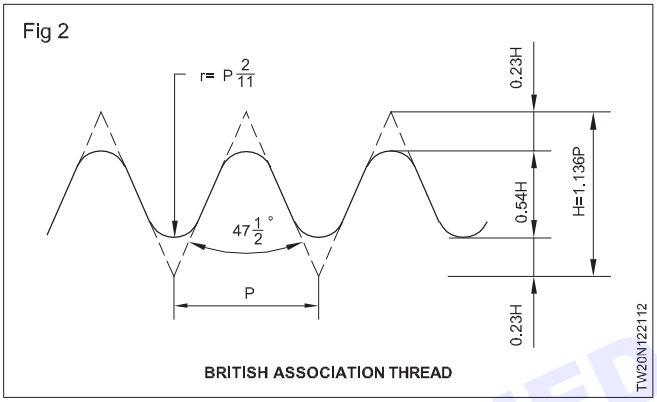
BSW thread is represented in a drawing by giving the major diameter. For example: 1/2" BSW, 1/4" BSW. The table indicates the standard number of TPI for different diameters. BSW thread is used for general purpose fastening threads.

BSF thread: This thread is similar to BSW thread except the number of TPI for a particular diameter. The number of threads per inch is more than that for the BSW thread for a particular diameter. For example, 1" BSW has 8 TPI and 1" BSF has 10 TPI. The table indicates the standard number of TPI for different dia. of BSF threads. It is used in automobile industries.

BSP thread: This thread is recommended for pipe and pipe fittings. The table shows the pitch for different diameters. it is also similar to BSW thread. The thread is cut externally with a small taper for the threaded length. This avoids the leakage in the assembly and provides for further adjustment when slackness is felt.

BA Thread (Fig 2)

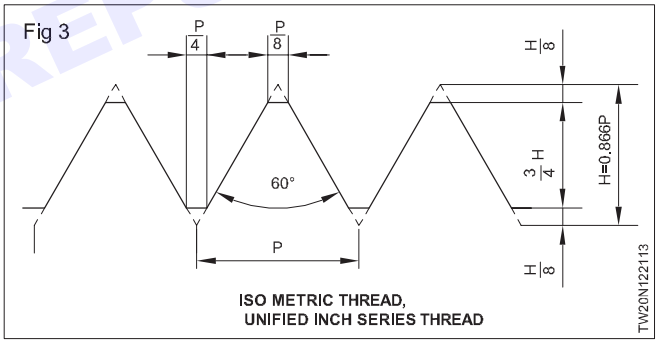
Fig 2



This thread has an included angle of 47 1/2°. Depth and other elements are as shown in the figure. It is used in small screws of electrical appliances, watch screws, screws of scientific apparatus.

Unified thread (Fig 3)

Fig 3



For both the metric and inch series, ISO has developed this thread. Its angle is 60°. The crest and root are flat and the other dimensions are as shown in the figure. This thread is used for general fastening purposes.

This thread of metric standard is represented in a drawing by the letter 'M' followed by the major diameter for the coarse series.

EX: M14, M12, etc.

For the fine series, the letter 'M' is followed by the major diameter and pitch.

EX: M14 x 1.5

M24 x 2

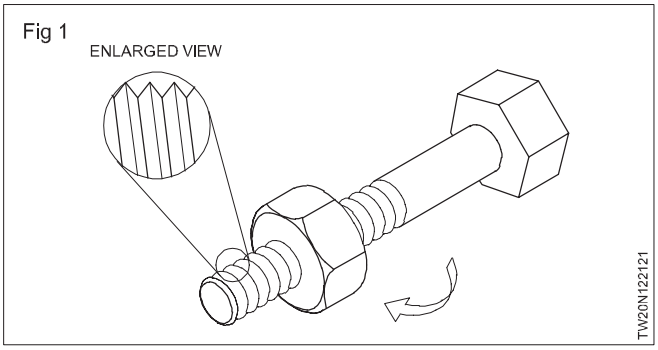
Screw thread applications

Objectives: At the end of this lesson your shall be able to
- **assemblies of internal and external threads**
- **uses of screw threads.**

In mechanical assemblies and in transfer of power these thread applications play a vital role. In milling machine worm& thread helps in indexing the job. The square thread is generally used for transferring power like screw jack, and lead screw of a thread in thread cutting.

External threads and internal threads are assembled together for different engineering uses. (Fig 1)

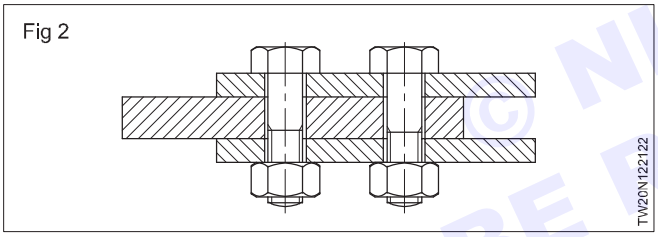
Fig 1



Uses of screw threads

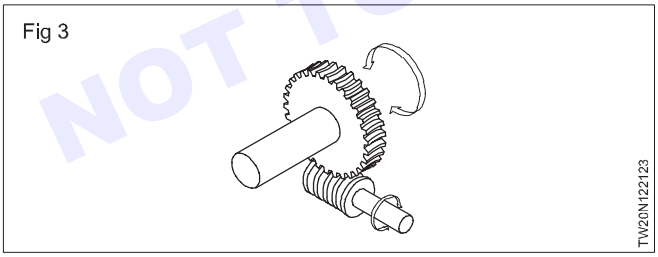
Screw threads are used as fasteners to hold together and dismantle components when needed (Fig 2)

Fig 2



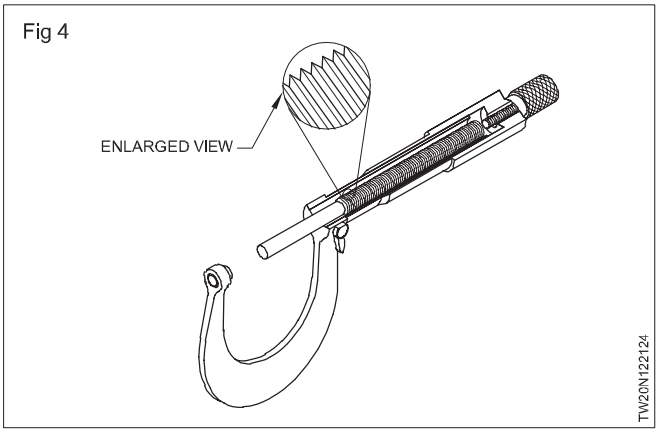
To transmit motion on machines from one unit to another (Fig 3)

Fig 3



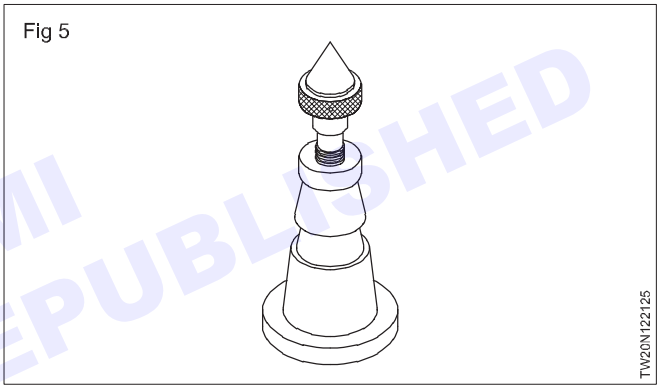
To make accurate measurements (Fig 4)

Fig 4



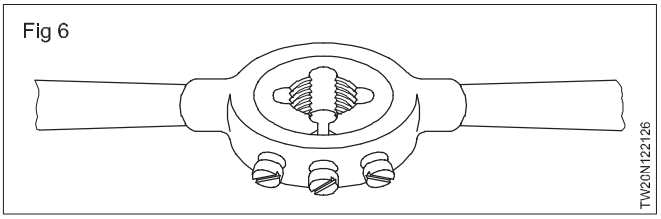
To apply pressure (Fig 5)

Fig 5



To make adjustments. (Fig 6)

Fig 6



Forms of screw threads

Objectives: At the end of this lesson you shall be able to
- **different types of screw threads**
- **thread angles.**

Basic forms of screw threads: Screw threads of different forms are available for meeting the various requirements. The basic forms of screw threads are

vee threads

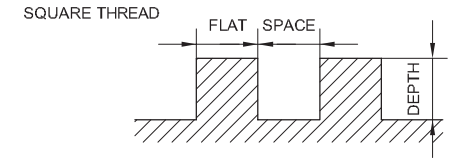
square threads

trapezoidal threads.

Vee threads (Fig 1): These threads are of a 'V' shape. Vee threads of different types are available. Vee thread is the most commonly used form of screw threads, and is used for domestic and industrial applications like bolts, nuts and spindles for micrometers etc.

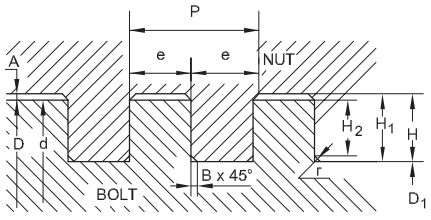
Square and trapezoidal threads: Square and trapezoidal threads have more cross-sectional area than 'V' threads. They are more suitable to transmit motion or power than 'V' threads. They are not used for fastening purposes.

Fig 1



DEPTH = $\frac{0.5000}{N}$ WIDTH OF FLAT = $\frac{0.5000}{N}$ WIDTH OF SPACE = $\frac{0.5000}{N}$

WHERE N =NUMBER OF THREADS PER INCH AND IS EQUAL TO 1/P INCH



FOR SQ.30 x 3 & 60 x 3

h1	1.5	e	1.5
H	1.75	r	0.12
h2	1.25	b	0.25
a	0.25		

TW20N122131

Square thread: In this thread the flanks are perpendicular to the axis of the thread. The relationship between the pitch and the other elements is shown in Fig 1.

Square threads are used for transmitting motion or power. Eg. screw jack, vice handles, cross-slide and compound slide, activating screwed shafts.

Modified square thread: Modified square threads are similar to ordinary square threads except for the depth of the thread. The depth of thread is less than half pitch of the thread. The depth varies according to the application. The crest of the thread is chamfered at both ends to 45° to avoid the formation of burrs. These threads are used where quick motion is required.

Trapezoidal threads: These threads have a profile which is neither square nor 'V' thread form and have a form of trapezoid. They are used to transmit motion or power. The different forms of trapezoidal threads are

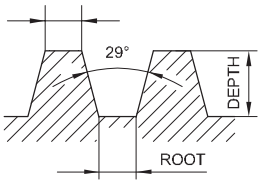
- acme thread - buttress thread
- saw-tooth thread - worm thread.

Acme thread (Fig 2): This thread is a modification of the square thread. It has an included angle of 29°. It is preferred for many jobs because it is fairly easy to machine.

Acme threads are used in lathe lead screws. This form of thread enables the easy engagement of the half nut. The metric acme thread has an included angle of 30°. The relationship between the pitch and the various elements is shown in the figure.

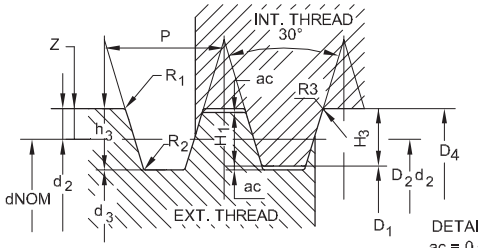
Buttress thread (Fig 3): In buttress thread one flank is perpendicular to the axis of the thread and the other flank is at 45°. These threads are used on the parts where pressure acts at one flank of the thread during transmission. Figure 3 shows the various elements of a buttress thread. These threads are used in power press, carpentry vices, gun breeches, ratchets etc.

Fig 2



DEPTH = $\frac{0.500}{N}$ + 0.010 IN. CREST = $\frac{0.3707}{N}$ ROOT = $\frac{0.3707}{N}$ - 0.0052 IN.

WHERE N = NUMBER OF THREADS PER INCH



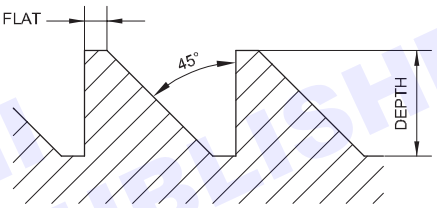
THESE DIMENSIONS ac R1 , R2 , H, H3 & h3 CHANGED AS PER PITCH. FOR DETAIL SEE IS:7008 (PART I, II, III & IV)

DETAIL FOR 36 x 6

ac = 0.5		H1 = 3	
R1 = 0.25		H3 = 3.5	
R2 = 0.5		h 3= 3.5	
dNOM	= 36	D4= 37	
d 2= 33		D2 = 33	
d 3= 33		d1 = 30	

TW20N122132

Fig 3



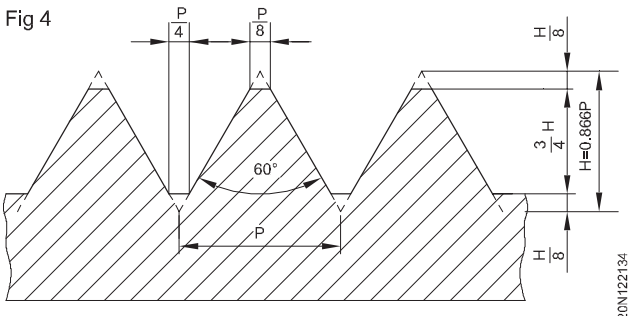
DEPTH = $\frac{0.7500}{N}$

WIDTH OF FLAT = $\frac{PITCH}{8}$

TW20N122133

American national thread (Fig 4): These threads are also called as seller's threads. It was more commonly used prior to the introduction of the ISO unified thread.

Fig 4



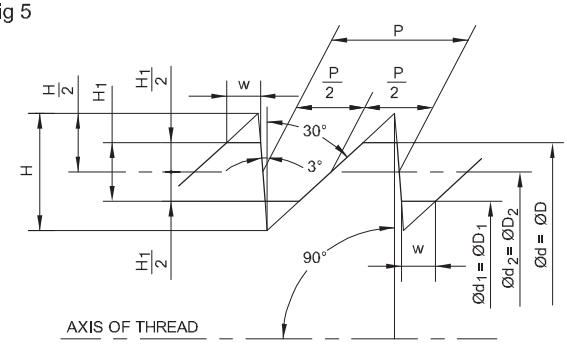
AMERICAN NATIONAL THREAD ,SI & DIN METRIC THREADS

TW20N122134

Saw-tooth thread: This is a modified form of buttress thread. In this thread, the flank taking the load is inclined at an angle of 3°, whereas the other flank is inclined at 30°. The basic profile of the thread illustrates this phenomenon. (Fig 5) The proportionate values of the dimensions with respect to the pitch.

Worm thread: This is similar to acme thread in shape but the depth of thread is more than that of acme thread. This thread is cut on the worm shaft which engages with the worm wheel. Fig 6 shows the elements of a worm thread.

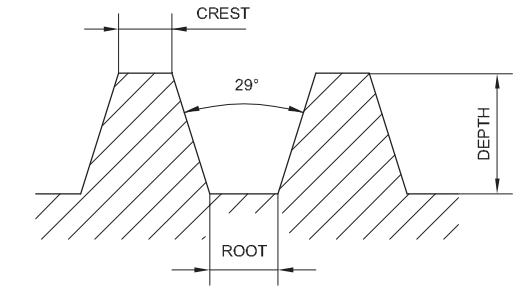
Fig 5



BASIC PROFILE FOR SAW TOOTH THREADS

TW20N122135

Fig 6



$$\text{DEPTH} = \frac{0.6866}{N} \qquad \text{ROOT} = \frac{0.310}{N}$$

$$\text{CREST} = \frac{0.335}{N}$$

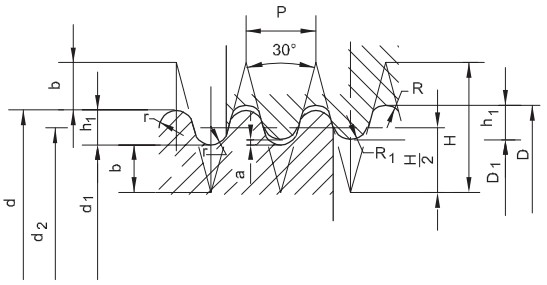
WORM THREAD

TW20N122136

The worm wheel and worm shaft are used in places where motion is to be transmitted between shafts at right angles. It also gives a high rate of speed reduction.

Knuckle threads: The shape of the knuckle thread is not trapezoidal but it has a rounded shape. It has limited application. The figure shows the form of knuckle thread. It is not sensitive against damage as it is rounded. It is used for valve spindles, railway carriage couplings, hose connections etc. (Fig 7).

Fig 7



BASIC PROFILE OF KNUCKLE THREAD

$b = 0.68301.P$
$h_1 = 0.5P$
$a = 0.05P$

DESIGNATION:- A KNUCKLE THREAD OF DIAMETER 60 mm & PITCH 4.233mm SHALL BE DESIGNATED AS k60x4.233 IS:4695

TW20N122137

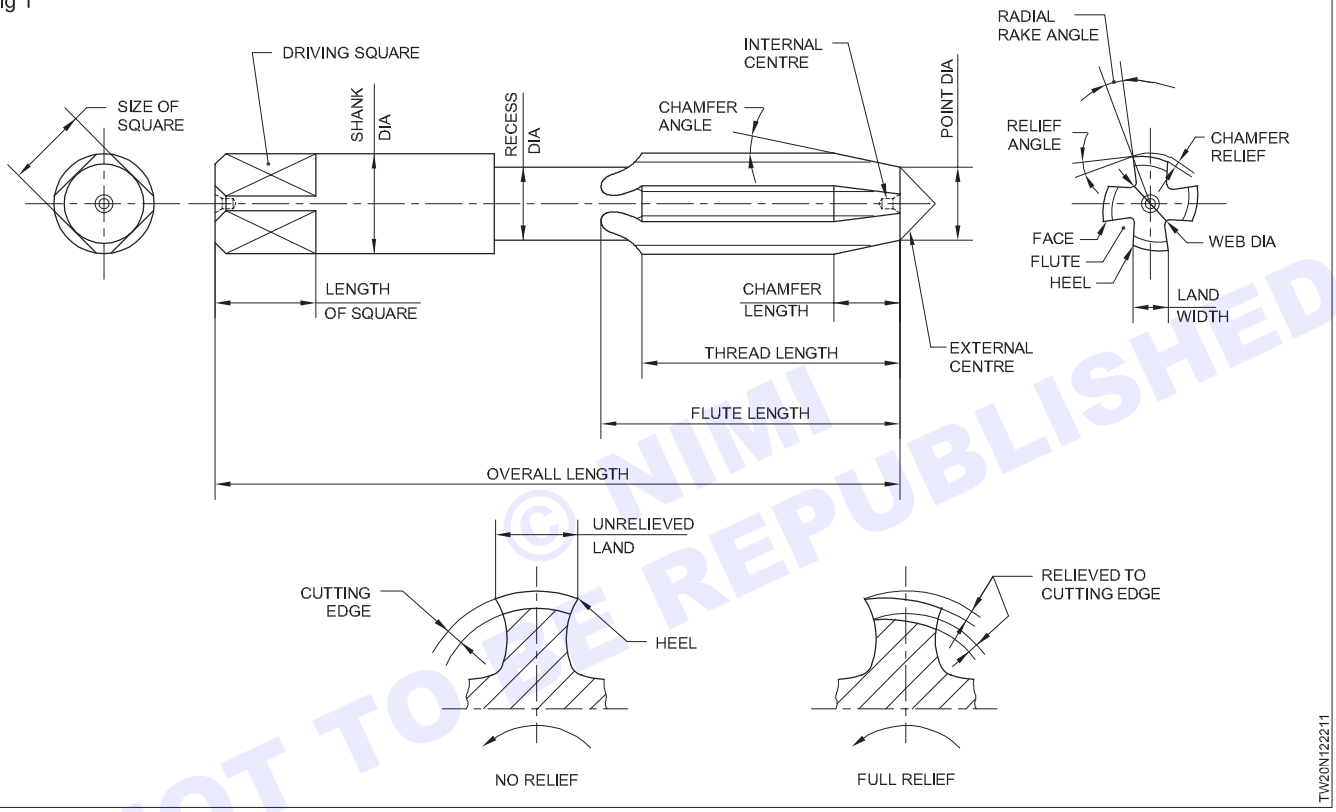
Types of thread applications, dieing process

Objectives: At the end of this lesson you shall be able to
- **state the use of hand taps and its feature**
- **distinguish between the different taps in a set**
- **name the different types of tap wrenches and its uses**
- **calculate the drill size for tapping.**

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.

Fig 1



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.

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

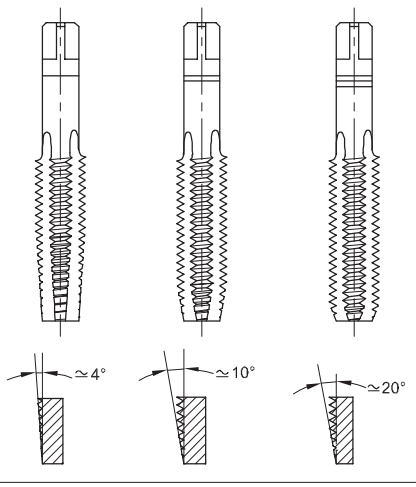
These are

– first tap or taper tap

– second tap or intermediate tap

– plug or bottoming tap

Fig 2



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.

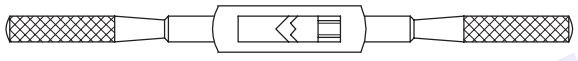
The taper tap has one ring, the intermediate tap has two and the bottoming tap has three rings. (Fig 2)

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



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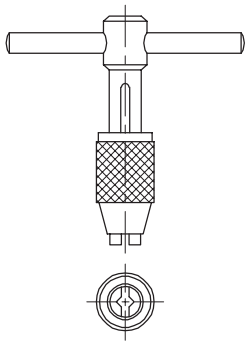
It is important to select the correct size of wrench.

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

Fig 4



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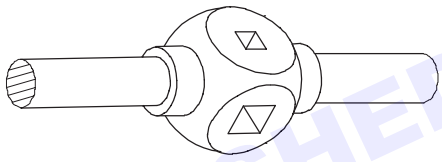
This tap wrench is useful to work in restricted places, and is turned with one hand only. Most suitable for smaller sizes of taps.

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

Fig 5



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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.

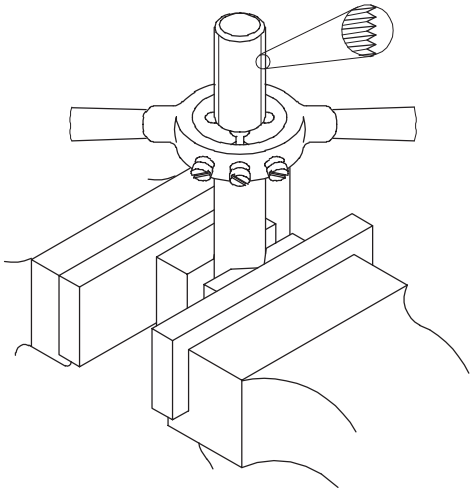
Die and die stock

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



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

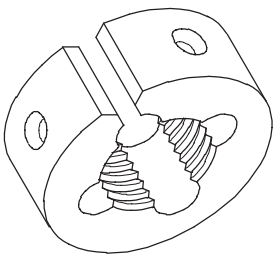
– Circular split die (Button die)

– 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



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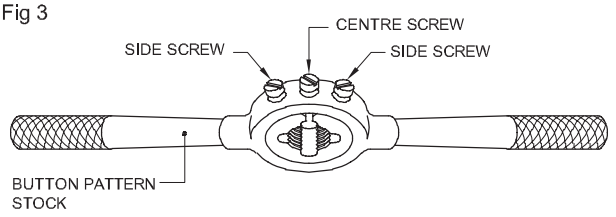
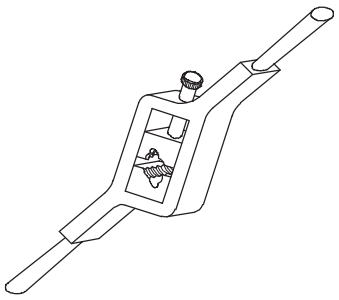
When held in the die stock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly. (Fig 3) For adjusting the depth of cut, the centre screw is advanced and locked in the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

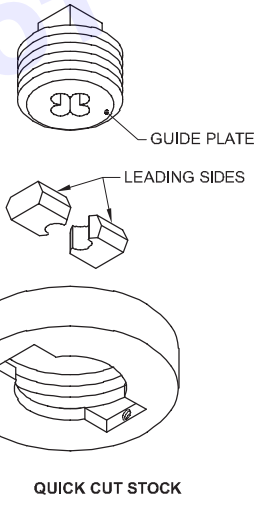
These dies are available in matching pairs and should be used together.

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.

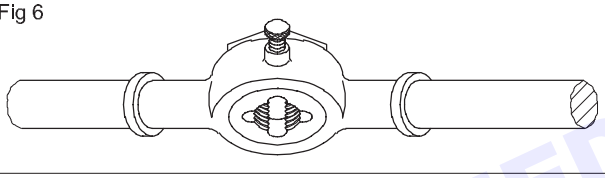
When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held.

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.

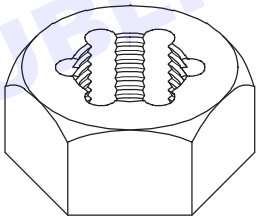
This type of die stock is called quick cut die stock (Fig 6)

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.

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

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

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

What is tap drill size?

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

Tap drill sizes for different threads

ISO metric thread

Tap drill size for M10 x 1.5 thread

Minor diameter = Major diameter - (2 x depth)

Depth of thread = 0.6134 x pitch of a screw

2 depth of thread = 0.6134 x 2 x pitch

= 1.226 x 1.5 mm

= 1.839 mm

Minor dia. = 10 mm - 1.839 mm

= 8.161 mm or 8.2 mm.

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

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

Considering this aspect, a more practical approach for determining the tap drill sizes is

Tap drill size = major diameter 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 =

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

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

$$= 7/8''$$

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	8.50	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

Different process of taper turning & calculation

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

- **define a taper**
- **state the uses of a taper**
- **identify the elements of a taper**
- **express the taper and its conversion**
- **classify the tapers**
- **state the different standard tapers and their uses.**

Definition of a taper

Taper is a gradual increase or decrease in the diameter along the length of the job.

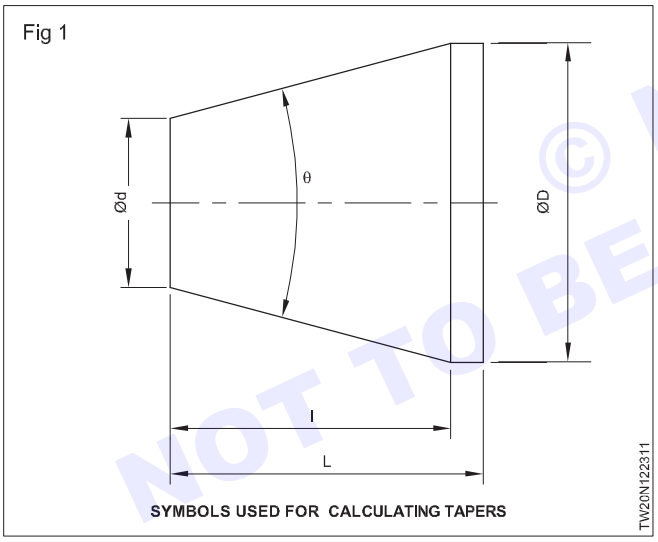
Uses of a taper

Tapers are used for

- easy assembly and disassembly of parts
- giving self-alignments in the assembled parts
- Transmitting the drive in the assembled parts.

Elements of a taper (Fig 1)

Fig 1



Big diameter	(D)
Small diameter	(d)
Length of the taper	(l)
Angle of taper	(θ)
Total length of the job	(L)

Different methods of expressing tapers

Tapers can be expressed by

- giving the big dia. small dia. and the length of the taper (Fig 2)
- giving the included angle of the taper in degrees (Fig 3)

Fig 2

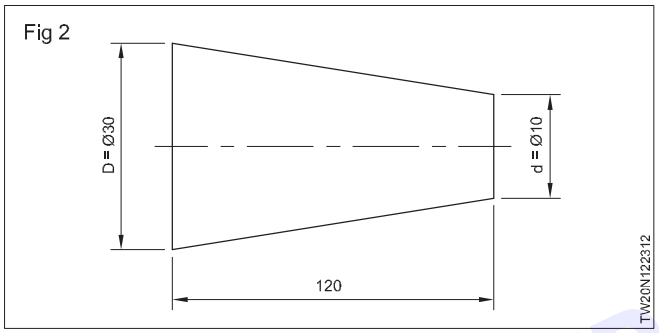
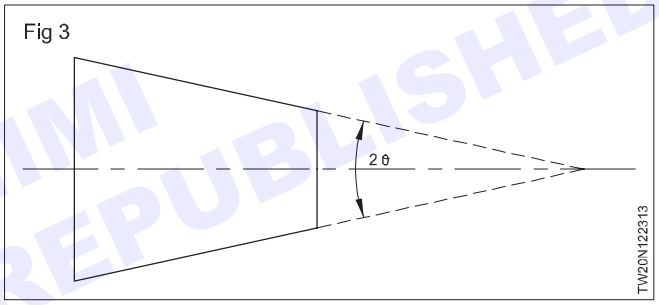
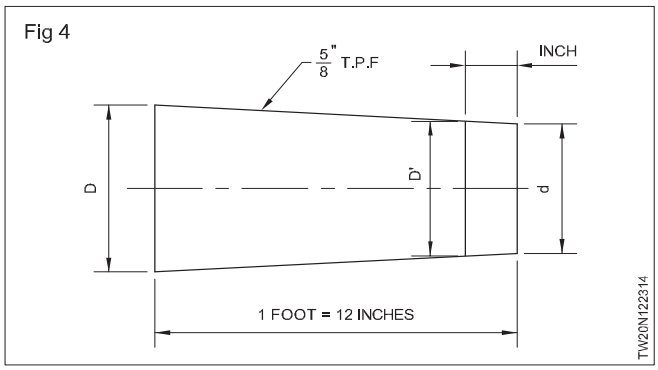


Fig 3



- giving the taper per foot, (Ex: 5/8” TPF means in a 12” (one foot) taper length , the difference between big & small diameter is 5/8”) (Fig 4)

Fig 4



- giving the taper in ratio (This is also termed as conicity and it is indicated as K) (Ex: Ratio 1:20 means, for a taper length of 20 units, the difference in diameter is 1 unit.) (Fig 5)
- mentioning by standard taper MT3. (Fig 6)

Conversion

The relationship between the elements of a taper are

$$\text{Tan}\,\theta = \frac{D - d}{2L}$$

Fig 5

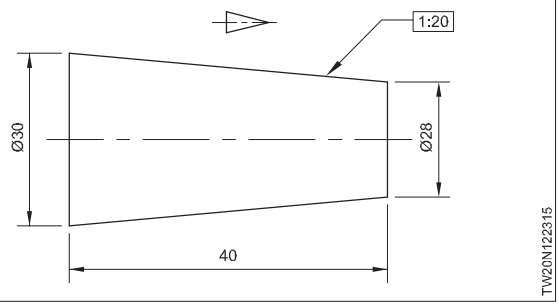
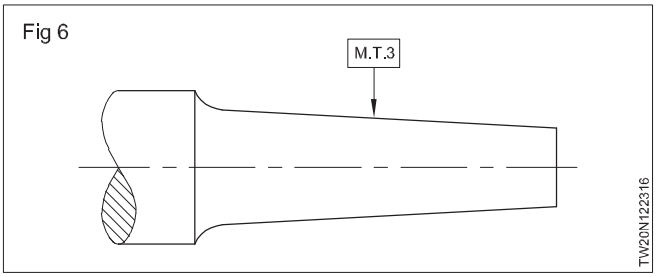


Fig 6



$$\text{Tan}\,\theta = \frac{\text{TPF}}{24}$$

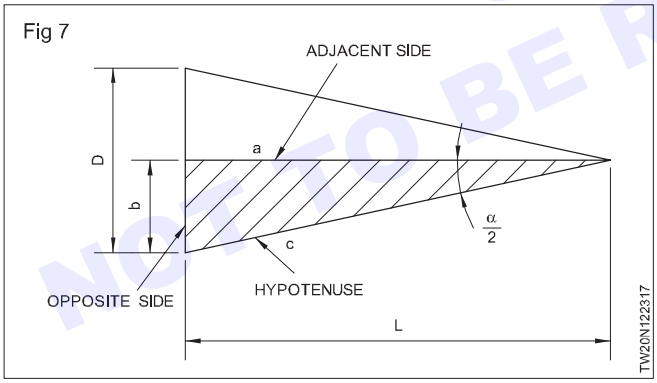
$$\text{Tan}\theta = \frac{\text{ratio}}{2}$$

Calculation of the compound slide swivel angle

Derivation of the formula

For convenience a tapered job whose small diameter is zero is taken (Fig 7) to illustrate as to how the formula can be derived.

Fig 7

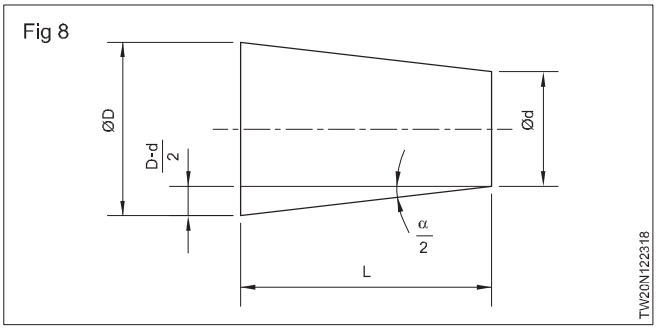


The taper is divided into two right angled triangles by the centre line. By referring to the shaded right angled triangle in figure 7, the side (b) shown against the half included angle of taper a/2, is termed as the opposite side. The side (a) is termed as the adjacent side and side (c) is termed as the hypotenuse. There is a relationship between the sides of the triangle and the angle a/2. They can be expressed as ratios. The ratio of the sides (b) and (a) is a constant value for a given angle a/2. This ratio b/a does not change for a given value of a/2. This means that if 'b' increases or decreases there will be a proportionate increase or decrease of side 'a' making the ratio b/a constant. This ratio between the opposite side to the adjacent side of an angle in a right angled triangle is referred to as the tangent value of the angle.

The equation for the tangent $\alpha/2$ is, therefore, Tan $\alpha/2$ = b/a. Since this value is the same for a particular angle, the tangent values for all angles are put together into tables under the heading 'Natural Tangents'. Therefore, they need no longer be calculated individually, but can be taken from the tables.

Referring to Fig 8, which has a small diameter also, the shaded triangle D-d refers to 'b' of the formula and l refers to 'a' of the formula.

Fig 8



D = 30 mm d = 22 mm & l = 40 mm

Now the formula becomes

$$\text{Tan}\,\frac{\alpha}{2} = \frac{D-d}{2} = \frac{D-d}{2\times l}$$

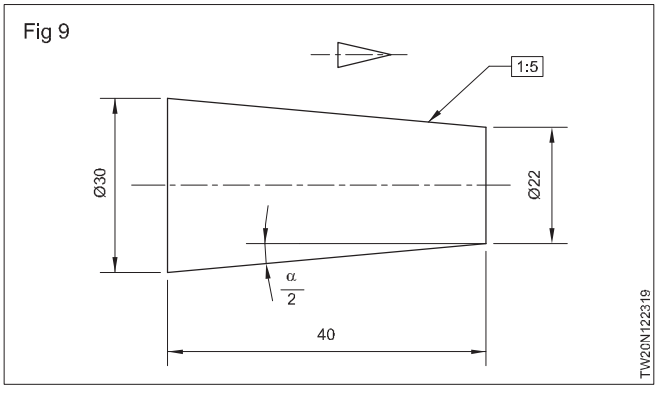
For example, referring to Fig 9 we have

$$\text{Tangent}\ \alpha/2 = \frac{D-d}{2l} = \frac{30-22}{80}$$

$$= \frac{8}{80} = \frac{1}{10} = 0.1$$

Referring to the logarithm tables of Natural Tangents we find that the angle whose tangent value is 0.1, is 5° - 45', and this is the top slide swivelling angle to turn the tapered job of Fig 9.

Fig 9



Taper expressed as a ratio to determine the swivel angle

The general formula is

$$\text{Tan}\,\frac{\alpha}{2} = \frac{D-d}{2l}$$

This can be rewritten as

$$\text{Tan}\,\frac{\alpha}{2} = \frac{D-d}{l} \text{ x } \frac{1}{2}$$

This $\frac{D-d}{l}$ is the taper ratio

Hence the formula becomes

$$\text{Tan of half the included angle} = \frac{\text{Taper ratio}}{2}$$

Example

The taper ratio is given as 1:5.

To determine the compound slide swivel angle (Fig 9), the Taper ratio=1:5= 1/5

$$\text{Tan}\frac{\alpha}{2} = \frac{1/5}{2} = \frac{1}{10} = 0.1$$

$$\frac{\alpha}{2} = 5^{o}45'$$

The compound slide swivel angle is 5°45'.

Taper per foot is given to determine the compound slide swiveling angle.

Example

(Given 5/8" TPF)

This means that the difference in diameter (D-d) is 5/8" for a taper length of 1 foot or 12".

$$\text{Tan}\,\alpha/2 = \frac{D-d}{2l}$$

Here D-d=5/8" and l=12"

$$\text{Tan}\,\alpha/2 = \frac{5"}{\frac{8}{2x12}} = \frac{5}{8x24} = 0.0260$$

$$\alpha/2 = 1^{\circ}26'$$

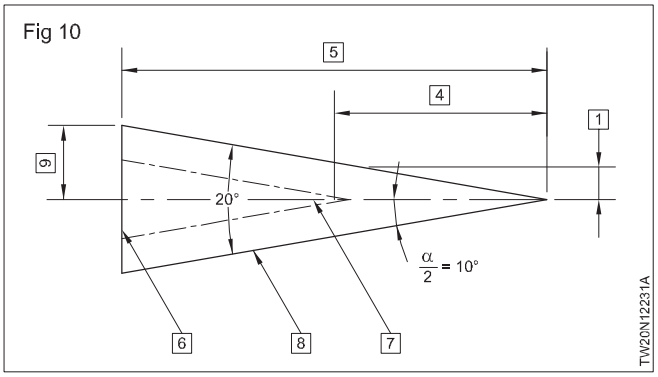
The formula is Tan of half included

$$= \frac{\text{Taper per foot}}{24}$$

Remember that it is the half included angle of the taper to which the top slide is to be swivelled.

To determine the depth of cut to be given to get a definite change in length of the taper, the taper angle remaining the same. (Fig 10)

Fig 10



Referring to Fig 10, [9] is the radius at the bigger end, (also the difference in diameter divided by 2, since the small diameter of the taper is zero), [5] is the length of the taper, [4] is the change in the taper length, [1] is the depth of cut to be given to get the change in taper length.

[6] Opposite side to $\alpha/2$

[7] Adjacent side

[8] Hypotenuse

Then [1] = [4] x tan $\alpha/2$

Example

The taper length [5] of Fig 10 with an included angle of 20° is to be shortened by 2 mm. What should be the depth of cut?

l = [4] x tan $\alpha/2$

[1] = 2mm x tan 20°/2

= 2mm x tan 10°

= 2 x 0.1763

= 0.3526mm

Hence a depth of cut of 0.35 mm is to be given in order to reduce the taper length by 2 mm, the taper included angle remaining the same 20°.

Welding and safety precautions

Objectives: At the end of this lesson you shall be able to
- **state the importance of safety in welding shop**
- **list the general safety precautions to be observed in welding shop.**

Safety

Welding can be dangerous and unhealthy if the proper precautions are not taken. However, using new technology and proper protection greatly reduces risks of injury and death associated with welding. Since many common welding procedures involve an open electric arc or flame, the risk of burns and fire is significant, that is why it is classified as a hot work process.

To prevent injury, welders wear personal protective equipment in the form of heavy leather gloves and protective long-sleeve jackets to avoid exposure to extreme heat and flames. Additionally, the brightness of the weld area leads to a condition called arc eye or flash burns in which ultraviolet light causes inflammation of the cornea and can burn the retinas of the eyes. Goggles and welding helmets with dark UV-filtering face plates are worn to prevent this exposure.

Since the 2000s, some helmets have included a face plate which instantly darkens upon exposure to the intense UV light. To protect bystanders, the welding area is often surrounded with translucent welding curtains. These curtains, made of a polyvinyl chloride plastic film, shield people outside the welding area from the UV light of the electric arc, but can't replace the filter glass used in helmets.

Welders are often exposed to dangerous gases and particulate matter. Processes like flux-cored arc welding and shielded metal arc welding produce smoke containing particles of various types of oxides. The size of the particles in question tends to influence the toxicity of the fumes, with smaller particles presenting a greater danger. This is because smaller particles have the ability to cross the blood brain barrier. Fumes and gases, such as carbon-di-oxide, ozone, and fumes containing heavy metals, can be dangerous to welders lacking proper ventilation and training. Exposure to manganese welding fumes, for example, even at low levels (<0.2 mg/m^3) may lead to neurological problems or to damage to the lungs, liver, kidneys, or central nervous system. Nano particles can become trapped in the alveolar macrophages of the lungs and induce pulmonary fibrosis. The use of compressed gases and flames in many welding processes possess an explosion and fire risk. Some common precautions include limiting the amount of oxygen in the air, and keeping combustible materials away from the workplace.

General safety

- To prevent injury to personnel, extreme caution should be exercised when using any types of welding equipment. Injury can result from fire, explosions, electric shock, or harmful agents. Both the general and specific safety precautions listed below must be strictly observed by workers who weld or cut metals.
- Do not permit unauthorized persons to use welding or cutting equipment.
- Do not weld in a building with wooden floors, unless the floors are protected from hot metal by means of fire resistant fabric, sand, or other fireproof material. Be sure that hot sparks or hot metal will not fall on the operator or on any welding equipment components.
- Remove all flammable material, such as cotton, oil, gasoline, etc., from the vicinity of welding.
- Before welding or cutting, warn those in close proximity who are not protected to wear proper clothing or goggles.
- Remove any assembled parts from the component being welded that may become warped or otherwise damaged by the welding process.
- Do not leave hot rejected electrode stubs, steel scrap, or tools on the floor or around the welding equipment. Accidents and/or fires may occur.
- Keep a suitable fire extinguisher nearby at all times. Ensure the fire extinguisher is in operable condition.
- Mark all hot metal after welding operations are completed. Soapstone is commonly used for this purpose.

Safety precautions in handling gas welding plant

Objectives: At the end of this lesson you shall be able to
- **state the general safety precautions in oxy-acetylene plants**
- **state the safety rules for handling gas cylinders**
- **state the safety practices for handling gas regulators and hose-pipes**
- **state the safety precautions related to blowpipe operations.**

To be accident-free, one must know the safety rules first and then practice them as well. As we know can 'accident starts when safety ends'.

Ignorance of rules is no excuse

In gas welding, the welder must follow the safety precautions in handling gas welding plants and flame-setting to keep himself and others safe.

Safety precautions are always based on good common sense.

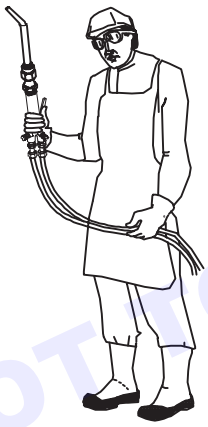
The following precautions are to be observed, to keep a gas welder accident-free.

General safety

Do not use lubricants (oil or grease) in any part or assembly of a gas welding plant. It may cause explosion.

Keep all flammable material away from the welding area. Always wear goggles with filter lens during gas welding. (Fig 1)

Fig 1



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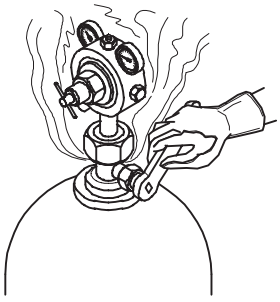
Always wear fire resistant clothes, asbestos gloves and apron.

Never wear nylon, greasy and torn clothes while welding.

Whenever a leakage is noticed rectify it immediately to avoid fire hazards. (Fig 2)

Fig 2



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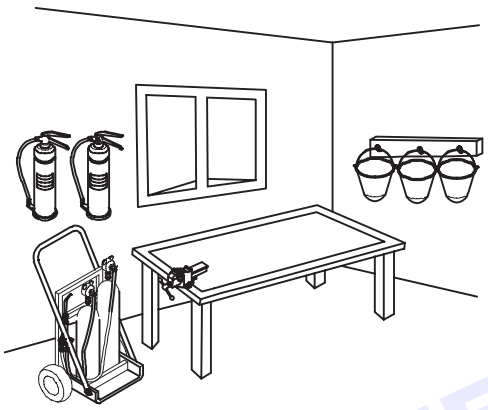
Even a small leakage can cause serious accidents.

Always keep fire-fighting equipment handy and in working order to put out fires. (Fig 3)

Fig 3



TW20N132413

Keep the work area free from any form of fire.

Safety precautions before gas welding

Safety for cylinders.

Do not roll gas cylinders or use them as rollers.

Use a trolley to carry the cylinders.

Close the cylinder valves when not in use or empty.

Keep full and empty cylinders separately.

Always open the cylinder valves slowly, not more than one and a half turn.

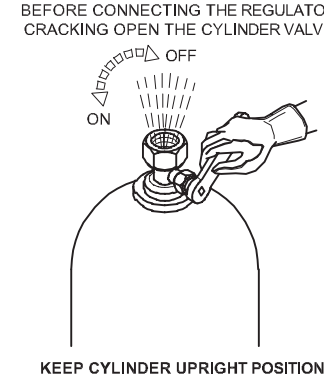
Use the correct cylinder keys to open the cylinders.

Do not remove the cylinder keys from the cylinders while welding. It will help to close the cylinders QUICKLY in the case of a back-fire or flash-back.

Always use the cylinders in an upright position for easy handling and safety.

Always crack the cylinder valves to clean the valve sockets before attaching regulators. (Fig 4)

Fig 4



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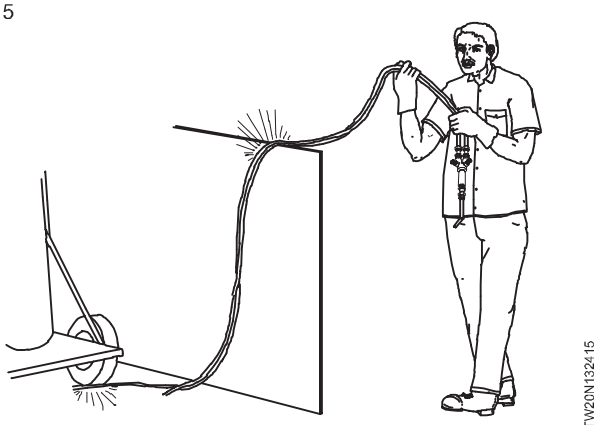
Safety for rubber hose pipes (Fig 5)

Fig 5



Inspect the rubber hose pipes periodically and replace the damaged ones.

Do not use odd bits of hose pipes / tubes.

Do not replace the hose pipes for acetylene with the ones used for oxygen.

Always use a black hose pipes for oxygen and maroon hosepipes for acetylene.

Safety for regulators

Prevent hammer blows to the gas cylinders and ensure that water, dust and oil do not settle on the cylinders.

One right hand threaded connection for oxygen and left hand threaded connection for acetylene.

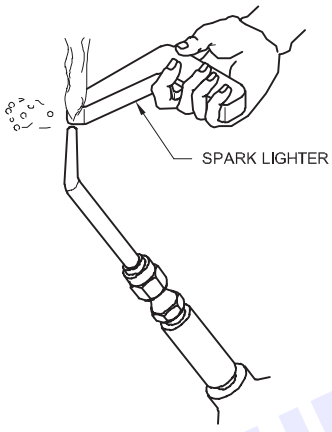
Safety for blowpipes

When a blowpipe is not in use put out the flame and place the blowpipe in a safe place.

When flame snaps out and backfires, quickly shut both the blowpipe valves (oxygen first) and dip in water.

While igniting the flame, point the blowpipe nozzle in a safe direction. (Fig 6)

Fig 6



While extinguishing the flame, shut off the acetylene valve first and then the oxygen valve to avoid a backfire.

Safety precautions before, during, after arc welding

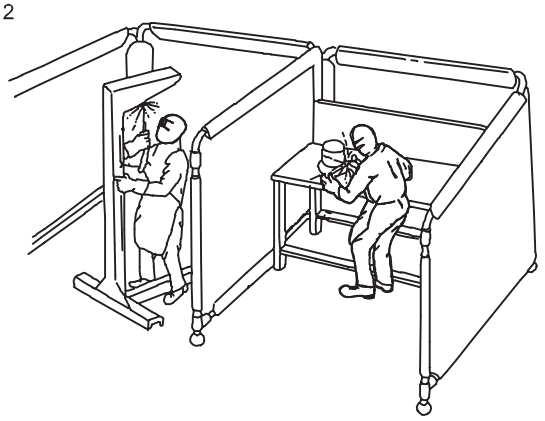
Objective: At the end of this lesson you shall be able to
- **state the precautions necessary in arc-welding.**

Safety precautions

- Never stand on a damp or wet place while arc-welding.
- Always wear all the safety apparels (gloves, apron, sleeves, shoes). (Fig 1)
- Use welding and a chipping screen during welding and chipping respectively, for the protection of the eyes and the face.
- Switch off the machine when not in use.
- Keep the clothes free from oil and grease.
- Use tongs while handling hot metals.
- Do not carry matches or petrol lighters in your pocket during arc-welding.
- Protect the outsiders from radiation and reflection of rays, by using portable screens or welding booths. (Fig 2)
- Keep the welding area free from moisture and flammable material.
- Do not try to rectify electrical faults yourself; call an electrician.

Fig 1

Fig 2



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- Do not throw the electrode stubs on the floor. Put them in a container. (Fig 3)
- Use exhaust fans to remove the arc-welding smoke and fumes. (Fig 4)
- Safety precautions after gas and electric welding after working gas welding and gas cutting bleed the lines to take pressure off regulators, neatly coil the hoses and replace equipment.
- Store hoses, torches, blow pipes regulators safety in proper place.
- Store away the gas cylinders from in flammable and combustible materials.
- After electric welding operations are completed the welder will mark the hot metal or provide some other means of warning other workers.

Fig 3

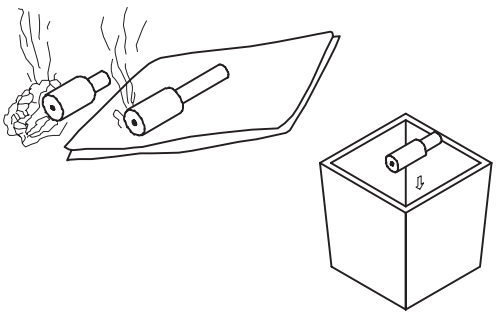

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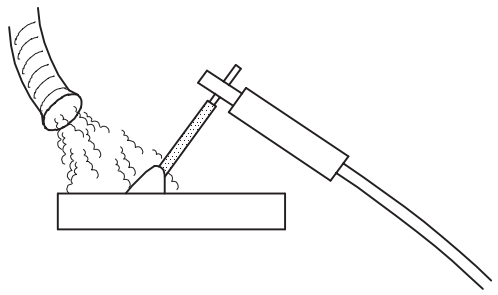
Fig 4



EXHAUST DUCTS CAN CAPTURE FUMES AND GASES

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- Welding machines will be disconnected from the power source.
- Disconnect the welding cables from welding equipment.
- Neatly coil the cable and kept in place safety.
- Place and store electrode holder and other hand tools safely.

Safety equipment and their uses in welding

Objective: At the end of this lesson you shall be able to

- **name the safety apparels and accessories used in arc welding**
- **select the safety apparels and accessories to protect from burns and injuries**
- **learn how to protect yourself and others from the effect of harmful arc rays and toxic fumes**
- **select the shielding glass for eye and face protection.**

Non-fusion welding: This is a method of welding in which similar or dissimilar metals are joined together without melting the edges of the base metal by using a low melting point filler rod but without the application of pressure.

Example: Soldering, Brazing and Bronze welding.

During arc welding the welder is exposed to hazards such injury due to harmful rays (ultra violet and infra red rays)of the arc, burns due to excessive heat from the arc and contact with hot jobs, electric shock, toxic fumes, flying hot spatters and slag particles and objects falling on the feet.

The following safety apparels and accessories are used to protect the welder and other persons working near the welding area from the above mentioned hazards.

1 Safety apparels
   - a Leather apron
   - b Leather gloves
   - c Leather cape with sleeves
   - d Industrial safety shoes

2 a Hand screen
   - b Adjustable helmet
   - C Portable fire proof canvas screens

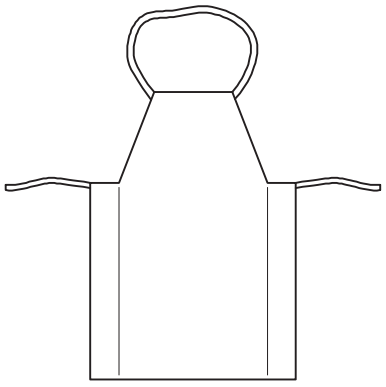
3 Chipping/grinding goggles

4 Respirator and exhaust ducting

The leather apron, gloves, cape with sleeves and leg guard Fig 1,2,3 and 4 are used to protect the body, hands, arms, neck and chest of the welder from the heat radiation and hot spatters from the arc and also from the hot slag particles flying from the weld joint during chipping off the solidified slag.

All the above safety apparels should not be loose while wearing them and suitable size has to be selected by the welder.

Fig 1



APRON

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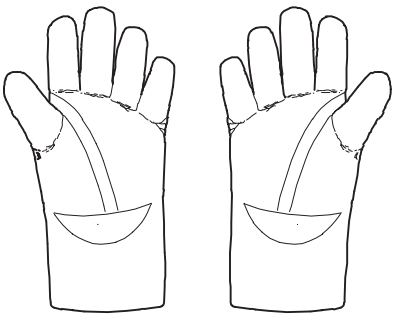
Fig 2



GLOVES

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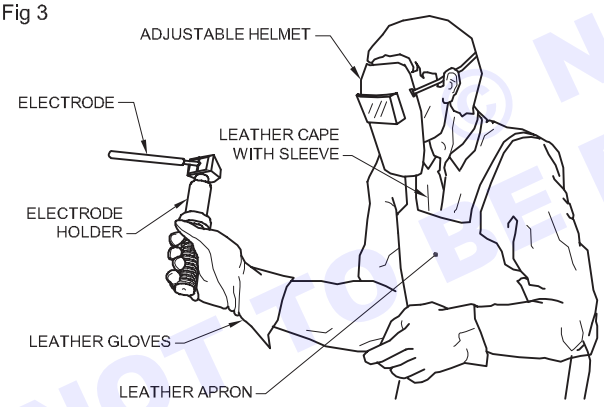
Fig 3



CAPE WITH SLEEVES

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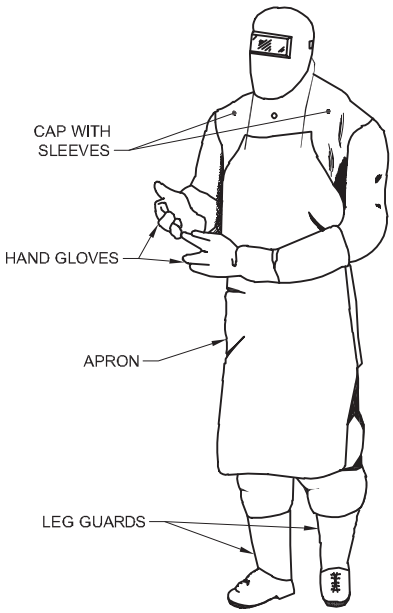
Fig 4



LEG GUARDS

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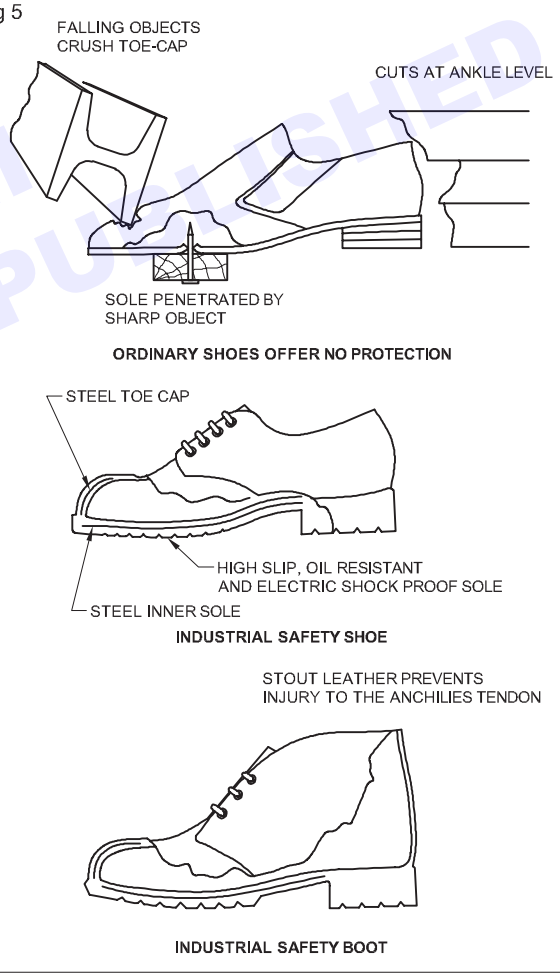
Fig 5



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The industrial safety boot (Fig 5) is used to avoid slipping. injury to the toes and ankle of the foot. It also protects the welder from the electric shock as the sole of the shoe is specially made of shock resistant material.

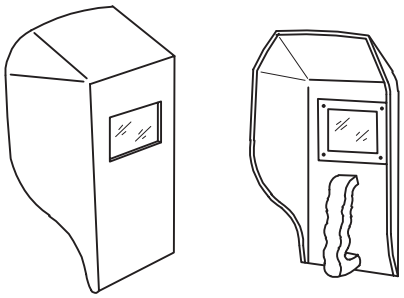
Welding hand screens and helmet: These are used to protect the eyes and face of a welder from arc radiation and sparks during arc welding.

A hand screen is designed to hold in hand (Fig 6)

A helmet screen is designed to wear on the head.(Fig 7)

Clear glasses are fitted on each side of the coloured glass to protect it from weld spatters. (Fig 8)

Fig 6



HAND SCREEN

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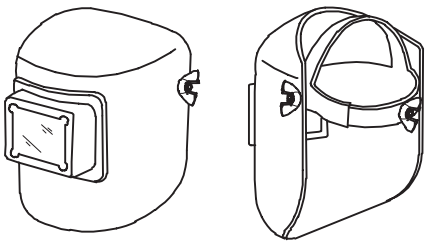
Fig 7



WELDING HELMET

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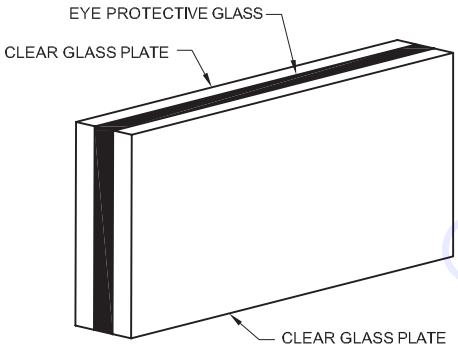
Fig 8



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The helmet screen provides better protection and allows the welder to use his both hands freely.

Coloured (filter) glasses are made in various shades depending on the welding current ranges used. (Table 1)

Table 1

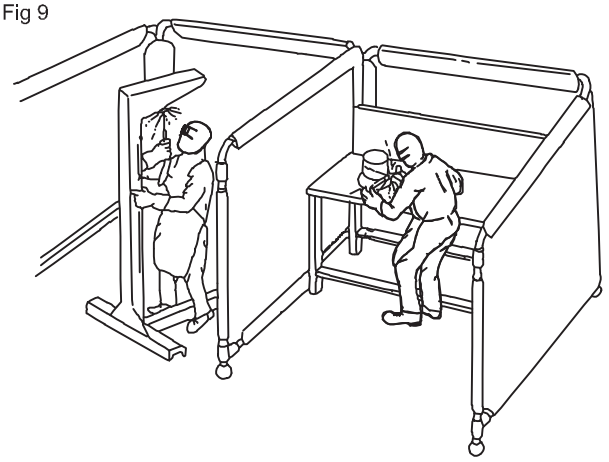
Recommendations of filter glasses for manual metal arc welding

Shade no of coloured glass	Range of welding current in amperes
8-9	Up to 100
10-11	100 to 300
12-14	Above 300

Portable fire proof canvas screens. Fig 9 are used to protect the persons who work near the welding area from arc flashes

Plain goggles are used to protect the eyes while chipping the slag or grinding the job. Fig 10

Fig 9



PORTABLE FIREPROOF CANVAS SCREENING

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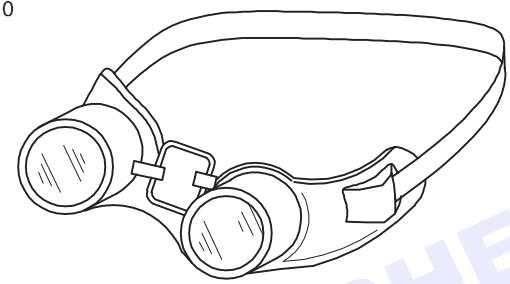
Fig 10



SAFETY GOGGLES

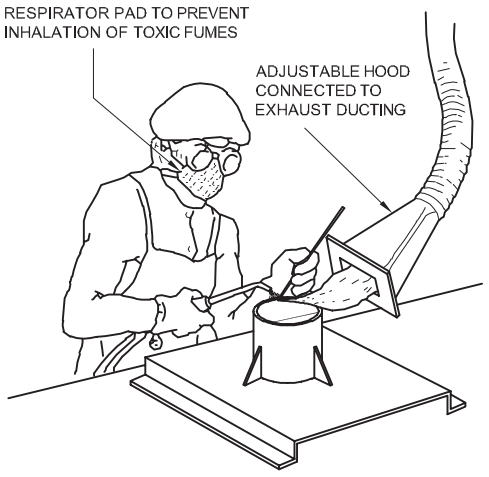
TW20N13243A

It is made of bakelite frame fitted with clear glasses and an elastic band to hold it securely on the operator's head.

It is designed for comfortable fit, proper ventilation and full protection from all sides.

Sometimes toxic fumes and heavy smoke may be liberated (given out) from the weld while welding non-ferrous alloys like brass etc. Use a respirator and use exhaust ducts and fans near the weld area to avoid inhaling the toxic fumes and smoke. Fig 11.

Fig 11



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Inhaling toxic fumes will make the welder to become unconscious and fall on the hot welded job/ on the floor.

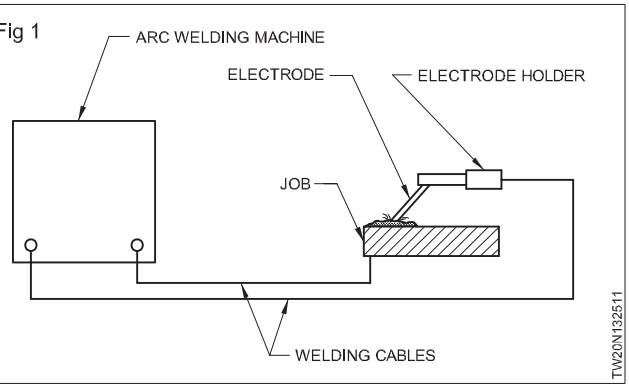
Types of arc welding and gas welding

Objectives : At the end of this lesson you shall be able to
- **state the function of arc-welding machines**
- **name the different types of arc-welding machines.**

In the arc-welding process, the source of heat is electricity (high ampere low voltage). This heat is supplied by the arc-welding machine which is the power source.

Function (Fig 1)

Fig 1



The equipment is used to

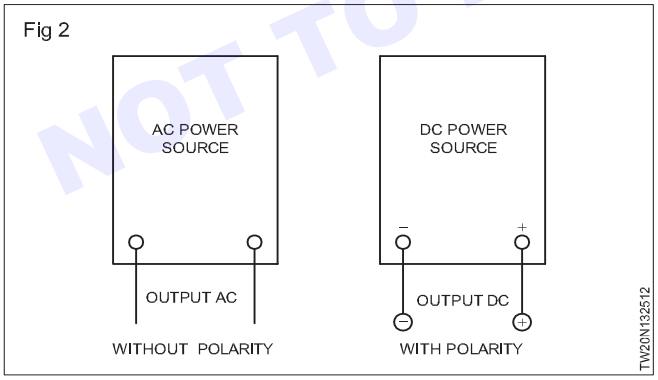
– Provide A.C. or D.C. supply for arc welding

– Change the high voltage of main supply (A.C.) to low voltage, heavy current (A.C. or D.C.) suitable for arc welding

– Control and adjust the required supply of current during arc welding

Types (Fig 2)

Fig 2



Basically the power sources are

– Alternating current (A.C.) welding machine

– Direct current (D.C.) welding machine.

These may be further classified as

– D.C.Machines

– Motor generator set

– Engine generator set

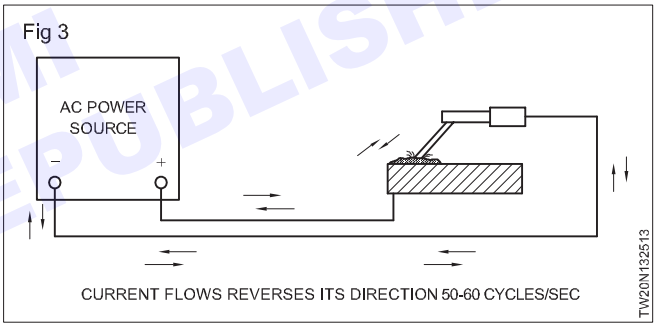
– Rectifier sets.

A.C. Machines

– Transformer sets

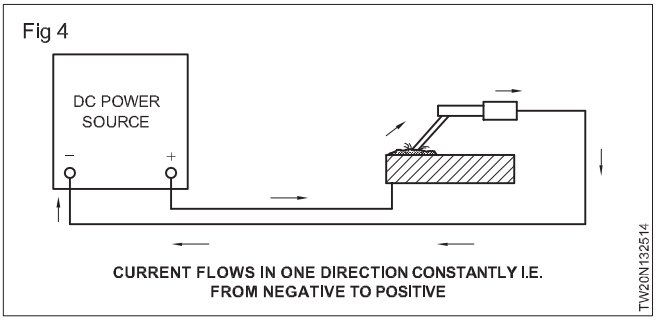
A.C. means Alternating Current. It changes or reverses its direction of flow 50-60 cycles per second. (Fig 3)

Fig 3



D.C. means Direct Current. It flows steadily and constantly in one direction. (Fig 4).

Fig 4



A.C. welding transformer and welding generator

Objectives: At the end of this lesson you shall be able to
- **state the features of A.C. welding transformers**
- **state the advantages and disadvantages of A.C. welding machines.**

A.C. welding transformer

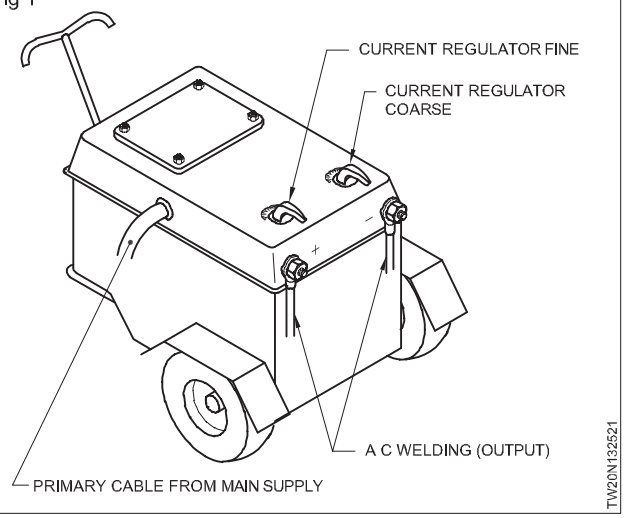
An A.C. welding transformer is a type of A.C. welding machine which converts the A.C. main supply into an A.C. welding supply. (Figs 1 and 2)

The A.C. main supply has high voltage - low ampere.

The A.C. welding supply has high ampere - low voltage.

It is a STEP-DOWN transformer which reduces the main supply voltage (220 or 440 volts) to the welding supply open circuit voltage (O.C.V.), between 40 and 100 volts.

Fig 1



It increases the main supply low current to the required output welding current in a hundred or thousand amperes.

The A.C. welding machine cannot be operated without the A.C. main supply.

Advantages

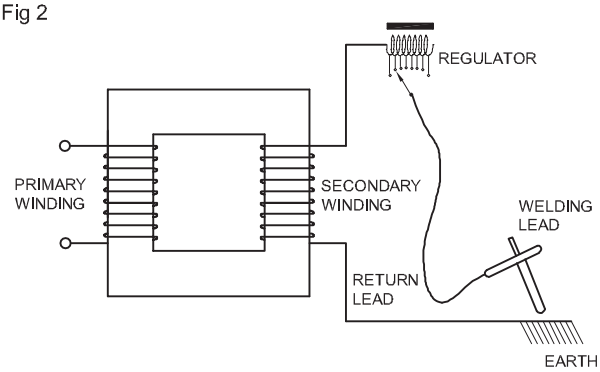
- Less initial cost
- Less maintenance cost
- Freedom from arc blow.

Magnetic effect which disturbs the arc is called the arc blow.

Disadvantages

- Not suitable for the welding of non-ferrous metals, light coated and special electrodes.
- The A.C. cannot be used without special safety precautions.

Fig 2

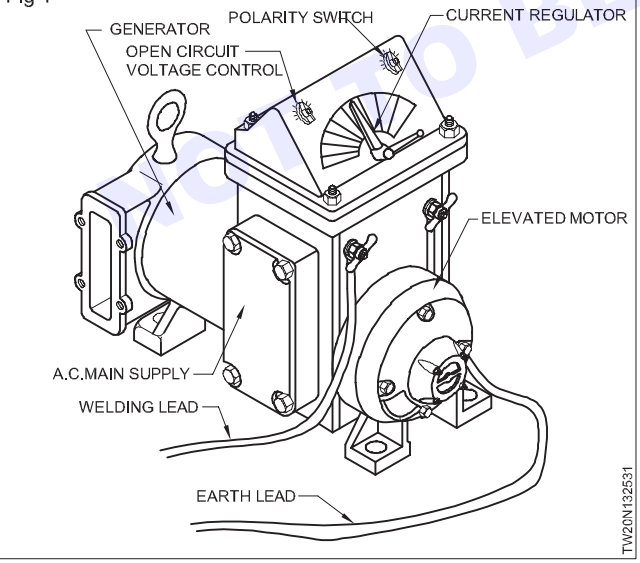


D.C. Arc-welding machines

Objectives: At the end of this lesson you shall be able to
- **state the features of a D.C. welding machine**
- **state its advantages and disadvantages.**

Motor generator set (Fig 1)

Fig 1



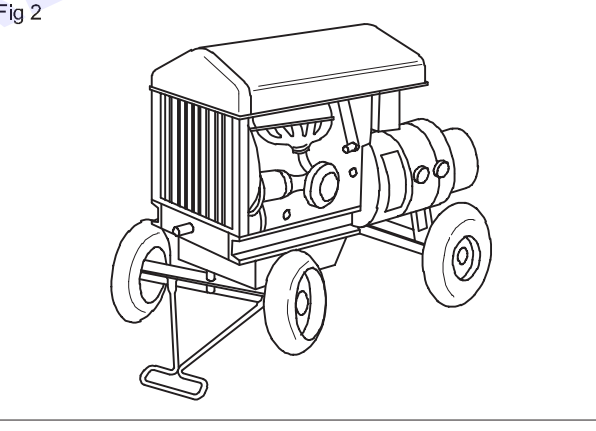
It is used to generate D.C. for arc-welding.

The generator is driven by an A.C. or D.C. motor.

Main supply is a must to run the machine.

Engine generator set (Fig 2): Equipment is similar to the motor generator set except that the generator is driven by a petrol or diesel engine.

Fig 2



Its running and maintenance charges are higher.

It can be used anywhere in field work, away from electric lines.

Rectifier set (Fig 3)

It is used to convert A.C. into D.C. welding supply.

Basically it is an A.C. welding transformer. The output of the transformer is connected with a rectifier to change the A.C. into D.C.

It may be designed to supply both A.C. and D.C. currents for welding (called A.C.-D.C. rectifier set).

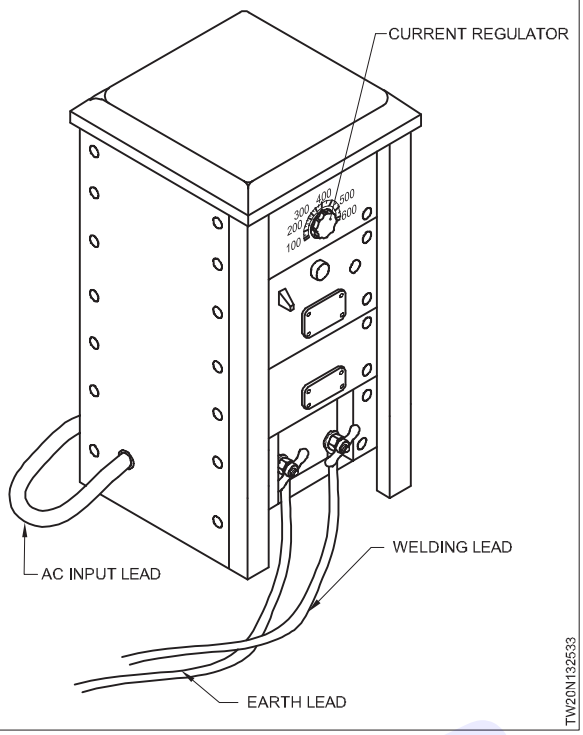
Advantages

- Suitable for welding all ferrous and non-ferrous metals using all types of electrodes
- Better heat distribution in the electrode and job due to polarity in the welding current supplies constant main load and accurate current setting.
- It ensures safe working.

Disadvantages

- Initial cost is higher
- Maintenance cost is more
- Arc-blow trouble faced at certain times.

Fig 3



Polarity in arc welding

Objectives: At the end of this lesson you shall be able to
- **state what is polarity in arc welding**
- **state the types of polarity.**

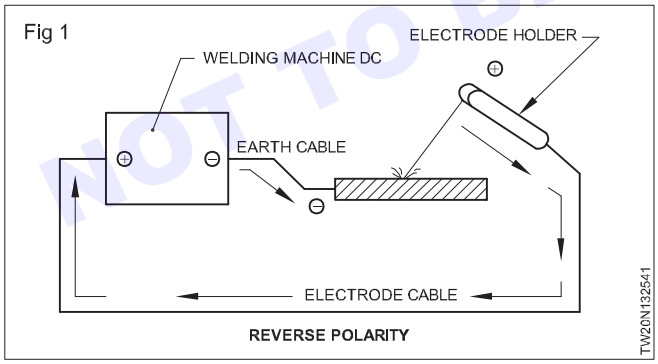
Polarity in D.C. power source: The polarity of a machine refers to the direction of the current flow.

The polarity can be obtained only in D.C.

Polarity may be straight or reverse.

Reverse polarity (Fig 1)

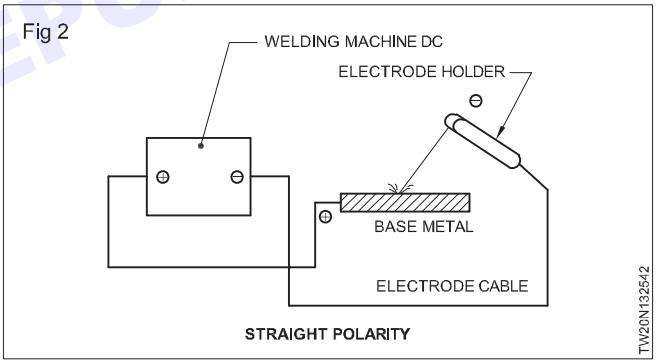
Fig 1



When the electrode cable is connected to the positive terminal, it is called positive polarity or reverse polarity.

Straight polarity (Fig 2)

Fig 2



When the electrode cable is connected to the negative terminal as it is called negative polarity or straight polarity.

Remember

A.C. has no polarity

The total heat produced in D.C. arc consists of 2/3 heat from the POSITIVE Terminal (66%) and 1/3 heat from the NEGATIVE Terminal (33%).

Gas welding equipment and accessories

Objectives: At the end of this lesson you shall be able to
- **brief the process of gas welding**
- **list the equipment used in gas welding**
- **state the functions of each equipment used in gas welding.**

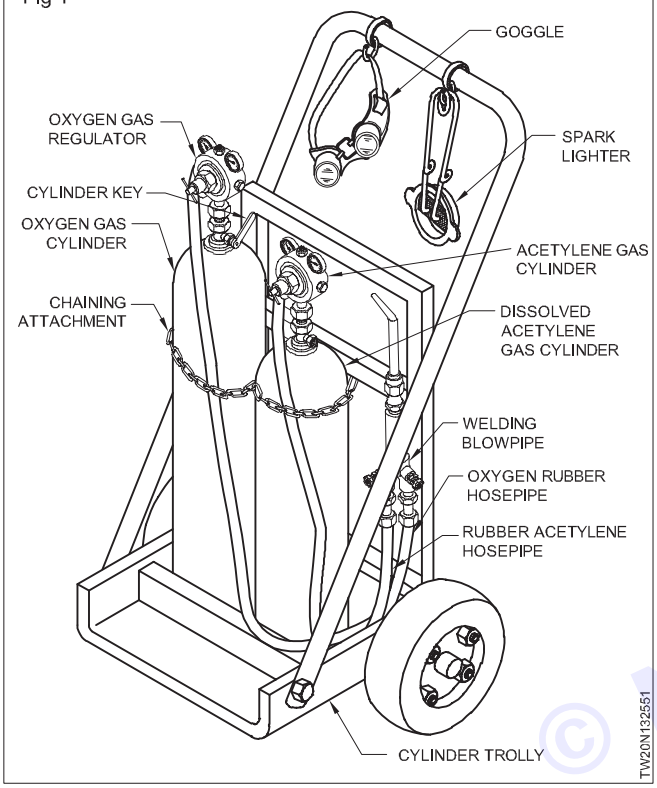
Oxy-acetylene welding, popularly known as gas welding is simple, cheap and easy to operate. The heat input can be closely controlled to weld even thin, tiny components.

In oxy-acetylene welding process, the metal is heated by an intense flame (3300ºC) produced by burning proper quantity of oxygen and acetylene at the tip of welding

torch. The flame is directed towards the weld location to melt the metal to be joined and are fused together thus producing weld.

Gas welding equipment: The principle function of the oxy-acetylene welding equipment is to supply the oxy-acetylene gas mixture in the correct ratio to the welding tip at the correct rate of flow and velocity. (Fig 1)

Fig 1



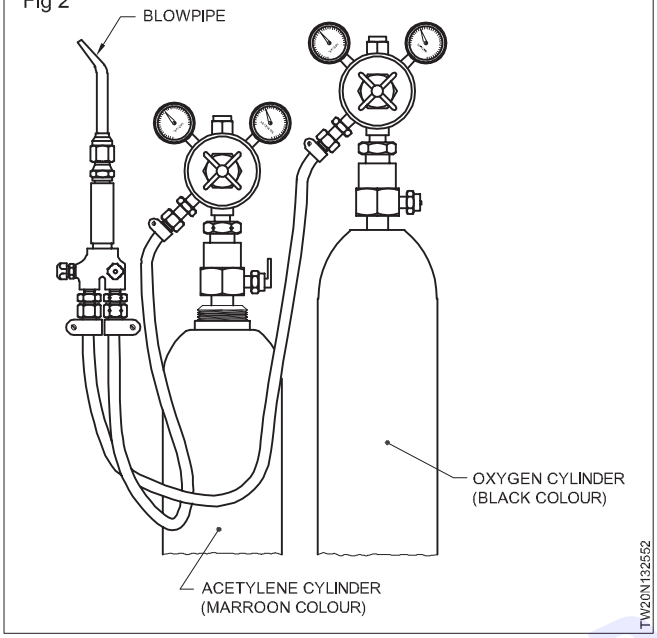
The basic equipment used to carry out gas welding are

- Oxygen gas cylinder
- Acetylene gas cylinder
- Oxygen pressure regular
- Oxygen gas hose (black/green)
- Acetylene gas hose (Maroon)
- Welding torch or blow pipe with a set of nozzles and gas lighter.
- Trolleys for transportation of oxygen and acetylene cylinder.
- A set of keys and spanners
- Filler rod and fluxes
- Protective clothing for welder (Leather apron, gloves, goggles, etc)

Oxygen gas cylinders: The oxygen gas required for gas welding is stored in bottle-shaped cylinders. These cylinders are painted in black colour. (Fig 2) Oxygen cylinders can store gas to a capacity of $7m^3$ with the pressure ranging between 120 to 150 kg/cm^2. Oxygen gas cylinder valves are right hand threaded.

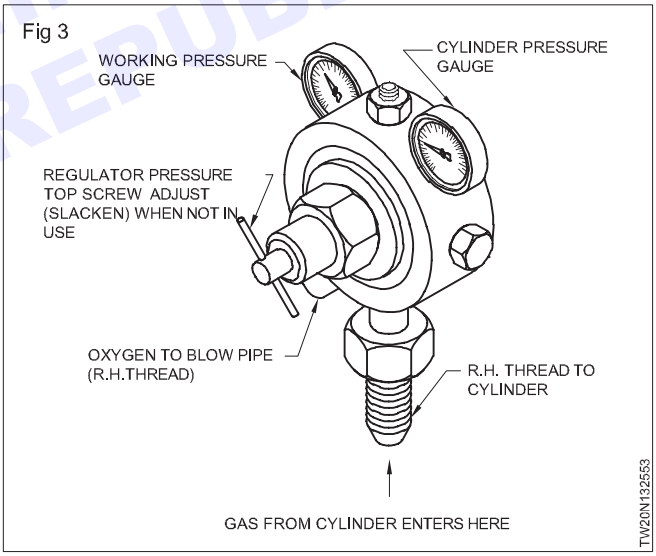
Dissolved acetylene cylinders: The acetylene gas used in gas welding is stored in steel bottles (cylinders) painted in maroon colour. The normal storing capacity of storing acetylene in dissolved state is $6m^3$ with the pressure ranging between 15-16 kg/cm^2.

Fig 2



Oxygen pressure regulator: This is used to reduce the oxygen cylinder gas pressure according to the required working pressure and to control the flow of oxygen at a constant rate to the blowpipe. The threaded connections are right hand threaded. (Fig 3)

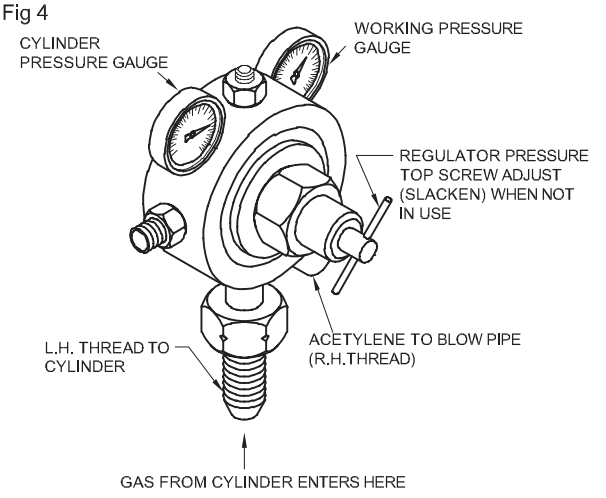
Fig 3



Acetylene regulator: As with the case of oxygen regulator this also is used to reduce the cylinder gas pressure to the required working pressure and to control the flow of acetylene gas at a constant rate to the blowpipe. The threaded connections are left handed. For quickly identifying the acetylene regulator, a groove is cut at the corners of the nut. (Fig 4)

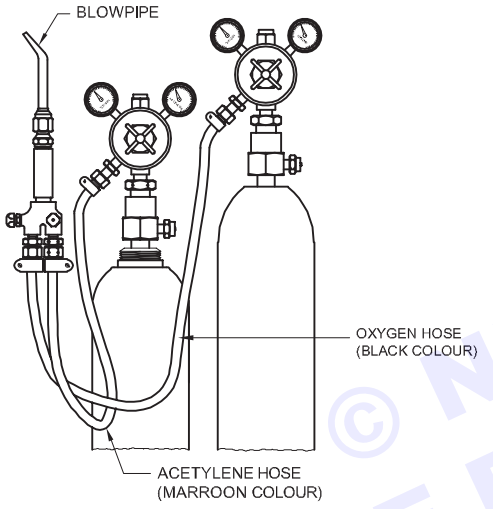
Rubber hose-pipes and connections: These are used to carry gas from the regulator to the blowpipe. These are made of strong canvas rubber having good flexibility. Hose-pipes which carry oxygen are black in colour and the acetylene hoses are of maroon colour. (Fig 5)

Fig 4



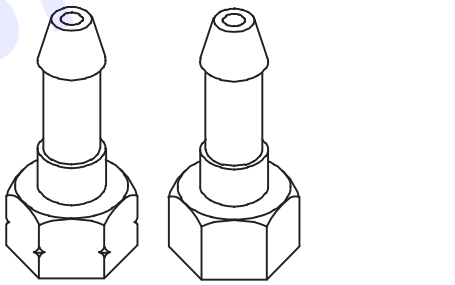
ACETYLENE PRESSURE REGULATOR

Fig 5



Rubber hoses are connected to regulators with the help of unions. These unions are right hand threaded for oxygen and left hand threaded for acetylene. Acetylene hose unions have a groove cut on the corners. (Fig 6)

Fig 6

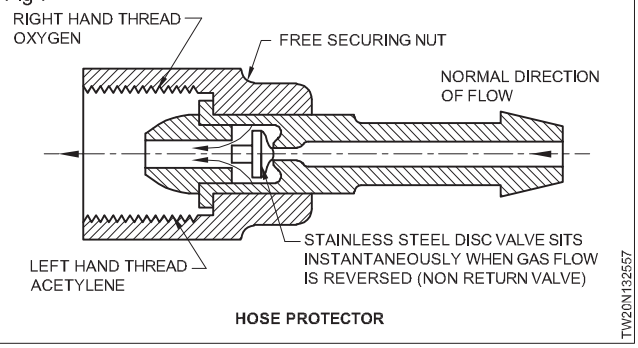


At the blowpipe end of the rubber hoses hose-protectors are fitted. The hose protectors are in the shape of a connecting union and have a non-return disc fitted inside to protect from flashback and backfire during welding. (Fig 7)

Blowpipe and nozzle: Blowpipes are used to control and mix the oxygen and acetylene gases to the required proportion. (Fig 8)

A set of interchangeable nozzles/tips of different sizes is available to produce smaller or bigger flames. (Fig 9)

Fig 7



HOSE PROTECTOR

Fig 8

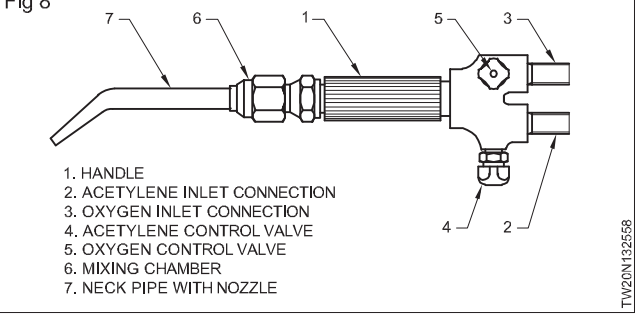
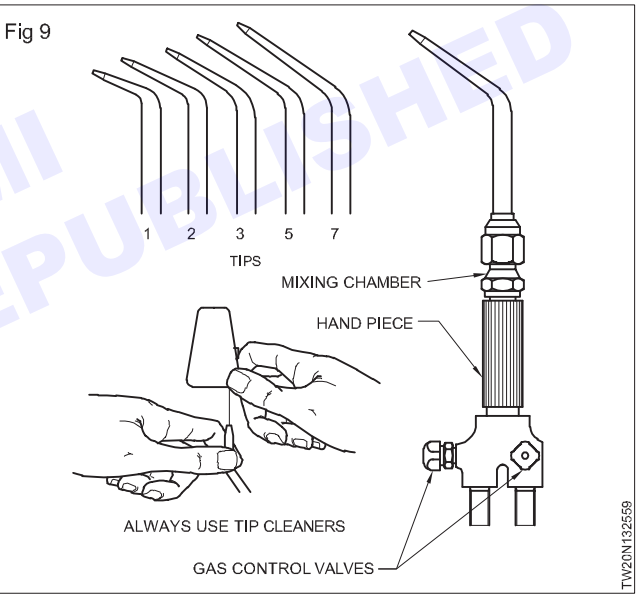


Fig 9



The size of the nozzle varies according to the thickness of the plates to be welded. (Table 1)

Table 1

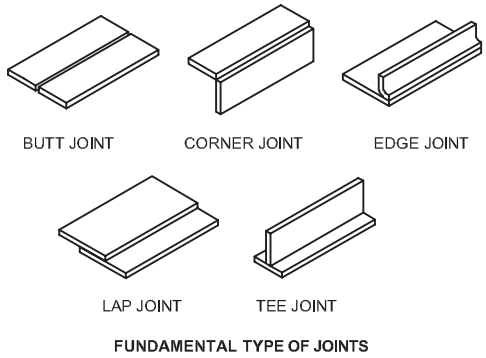
Plate thickness (mm)	Nozzle size (Number)
0.8	1
1.2	2
1.6	3
2.4	5
3.0	7
4.0	10
5.0	13
6.0	18
8.0	25
10.0	35
12.0	45
19.0	55
25.0	70
Over 25.0	90

Types of welding joints, electrode and current selection

Objectives: At the end of this lesson you shall be able to
- **illustrate and name the basic welding joints**
- **explain the nomenclature of butt and fillet welds.**

Basic welding joints (Fig 1): The various basic welding joints are shown in Fig 1.

Fig 1

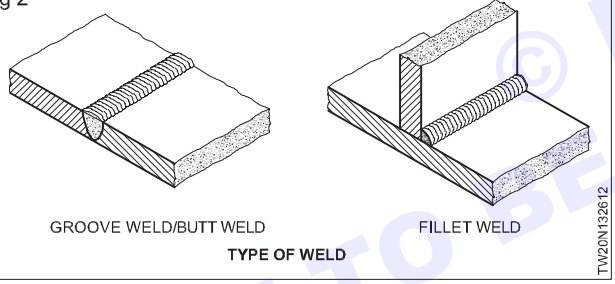


FUNDAMENTAL TYPE OF JOINTS

The above types mean the shape of the joint, that is, how the joining edges of the parts are placed together.

Types of weld: There are two types of weld. (Fig 2)

Fig 2



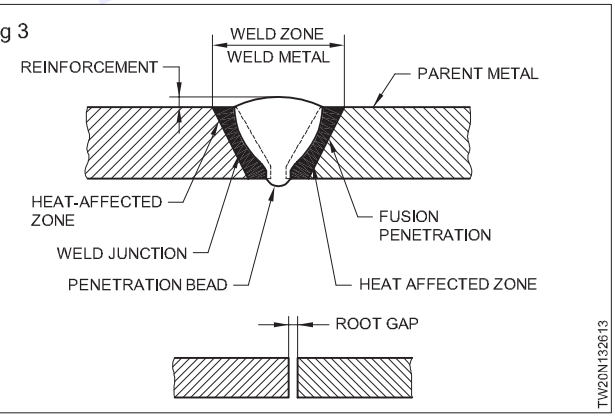
TYPE OF WELD

– Groove weld/butt weld

– Fillet weld

Nomenclature of butt and fillet weld (Fig 3 & 4)

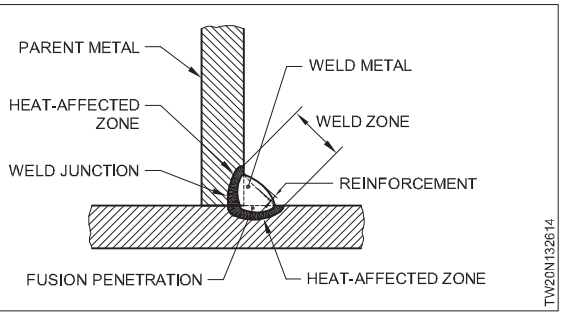
Fig 3



Root gap: It is the distance between the parts to be joined. (Fig 3)

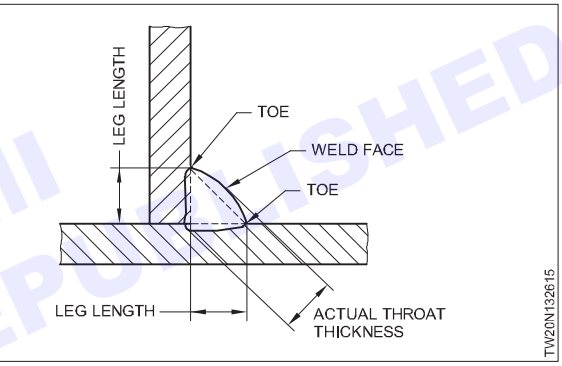
Heat affected zone: Metallurgical properties have been changed by the welding heat adjacent to weld.

Fig 4



Leg length: The distance between the junction of the metals and the point where the weld metal touches the base metal ‘ toe’. (Fig 5)

Fig 5

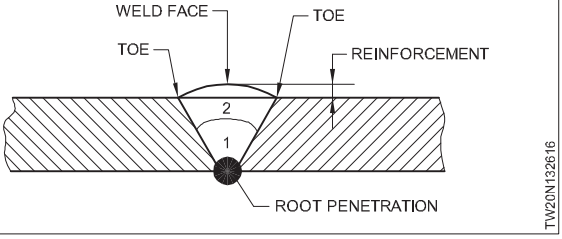


Parent metal: The material or the part to be welded.

Fusion penetration: The depth of fusion zone in the parent metal. (Fig 3 & 4)

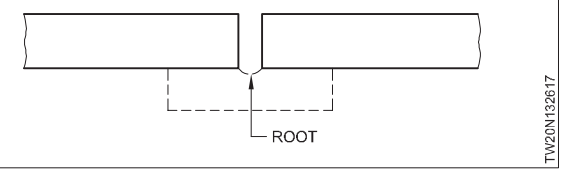
Reinforcement: Metal deposited on the surface of the parent metal or the excess metal over the line joining the two toes. (Fig 6)

Fig 6



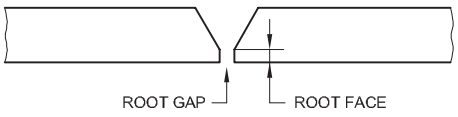
Root: The parts to be joined that are nearest together. (Fig 7)

Fig 7



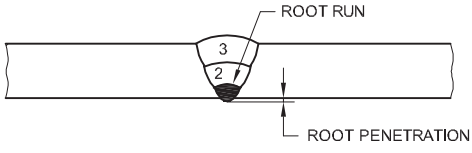
Root face: The surface formed by squaring off the root edge of the fusion face to avoid a sharp edge at the root. (Fig 8)

Fig 8



Root run: The first run deposited in the root of a joint. (Fig 9)

Fig 9



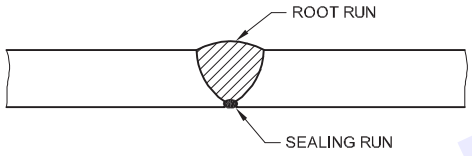
Root penetration: It is the projection of the root run at the bottom of the joint (Figs 6 - 9)

Run: The metal deposited during one pass. (Fig 9)

The second run is marked as 2 which is deposited over the root run. The third run is marked as 3 which is deposited over the second run.

Sealing run: A small weld deposited on the root side of a butt or corner joint (after completion of the weld joint). (Fig 10)

Fig 10



Backing run: A small weld deposited on the root side of the butt or corner joint (before welding the joint). (Fig 6)

Throat thickness: The distance between the junction of the metals and the midpoint on the line joining the two toes. (Fig 5)

Toe of weld: The point where the weld face joins the parent metal. (Fig 5 & 6)

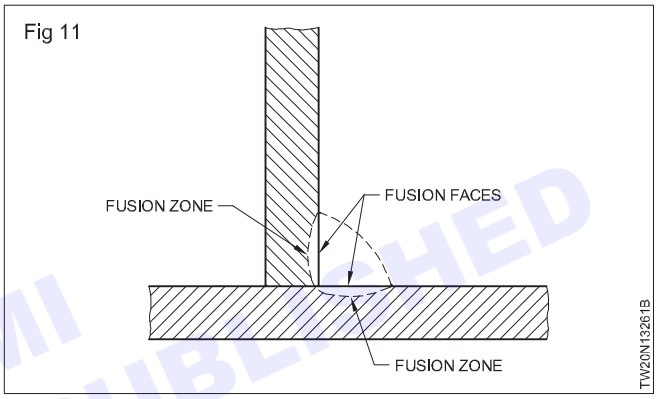
Weld face: The surface of a weld seen from the side from which the weld was made. (Fig 5 & 6)

Weld junction: The boundary between the fusion zone and the heat affected zone. (Fig 3 & 4)

Fusion face: The portion of a surface which is to be fused on making the weld. (Fig 11)

Fusion zone: The depth to which the parent metal has been fused. (Fig 11)

Fig 11



Gases and gas cylinders description, kinds, main difference and uses

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

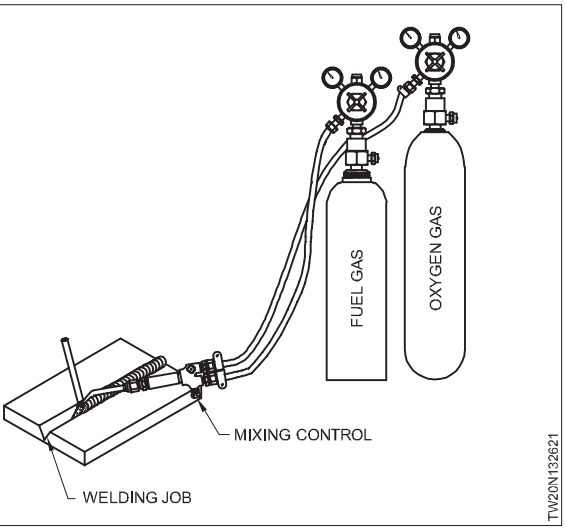
- **name the different types of gases used in gas welding**
- **state the different types of gas flame combinations**
- **state the temperatures and uses of the different gas flame combinations.**

In the different gas welding processes, the welding heat is obtained from the combustion of the fuel gases.

All the fuel gases require oxygen to support combustion.

As a result of the combustion of the fuel gases and oxygen, a flame is obtained. This is used to heat the metals for welding. (Fig 1)

Fig 1



Fuel gases used in welding

The following are the gases used as fuel for welding.

- Acetylene gas
- Hydrogen gas
- Coal gas
- Liquid petroleum gas (LPG)

Supporter of combustion gas: All gases burn with the help of oxygen. Hence it is known as the supporter of combustion.

Different gas flame combinations

Oxygen + Acetylene = Oxy - Acetylene gas flame

Oxygen + Hydrogen = Oxy - Hydrogen gas flame

Oxygen + Coal = Oxy - coal gas flame

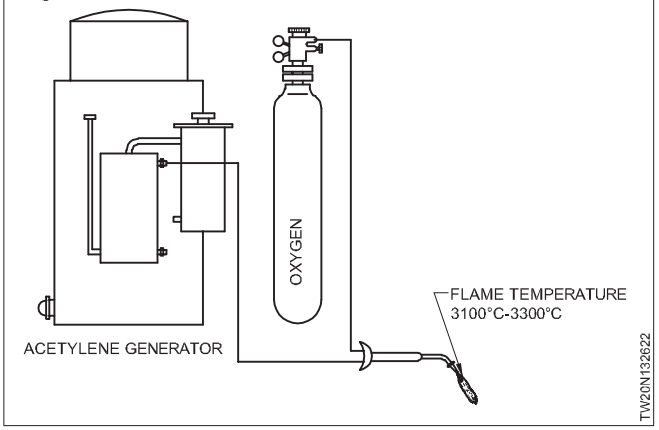
Oxygen + LPG = Oxy - LP gas flame

Temperature and uses of gas flame combinations

Oxy-acetylene gas flame (Fig 2)

Flame temperature: 3100° C to 3300° C

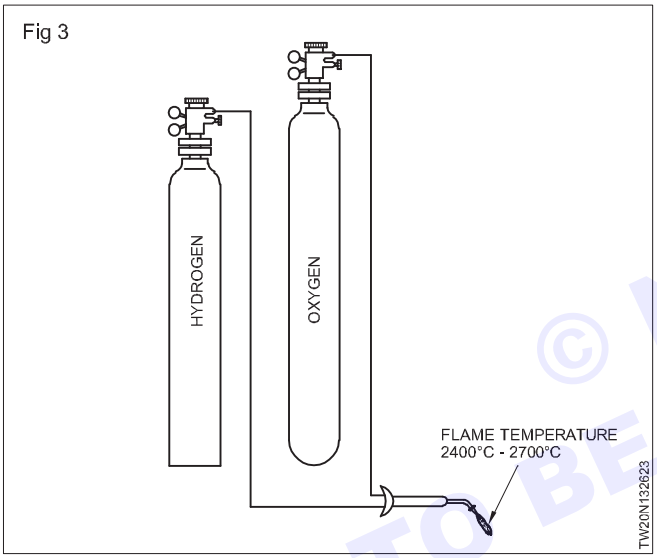
Fig 2



The Oxy - Acetylene gas flame is used for welding all ferrous and non-ferrous metals and their alloys, gas cutting, gouging, steel brazing, bronze welding, metal spraying and powder spraying.

Oxy - Hydrogen gas flame (Fig 3)

Fig 3



Flame temperature: 2400°C to 2700°C

It has carbon and moisture effect in the flame. It is used only for brazing, silver soldering and underwater gas cutting of steel.

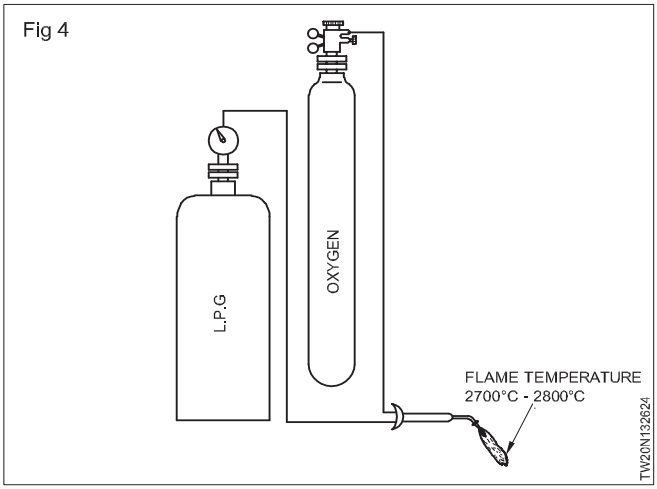
Oxy-liquid petroleum gas flame (Fig 4)

Flame temperature: 2700°C to 2800°C

This flame has carbon and moisture effect.

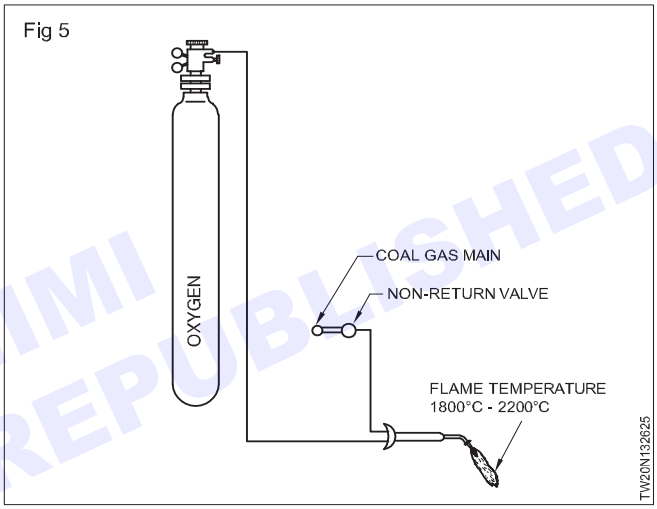
It is only used for gas cutting of steel, and for heating.

Fig 4



Oxy-coal gas flame (Fig 5)

Fig 5



Flame temperature: 1800°C to 2200°C

This flame has carbon effect in the flame and is used for silver soldering and brazing.

The most commonly used gas flame combination is OXY - ACETYLENE.

Oxygen gas cylinder

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

- **name different gas cylinders**
- **explain the constructional features of oxygen gas cylinder and the method of charging.**

Definition of a gas cylinder: It is a steel container, used to store different gases at high pressure safely and in large quantity for welding or other industrial uses.

Types and identifications of gas cylinders: Gas cylinders are called by names of the gas they are holding. (Table 1)

Table 1

Identification of gas cylinders

Name of gas cylinder	Colour coding	Valve threads
Oxygen	Black	Right hand
Acetylene	Maroon	Left hand

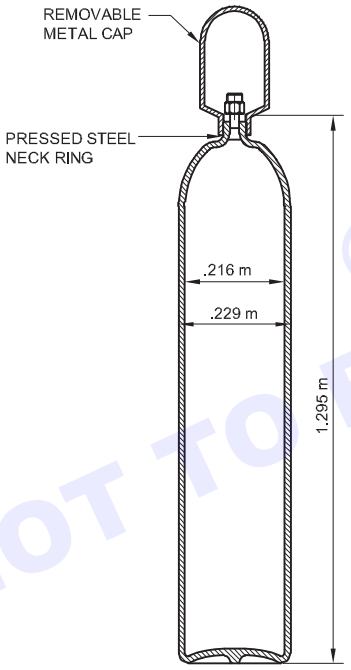
Coal	Red (with name coal gas)	Left hand
Hydrogen	Red	Left hand
Nitrogen	Grey (with black neck)	Right hand
Air Propane	Grey Red (with larger dia-meter and name propane)	Right hand Left hand
Argon Carbon-di-oxide	Blue Black (with white neck)	Right hand Right hand

Gas cylinders are identified by their body colour marks and valve threads. (Table 1)

Oxygen gas cylinder: It is a seamless steel container used to store oxygen gas safely and in large quantity under a maximum pressure of 150 kg/cm^2, for use in gas welding and cutting.

Constructional features of oxygen gas cylinder (Fig 1)

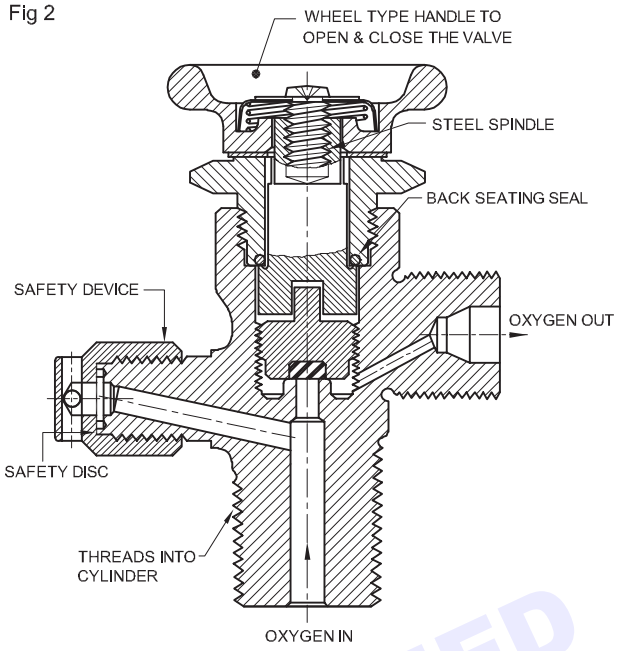
Fig 1



CONSTRUCTIONAL FEATURE OF OXYGEN GAS CYLINDER

It is made from seamless solid drawn steel and tested with a water pressure of 225kg/cm^2. The cylinder top is fitted with a high pressure valve made from high quality forged bronze. (Fig 2)

Fig 2



CONSTRUCTIONAL FEATURES OF A CYLINDER VALVE

The cylinder valve has a pressure safety device, which consists of a pressure disc, which will burst before the inside cylinder pressure becomes high enough to break the cylinder body. The cylinder valve outlet socket fitting has standard right hand threads, to which all pressure regulators may be attached. The cylinder valve is also fitted with a steel spindle to operate the valve for opening and closing. A steel cap is screwed over the valve to protect it from damage during transportation. (Fig 1)

The cylinder body is painted black.

The capacity of the cylinder may be 3.5m^3– 8.5m^3.

Oxygen cylinders of 7m^3 capacity are commonly used.

Charging of gas in oxygen cylinder: The oxygen cylinders are filled with oxygen gas under a pressure of 120-150 kg/cm^2. The cylinders are tested regularly and periodically. They are annealed to relieve stresses caused during 'on the job' handling. They are periodically cleaned using caustic solution.

Dissolved acetylene gas cylinder

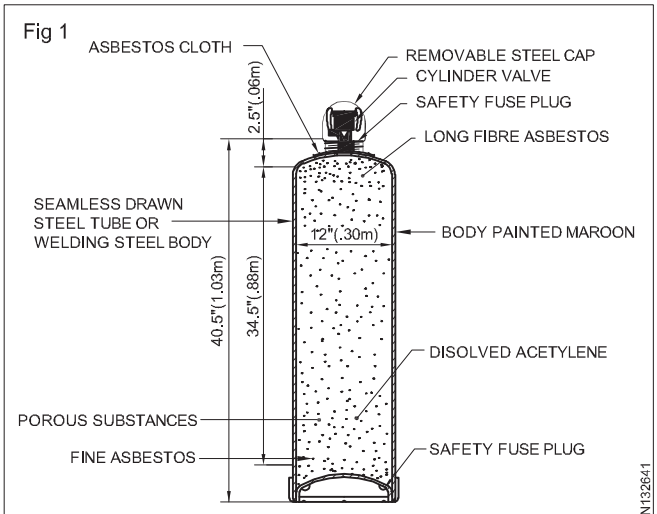
Objectives: At the end of this lesson you shall be able to

- **describe the constructional features of the DA gas cylinder and the method of charging**
- **state the safety rules for handling gas cylinders**
- **explain the safe procedure to be followed in handling an internally fired DA cylinder.**

Definition: It is a steel container used to store high pressure acetylene gas safely in dissolved state for gas welding or cutting purpose.

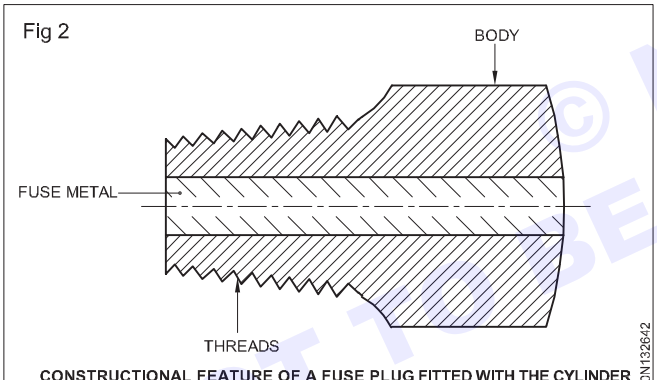
Constructional features (Fig 1): The acetylene gas cylinder is made from seamless drawn steel tube or welded steel container and tested with a water pressure of 100kg/cm^2 The cylinder top is fitted with a pressure valve made from high quality forged bronze. The cylinder valve outlet socket has standard left hand threads to which acetylene regulators of all makes may be attached. The cylinder valve is also fitted with a steel spindle to operate the valve for opening and closing. A steel cap is screwed over the

valve to protect it from damage during transportation. The body of the cylinder is painted maroon. The capacity of the D A cylinder may be 3.5m^3–8.5m^3.



CONSTRUCTIONAL FEATURES OF A DISSOLVED ACETYLENE GAS CYLINDER

The base of the D A cylinder (curved inside) is fitted with fuse plugs which will melt at a temperature of app. 100°C. (Fig 2) In case the cylinder is subjected to high temperature, the fuse plugs will melt and allow the gas to escape, before the pressure increases enough to harm or rupture the cylinder. Fuse plugs are also fitted on the top of the cylinder.



CONSTRUCTIONAL FEATURE OF A FUSE PLUG FITTED WITH THE CYLINDER TOP AND BOTTOM

Method of charging DA gas cylinder: The storage of acetylene gas in its gaseous form under pressure above 1kg/cm^2 is not safe. A special method is used to store acetylene safely in cylinders as given below.

The cylinders are filled with porous substances such as:

- pith from corn stalk
- fullers earth
- lime silica
- specially prepared charcoal
- fibre asbestos.

The hydrocarbon liquid named acetone is then charged in the cylinder, which fills the porous substances (1/3rd of total volume of the cylinder).

Acetylene gas is then charged in the cylinder, under a pressure of app.15 kg/cm^2.

The liquid acetone dissolves the acetylene gas in large quantity as safe storage medium; hence, it is called dissolved acetylene. One volume of liquid acetone can dissolve 25 volumes of acetylene gas under normal atmospheric pressure and temperature. During the gas charging operation one volume of liquid acetone dissolves 25x15=375 volumes of acetylene gas under 15kg/cm^2 pressure at normal temperature. While charging cold water will be sprayed over the cylinder so that the temperature inside the cylinder does not cross certain limit.

Safety rules for gas cylinders

Oxy-acetylene equipment is safe if it is properly handled, but it may become a great destructive power if handled carelessly. It is important that the operator be familiar with all the safety rules before handling gas cylinders.

Keep the cylinders free of oil, grease or any type of lubrication.

Check leakage before use.

Open cylinder valves slowly.

Never fall or trip over gas cylinders.

A valve broken in the oxygen cylinder will cause it to become a rocket with tremendous force.

Keep the gas cylinders away from exposure to high temperature.

Remember the pressure in the gas cylinders increases with the temperature.

Store full and empty gas cylinders separately in a well ventilated place.

Mark the empty cylinders (MT/EMPTY) with chalk .

If a cylinder leaks due to defective valve or safety plug, do not try to repair it yourself, but move it to a safe area with a tag to indicate the fault and then inform the supplier to pick it up.

When the cylinders are not in use or they are being moved, put on the valve protection caps.

Cylinders should always be kept in upright position and properly chained when in use.

Close the cylinder valves both when they are full or empty.

Never remove the valve protection cap while lifting cylinders.

Avoid exposing the cylinders to furnace heat, open fire or sparks from the torch.

Never move a cylinder by dragging, sliding or rolling it on its sides.

Never apply undue force to open or close a cylinder valve.

Avoid the use of hammer or wrench.

Always use a proper cylinder (or spindle) key to open or close the cylinder valves.

Do not remove the cylinder key from the cylinder valve when it is in use. It may be needed immediately to close the gas in case of emergency.

Smoking or naked lights should be strictly prohibited near gas cylinders.

Never strike an arc or direct gas flame on a gas cylinder.

Safety procedure for handling an internally fired dissolved acetylene (DA) cylinder

In the case of severe backfire or flashback the DA cylinder may catch fire.

Close the blowpipe valve immediately (oxygen first).

No damage will occur to the cylinder if the backfire is arrested at the blowpipe.

The signs of severe backfire or flashback are:

- a squealing or hissing noise in the blowpipe
- a heavy black smoke and sparks coming out of the nozzle
- overheating of the blowpipe handle.

To control this

- close the cylinder valves
- disconnect the regulator from the cylinder valve
- check the hosepipes and blowpipe before re-use.

If the cylinder catches fire externally due to the leakage of gas at the connection:

- close the cylinder valve immediately (wearing asbestos gloves as a safety measure)
- use carbon dioxide fire extinguisher to extinguish the fire
- rectify the leakage thoroughly before putting into further use.

If the cylinder becomes overheated due to internal or external fire:

- close the cylinder valve
- detach the regulator from the cylinder
- remove the cylinder to an open space, away from smoke or naked light
- cool the cylinder by spraying with water
- inform the gas cylinder supplier immediately.

Never keep such defective cylinders with the other cylinders.

Setting up parameter for arc welding machine

Objective: At the end of this lesson you shall be able to
- **select and set the electrode and current according to the plate thickness.**

Electrode size and AMPS used: The following will serve as a basic guide of the amp range that can be used for different size electrodes. Note that these ratings can be different between various electrode manufactures for the same size rod. Also the type coating on the electrode could effect the amperage range. When possible, check the manufactures info of the electrode you wil be using for their recommended amperage settings.

Electrode table

Electrode	AMP	Plate
1/16"	20 - 40	Up to 3/16"
3/32"	40 - 125	Up to 1/4"
1/8	75 - 185	Over 1/8"
5/32"	105 - 250	Over 1/4"
3/16"	140 - 305	Over 3/8"
1/4"	210 - 430	Over 3/8"
5/16"	275 - 450	Over 1/2"

Note: The thicker the material to be welded, the higher the current needed and the larger the electrode needed.

Selection and storage of electrodes

Objectives: At the end of this lesson you shall be able to
- **select a suitable electrode to weld a particular job**
- **state the necessity of baking a coated electrode**
- **store and handle the electrode properly for better weld quality.**

Selection/choice of electrodes: Selection of an electrode is very important in order to get a joint welded with the required strength.

Selection factors

Properties of base metal: Top quality weld should be as strong as the base metal.

Select an electrode that is recommended as per the properties of the base metal. (Fig 1)

The size of the electrode depends on

– thickness of metal to be welded

– edge preparation of joints

– root run, intermediate or covering run

– welding position

– welder's skill.

Fig 1

BASE METAL	ELECTRODE SELECTED
MILD STEEL	MEDIUM COATED RUTILE M.S. ELECTRODE
MEDIUM CARBON STEEL	HEAVY COATED LOW HYDROGEN M.S. ELECTRODE
STAINLESS STEEL	COLUMBIAM BASED STABILISED STAINLESS STEEL ELECTRODE
COPPER	HEAVY COATED BRONZE ELECTRODE

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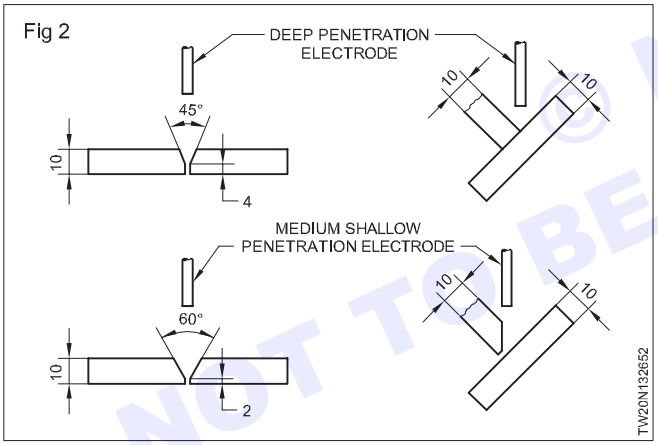
Never use a larger dia. electrode than the thickness of base metal.

Joint design and fit up

Select

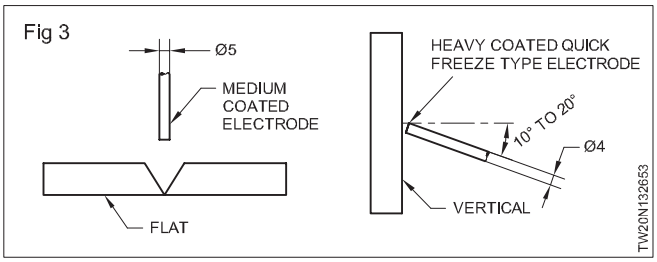
– deep penetration electrodes for insufficiently bevelled joints

– medium penetration electrodes for open and sufficiently bevelled joints. (Fig 2)



Welding position: Electrodes are manufactured for different positions, to produce better welds.

Select an electrode as per the welding position. (Fig 3)



Welding current: Electrodes are available for use with:

– AC or DC (straight or reverse polarity)

– AC and DC (both).

Select as per the availability of the welding machine.

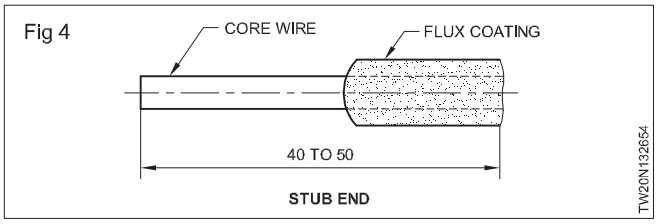
Production efficiency: The deposition rate of electrode is important in production work. So select an iron powder electrode for production work.

Faster the weld, lower the cost: Select the electrode, which is designed for the particular production work.

Usage and storage of electrodes

Electrodes are costly, therefore, use and consume every bit of them.

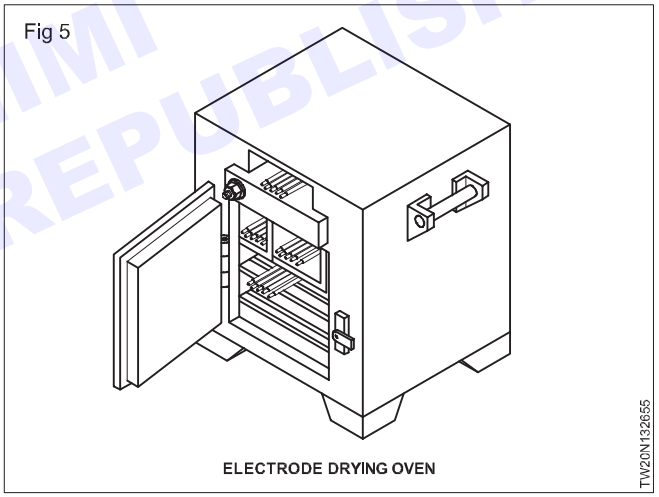
Do not discard STUB ENDS more than 40-50 mm length. (Fig 4)



Electrode coating can pick up moisture if exposed to atmosphere.

Store and keep the electrodes (air tight) in a dry place.

Heat the moisture affected/prone electrodes in an electrode drying oven at 110 - 150° C for one hour before using. (Fig 5)



Remember a moisture-affected electrode

– Has rusty stub end

– Has white powder appearance in coating

– Produces porous weld.

Always pick up the right electrode that will provide

– Good arc stability

– Smooth weld bead

– Fast deposition

– Minimum spatters

– Maximum weld strength

– Easy slag removal.

Storage of electrodes: The efficiency of an electrode is affected if the covering becomes damp.

– Keep electrodes in unopened packets in a dry store.
– Place packages on a duckboard or pallet, not directly on the floor.
– Store so that air can circulate around and through the stack.
– Do not allow packages to be in contact with walls or other wet surfaces.
– The temperature of the store should be about 5°C higher than the outside shade temperature to prevent condensation of moisture.
– Free air circulation in the store is as important as heating. Avoid wide fluctuations in the store temperature.
– Where electrodes cannot be stored in ideal conditions place a moisture - absorbent material (e.g silica-gel) inside each storage container.

Drying electrodes: Water in electrode covering is a potential source of hydrogen in the deposited metal and thus may cause

– Porosity in the weld
– Cracking in the weld.

Indications of electrodes affected by moisture are

– White layer on covering.
– Swelling of covering during welding.
– Disintegration of covering during welding.
– Excessive spatter.
– Excessive rusting of the core wire.

Electrodes affected by moisture may be dried before use by putting them in a controlled drying oven for approximately one hour at a temperature around 110 - 150°C. This should not be done without reference to the conditions laid down by the manufacturer. It is important that hydrogen controlled electrodes are stored in dry, heated conditions at all times.

Warning: Special drying procedures apply to hydrogen controlled electrodes. Follow the manufacturer's instructions.

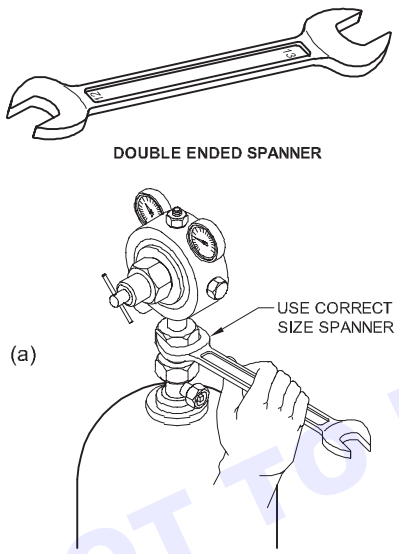
Welding tools and equipments

Objectives: At the end of this lesson you shall be able to
- **name the hand tools used by a welder**
- **state their uses**
- **state the care and maintenance to keep the hand tools in good working condition.**

The following are the details of different hand tools used by a welder.

Double ended spanner: A double ended spanner is shown in Fig 1 and 1a. It is made of forged chrome vanadium steel. It is used to loosen or tighten nuts, bolts with hexagonal or square heads. The size of the spanner is marked on it as shown in Fig 1. In welding practice the spanners are used to fix the regulator onto the gas cylinder valves, hose connector and protector to the regulator and blow pipe, fix the cable lugs to the arc welding machine output terminals, etc.

Fig 1



Do not use the spanner as a hammer; use the correct size spanner to avoid damage to the nut/bolt head.

Cylinder key: A cylinder key is shown in Fig 2. It is used to open or close the gas cylinder valve socket to permit or stop the gas flow from the cylinder to the gas regulator.

Always use correct size key to avoid damage to the square rod used to operate the valve. The key must always be left on the valve socket itself so that the gas flow can be stopped immediately in case of flash back/ back fire.

Nozzle or tip cleaner

Cleaning the tip: All welding torch tips are made of copper. They can be damaged by the slightest rough handling-dropping, tapping or chopping with the tip on the work may damage the tip beyond repair.

Tip cleaner: A special tip cleaner is supplied with the torch container. For each tip there is a kind of drill and a smooth file Fig 3.

Fig 2

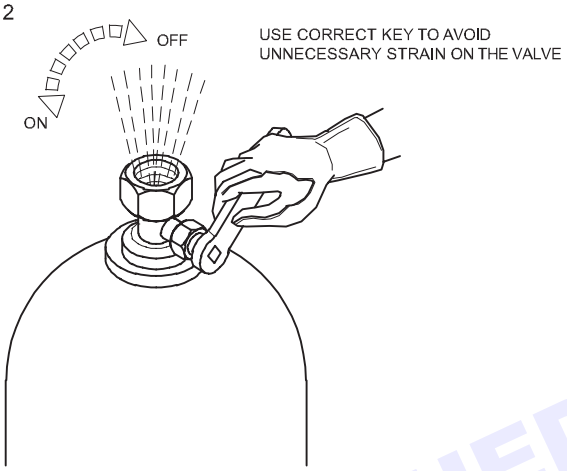
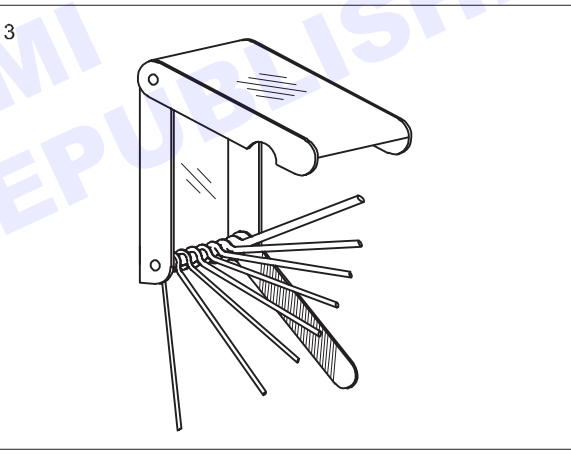
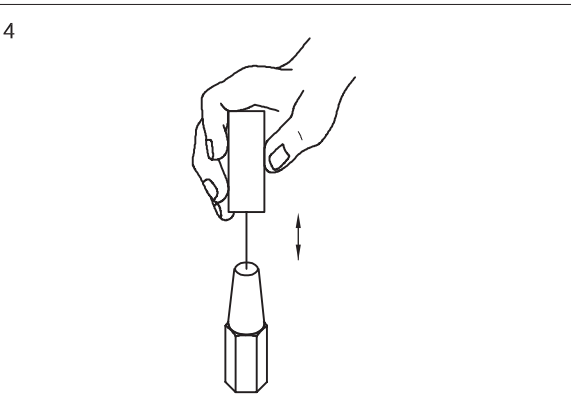


Fig 3



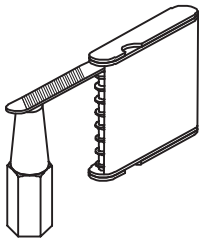
Before cleaning the tip, select the correct drill and move it, without turning, up and down through the hole in the tip Fig 4.

Fig 4



The smooth file is then used to clean the surface of the tip Fig 5. While cleaning, leave the oxygen valve partly open to blow out the dust.

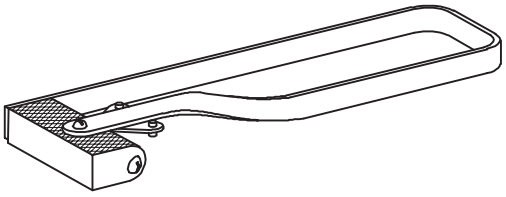
Fig 5



TW20N142815

Spark lighter: The spark lighter, as illustrated in Fig 6 & 7 is used for igniting the torch. While welding, form the habit of always employing a spark lighter to light a torch. Never use matches. The use of matches for this purpose is very dangerous because the puff of the flame produced by the ignition of the acetylene flowing from the tip is likely to burn your hand.

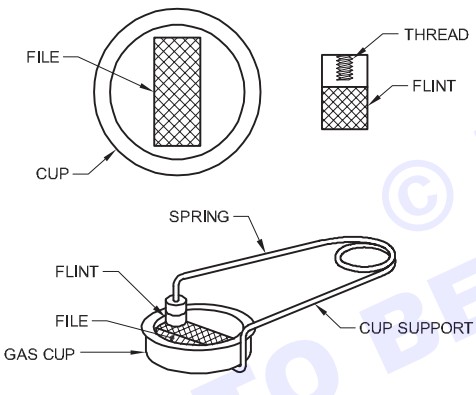
Fig 6



ALWAYS USE A SPARKLIGHTER TO LIGHT A TORCH

TW20N142816

Fig 7



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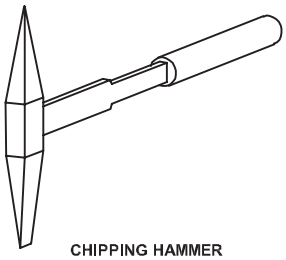
Chipping hammer: The chipping hammer (Fig 8) is used to remove the slag which covers the deposited weld bead. It is made of medium carbon steel with a mild steel handle. It is provided with a chisel edge on one end and a point on the other end for chipping off slag in any position.

Fig 8



CHIPPING HAMMER

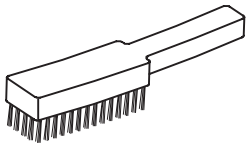
TW20N142818

Care should be taken to maintain the sharp chisel edge and the point for effective chipping of slag.

Carbon steel wire brush: A carbon steel wire brush is shown in Fig 9. It is used for

– Cleaning the work surface from rust, oxide and other dirt etc. prior to welding.

Fig 9



WIRE BRUSH

TW20N142819

– Cleaning the interbreed weld deposits after chipping off the slag.

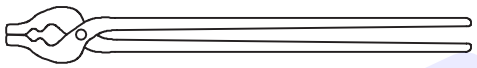
– General cleaning of the weldment.

A stainless steel wire brush is used for cleaning a non ferrous and stainless steel welded joint.

It is made of bunch of steel wires fitted in three to five rows on a wooden piece with handle. The wires are hardened and tempered for long life and to ensure good cleaning action.

Tongs: Fig 10 & 11 shows a pair of tongs used to hold hot work pieces and to hold the job in position.

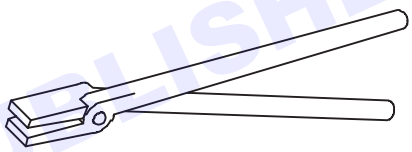
Fig 10



TONGS

TW20N142814A

Fig 11

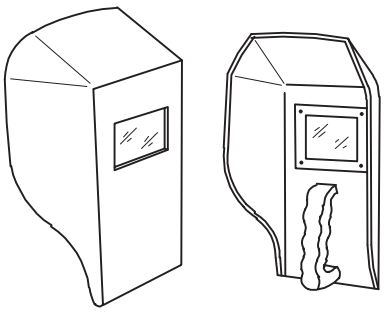


TONGS

TW20N142814B

Welding hand screen (Fig 12)

Fig 12



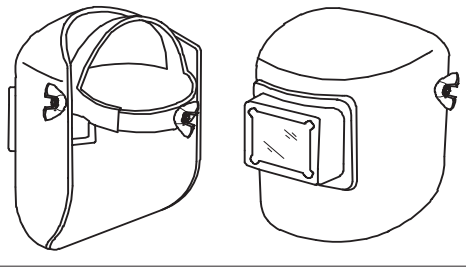
TW20N142814C

A welding hand screen is used to shield and protect the face and the eyes from the arc radiation.

It is fitted with a filter lens, and plain glass to protect the lens.

Welding helmet screen (Fig 13)

Fig 13

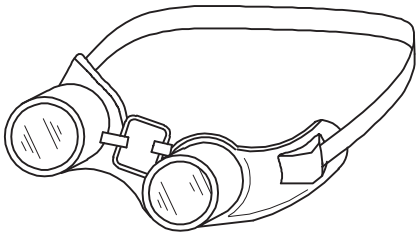


TW20N142814D

It is used as a hand screen but it can be worn on the head of the welder to enable him to use both his hands.

Chipping goggles (Fig 14)

Fig 14



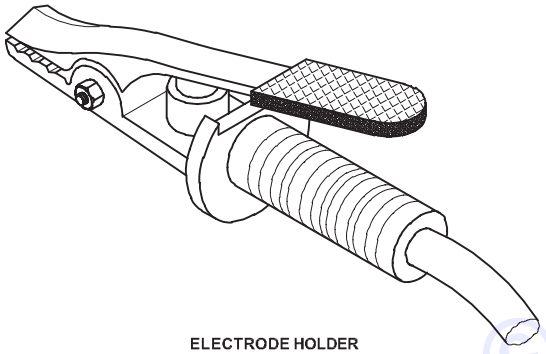
TW20N14281E

Chipping goggles are used to protect the eyes while chipping the slag.

They are fitted with a plain glass to see the area to be cleaned.

Electrode holder with cable (Fig 15)

Fig 15



ELECTRODE HOLDER

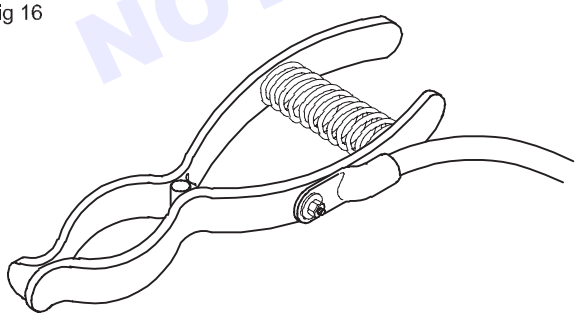
TW20N14281F

An electrode holder is used to hold and manipulate the electrode.

The cable is insulated with a good quality flexible rubber, and copper core wires, to carry the high current from the welding machines.

Earth clamp with cable (Fig 16)

Fig 16



TW20N14281G

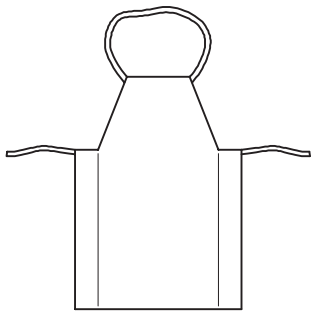
An earth clamp is used to connect the return lead firmly to the job or to the welding table.

Welding table

The welding table is used to keep the jobs and assemble the pieces during welding. The top of the table is made of metal.

Apron (Fig 17)

Fig 17



TW20N14281H

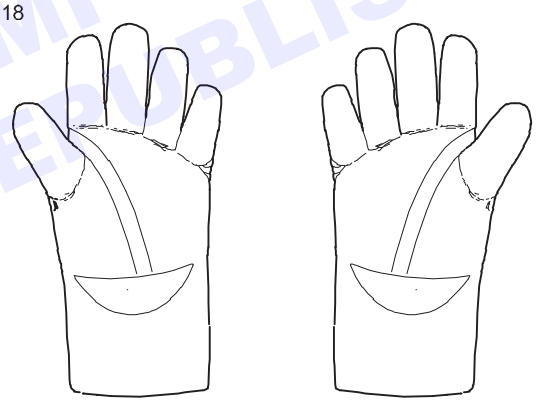
An apron is used to protect the body.

It should be made of leather and worn.

It must be worn for protection from the radiation of the heat rays and hot spatters.

Hand gloves (Fig 18)

Fig 18



TW20N14281I

Hand gloves are used to protect the hands from electrical shock, arc radiation, heat, and hot spatters.

The gloves are also made of leather.

Oxy-acetylene cutting equipment

Objectives: At the end of this lesson you shall be able to
- **explain the features of the oxy-acetylene cutting equipment, its parts and cutting torch**
- **describe the oxy-acetylene cutting procedure**
- **differentiate between cutting and welding blowpipes.**

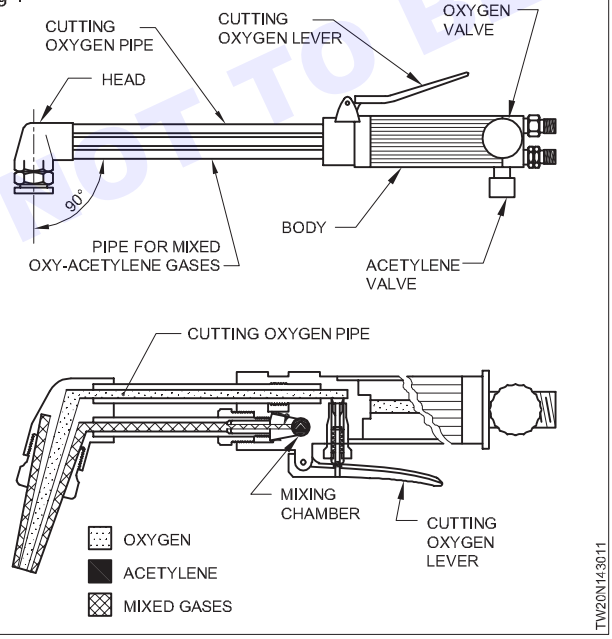
Cutting equipment: The oxy-acetylene cutting equipment is similar to the welding equipment, except that instead of using a welding blowpipe, a cutting blowpipe is used. The cutting equipment consists of the following.

- Acetylene gas cylinder
- Oxygen gas cylinder
- Acetylene gas regulator
- Oxygen gas regulator (Heavy cutting requires higher pressure oxygen regulator.)
- Rubber hose-pipes for acetylene and oxygen
- Cutting blowpipe

(Cutting accessories i.e. cylinder key, spark lighter, cylinder trolley and other safety appliances are the same as are used for gas welding.)

The cutting torch (Fig 1): The cutting torch differs from the regular welding blowpipe in most cases; it has an additional lever for the control of the cutting oxygen used to cut the metal. The torch has the oxygen and acetylene control valves to control the oxygen and acetylene gases while preheating the metal.

Fig 1



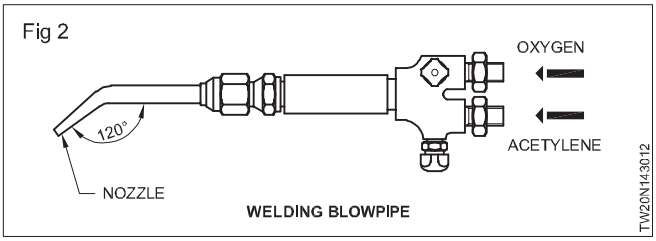
The cutting tip is made with an ORIFICE in the centre surrounded by five smaller holes. The centre opening permits the flow of the cutting oxygen and the smaller holes are for the preheating flame. Usually different tip sizes are provided for cutting metals of different thicknesses.

Oxy-acetylene cutting procedure: Fix a suitable size cutting nozzle in the cutting blowpipe. Ignite the cutting torch the same way as was done in the case of the welding blowpipe. Set the neutral flame for preheating. To start the cut, hold the cutting nozzle at angle 90° with the plate surface, and the inner cone of the heating flame 3 mm above the metal. Preheat the metal to bright red before pressing the cutting oxygen lever. If the cut is proceeding correctly, a shower of sparks will be seen to fall from the underside of the plate. Move the torch steadily on the punched line. If the edge of the cut appears to be too ragged, the torch is being moved too slowly. For a bevel cut, hold the cutting torch at the desired angle and proceed as is done in making a straight line cut. At the end of the cut, release the cutting oxygen lever and close the control valves of the oxygen and acetylene. Clean the cut and inspect.

Difference between cutting blowpipe and welding blowpipe: A cutting blowpipe has two control valves (oxygen and acetylene) to control the preheating flame and one lever type control valve to control the high pressure pure oxygen for making the cut.

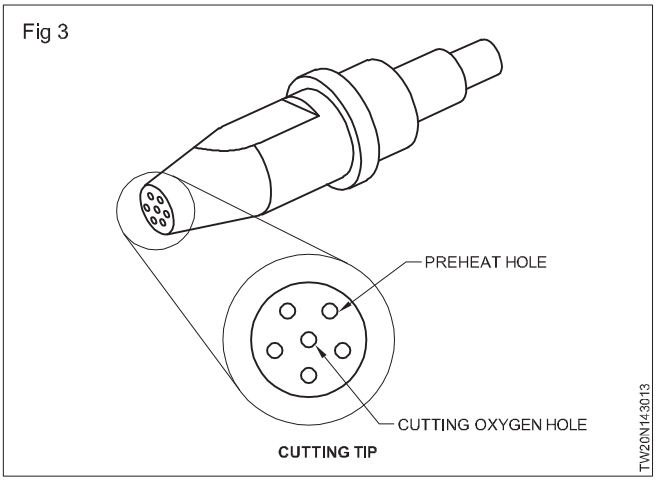
A welding blowpipe has only two control valves to control the heating flame. (Fig 2)

Fig 2



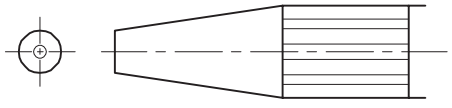
The nozzle of the cutting blowpipe has one hole in the centre for cutting oxygen and a number of holes around the circle for the preheating flame. (Fig 3)

Fig 3



The nozzle of the welding blowpipe has only one hole in the centre for the heating flame. (Fig 4)

Fig 4



WELDING NOZZLE

TW20N143014

The angle of the cutting nozzle with the body is 90°.

The angle of the welding nozzle with the neck is 120°.

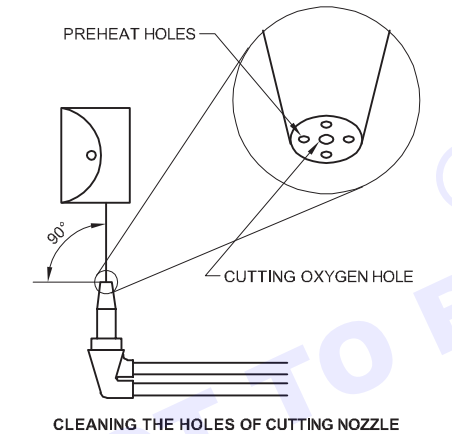
The cutting nozzle size is given by the diameter of the cutting oxygen orifice in mm.

The welding nozzle size is given by the volume of oxy-acetylene mixed gases coming out of the nozzle in cubic meter per hour.

Operating data for cutting mild steel

Cutting nozzle size - mm	Thickness of plate (mm)	Cutting oxygen pressure Kgf/cm^2
0.8	3 - 6	1.0 - 1.4
1.2	6 - 19	1.4 - 2.1
1.6	19 - 100	2.1 - 4.2
2.0	100 - 150	4.2 - 4.6
2.4	150 - 200	4.6 - 4.9
2.8	200 - 250	4.9 - 5.5
3.2	250 - 300	5.5 - 5.6

Fig 5



CLEANING THE HOLES OF CUTTING NOZZLE

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Care and maintenance: The high pressure cutting oxygen lever should be operated only for gas cutting purposes.

Care should be taken while fitting the nozzle with the torch to avoid wrong thread. Dip the torch after each cutting operation in water to cool the nozzle.

To remove any slag particles or dirt from the nozzle orifice use the correct size nozzle cleaner Fig 5. Use an emery paper if the nozzle tip is damaged to make it sharp and to be at 90^0 with the nozzle axis.

Method of handling cutting torch-description, parts, function and uses

Objectives: At the end of this lesson you shall be able to
- **explain the principle of gas cutting**
- **describe the cutting operation and its application.**

Introduction to gas cutting: The most common method of cutting mild steel is by an oxy - acetylene cutting process. With an oxy-acetylene cutting torch, the cutting (oxidation) can be confined to a narrow strip and with little effect of heat on the adjoining metal. The cut appears like a saw-cut on a wooden plank. The method can be successfully used to cut ferrous metals i.e. mild steel.

Non-ferrous metals and their alloys cannot be cut by this process.

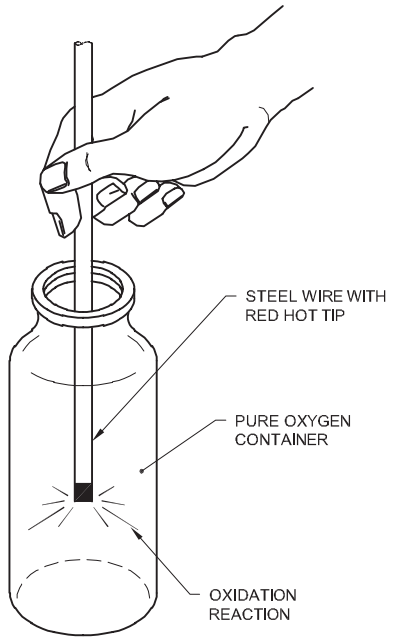
Principle of gas cutting: When a ferrous metal is heated to red hot condition and then exposed to pure oxygen, a chemical reaction takes place between the heated metal and oxygen. Due to this oxidation reaction, a large amount of heat is produced and cutting action takes place.

When a piece of wire with a red hot tip is placed in a container of pure oxygen, it bursts into flame immediately and is completely consumed. Fig 1 illustrates this reaction. Similarly in oxy-acetylene cutting the combination of red hot metal and pure oxygen causes rapid burning and iron is changed into iron oxide (oxidation).

By this continuous process of oxidation the metal can be cut through very rapidly.

The iron oxide is less in weight than the base metal.

Fig 1

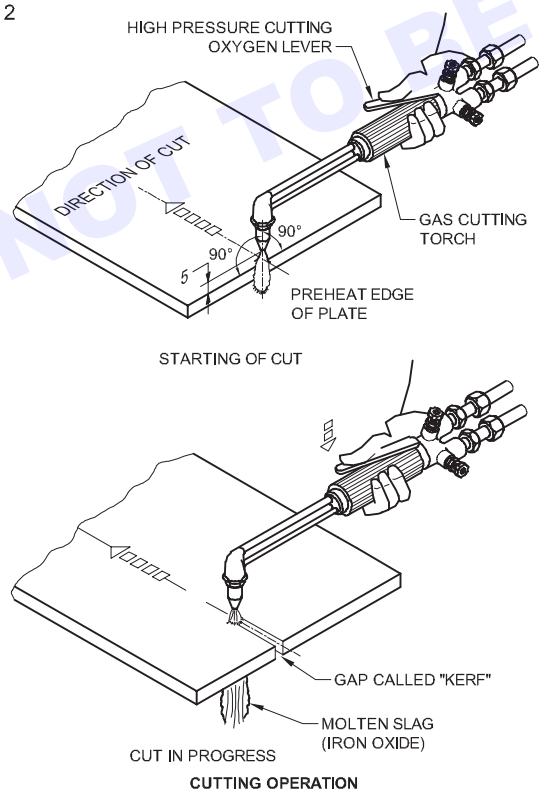


OXIDATION

Also the iron oxide is in molten condition called slag. So the jet of oxygen coming from the cutting torch will blow the molten slag away from the metal making a gap called 'Kerf'.

Cutting operation (Fig 2): There are two operations in oxy-acetylene gas cutting. A preheating flame is directed on the metal to be cut and raises it to bright red hot or ignition point (900°C app.). Then a stream of high pressure pure oxygen is directed on to the hot metal which oxidises and cuts the metal.

Fig 2



CUTTING OPERATION

The two operations are done simultaneously with a single torch.

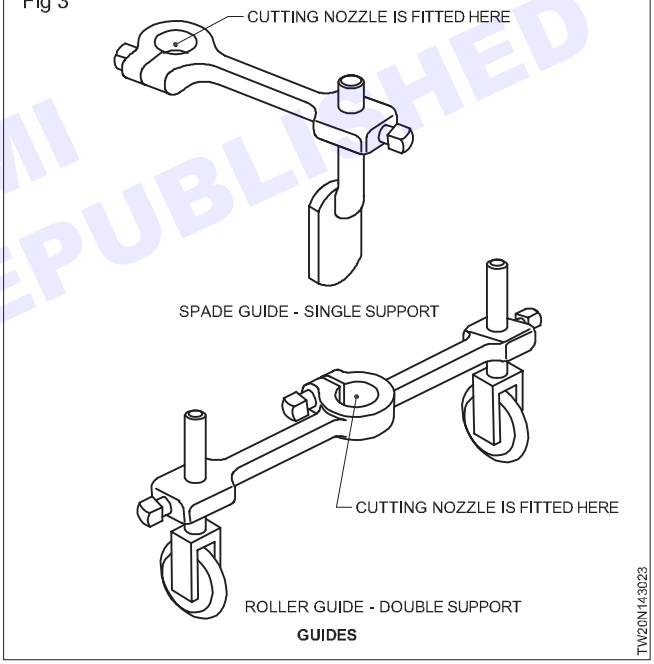
The torch is moved at a proper travel speed to produce a smooth cut. The removal of oxide particles from the line of cut is automatic by means of the force of oxygen jet during the progress of cut.

300 litres of oxygen are required to oxidize one kilogram of iron completely. The ignition temperature of steel for gas cutting is 875°C to 900°C.

Application of cutting torch: Oxy-acetylene cutting torch is used to cut mild steel plates above 4mm thickness. The M.S plate can be cut to its full length in straight line either parallel to the edge or at any angle to the edge of the plate. Bevelling the edges of a plate to any required angle can also be done by tilting the torch. Circles and any other curved profile can also be cut using the cutting torch by using a suitable guide or template.

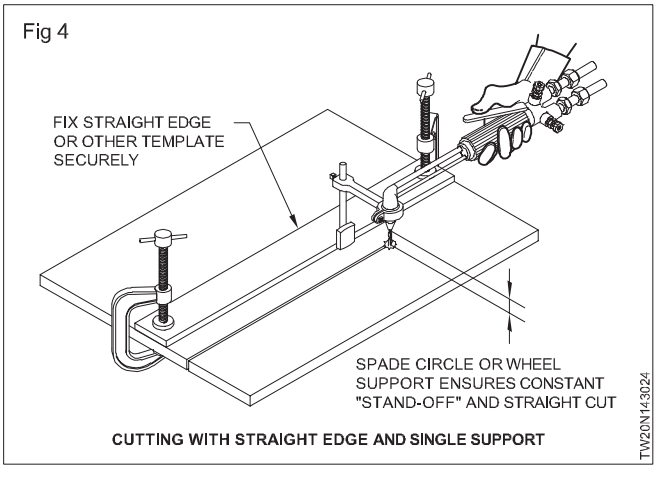
Figs 3 - 7 shows the guides used to cut straight lines, bevel and small circles.

Fig 3



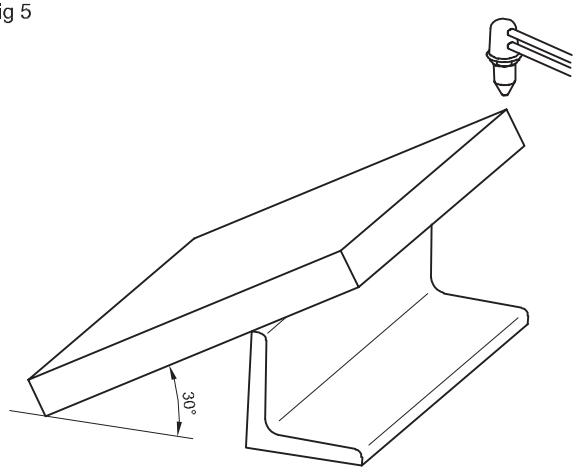
GUIDES

Fig 4



CUTTING WITH STRAIGHT EDGE AND SINGLE SUPPORT

Fig 5



ALTERNATIVE METHOD OF CUTTING BEVELLED EDGE ON INCLINE

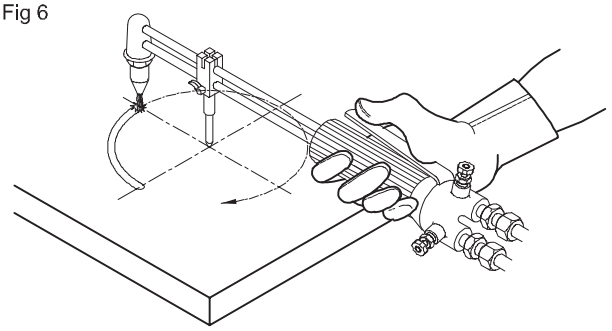
TW20N143025

Cutting torch guides: Guides are sometimes used during oxy acetylene cutting.

They can be either a roller guide, double support or spade guide with single support.

Cutting guides are held onto the nozzle of the cutting torch by tightening a clamp bolt. The clamps, where they are fitted, are adjusted so the inner cones of the preheat flames are approximately 2-3mm above the surface of the metal to be cut. The tip of the cutting nozzle is held at distance of 5-6mm above surface of the plate being cut.

Fig 6



SMALL CIRCLE CUTTING

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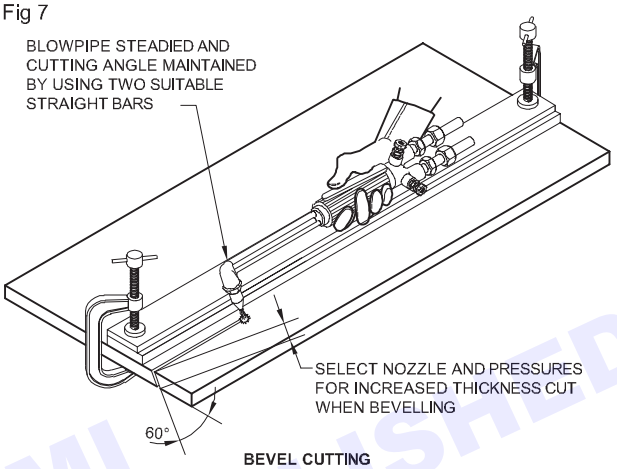
Fig 7



BEVEL CUTTING

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Types of oxy - acetylene flames and uses

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

- **name the different types of oxy - acetylene flames**
- **state the characteristics of each type of oxy - acetylene flame**
- **explain the uses of each type of oxy - acetylene flames.**

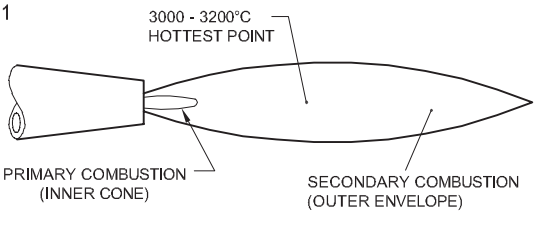
The essential requirement for oxy-acetylene welding is a well controlled flame with sufficient heat, which can be easily manipulated to heat and melt metals without altering the chemical composition of the metal/weld.

Flame types

- Neutral flame
- Oxidising flame
- Carburising flame.

Neutral flame (Fig 1)

Fig 1



PRIMARY AND SECONDARY COMBUSTION STAGES IN THE OXY-ACETYLENE FLAME

TW20N143031

Characteristics

The neutral flame is formed with oxygen and acetylene in equal proportion.

Complete combustion takes place in the flame.

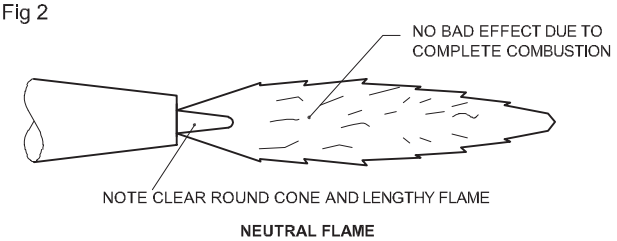
This flame does not have bad effect on metals/weld.

Uses

A neutral flame is used to weld most of the common metals, i.e. mild steel, cast iron, stainless steel, copper and aluminium.

Oxidising flame (Fig 2)

Fig 2



NEUTRAL FLAME (EQUAL QUANTITIES OF OXYGEN AND ACETYLENE)

TW20N143032

Characteristics

The oxidising flame is formed with excessive oxygen. The flame has oxidising effect on metals.

Uses

The oxidising flame is useful only for the welding of brass and to control the burning of zinc.

Carburising flame (Fig 3)

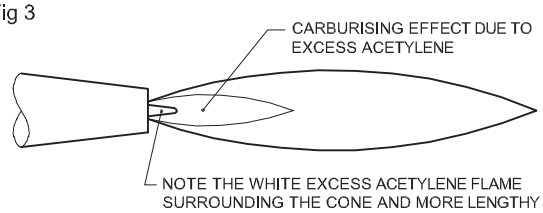
This flame contains excess of acetylene.

The flame has a carbusrising effect on steel, causing hard, and brittle weld.

Uses

Useful for stelliting (hard facing), LINDE welding of steel pipes and flame cleaning.

Fig 3



CARBURISING FLAME (EXCESS ACETYLENE)

The selection of the flame is based on the metal to be welded.

Neutral flame is the most commonly used.

Gas welding torch its type and construction

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

- **State the uses of the different types of blowpipes**
- **describe the working principle of each type of blowpipe**
- **explain its care and maintenance.**

Types

There are two types of blowpipes.

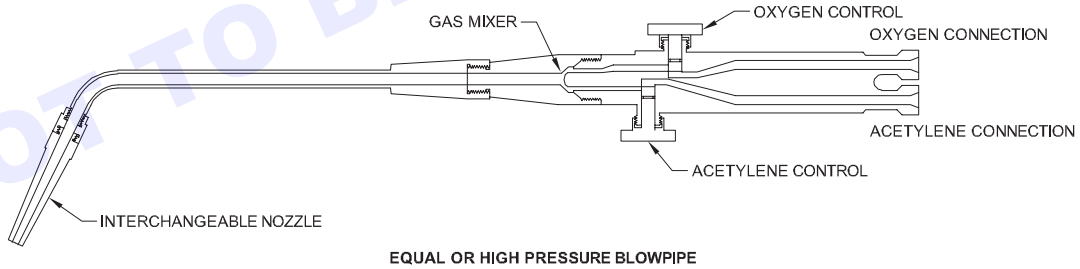
High pressure blowpipe or non-injector by blowpipe

Low pressure blowpipe or injector type blowpipe.

Uses of blow pipes: Each type consists of a variety of designs depending on the work for which the blowpipe is required. i.e gas welding, brazing, very thin sheet welding, heating before and after welding, gas cutting.

Equal or high pressure blowpipe (Fig 1): The H.P. blowpipe is simply a mixing device to supply approximately equal volume of oxygen and acetylene to the tip, and is fitted with valves to control the flow of the gases as required. i.e the blow pipes/ gas welding torches are used for welding of ferrous and non-ferrous metals, joining thin sheets by fusing the edges, preheating and post heating of jobs, brazing, for removing the dents formed by distortion and for gas cutting using a cutting blow pipe.

Fig 1

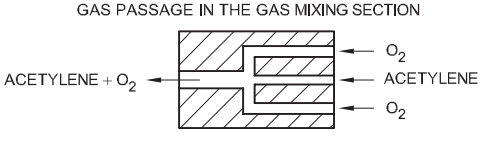


EQUAL OR HIGH PRESSURE BLOWPIPE

The equal pressure blow pipe (Fig 1) consists of two inlet connections for acetylene and oxygen gases kept in high pressure cylinders. Two control valves to control the quantity of flow of the gases and a body inside which the gases are mixed in the mixing chamber (Fig 2). The mixed gases flow through a neck pipe to the nozzle and then get ignited at the tip of the nozzle. Since the pressure of the oxygen and acetylene gases are set at the same pressure of 0.15 kg/cm^2 they mix together at the mixing chamber and flows through the blow pipe to the nozzle tip on its own. This equal pressure blow pipe/torch is also called as high pressure blow pipe/torch because this is used in the high pressure system of gas welding.

A set of nozzles is supplied with each blowpipe, the nozzles having holes varying in diameters, and thus giving various sized flames. The nozzles are numbered with their consumption of gas in litres per hour.

Fig 2



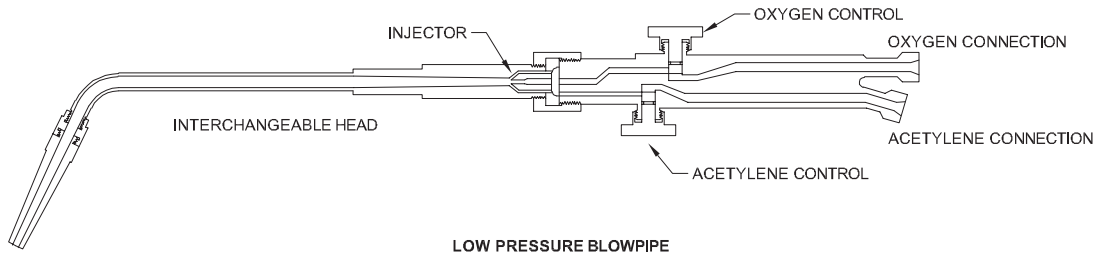
EQUAL PRESSURE TYPE TORCH

Important caution: A high pressure blowpipe should not be used on a low pressure system.

Low pressure blowpipe (Fig 3): This blowpipe has an injector (Fig 3) inside its body through which the high pressure oxygen passes. This oxygen draws the low

pressure acetylene from an acetylene generator into a mixing chamber and gives it the necessary velocity to get a steady flame and the injector also helps to prevent backfiring.

Fig 3

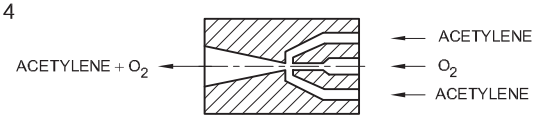


LOW PRESSURE BLOWPIPE

TW20N143043

The low pressure blow pipe is similar to the equal pressure blow pipe except that inside its body an injector with a very small (narrow) hole in its centre through which high pressure oxygen is passed. This high pressure oxygen while coming out of the injector creates a vaccuum in the mixing chamber and sucks the low pressure acetylene from the gas generator (Fig 4)

Fig 4



INJECTOR TYPE TORCH

TW20N143044

It is usual for the whole head to be interchangeable in this type, the head containing both the nozzle and injector. This is necessary, since there is a corresponding injector size for each nozzle.

The L.P. blowpipe is more expensive than the H.P. blowpipe but it can be used on a high pressure system, if required.

Care and maintenance

Welding tips made of copper may be damaged by careless handling.

Nozzles should never be dropped or used for moving or holding the work.

The nozzle seat and threads should be absolutely free from foreign matter in order to prevent any scoring/scratch on the fitting surfaces when tightening on assembly.

The nozzle orifice should only be cleaned with a tip cleaner specially designed for this purpose. (Fig 5, 6 & 7)

At frequent intervals the nozzle tip should be filed to remove any damage to the tip due to the excessive heat of the flame and the molten metal.

The inlet for acetylene has left hand thread and that for oxygen has right hand thread. Take care to fit the correct hose pipe with the blow pipe inlet. At frequent intervals, put off the flame and dip the blow pipe in cold water.

Fig 5

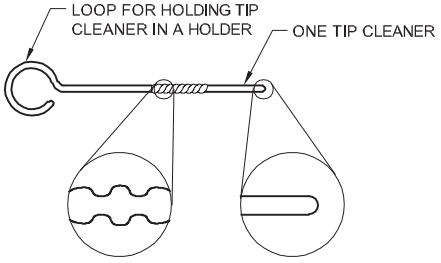


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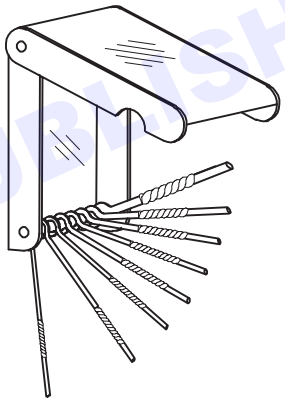
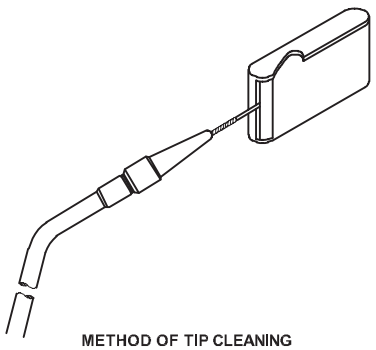
Fig 6



SET OF DIFFERENT SIZE TIP CLEANERS IN A HOLDER

TW20N143046

Fig 7



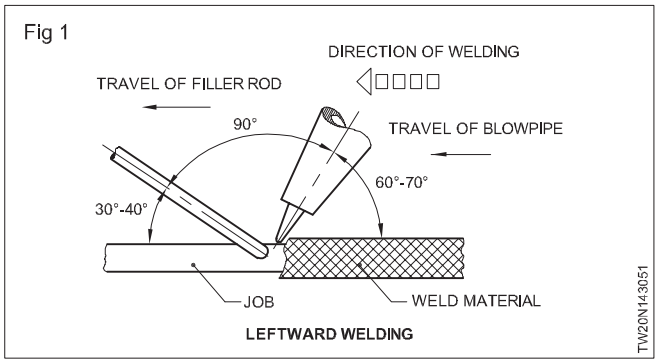
METHOD OF TIP CLEANING

TW20N143047

Leftward and rightward welding techniques

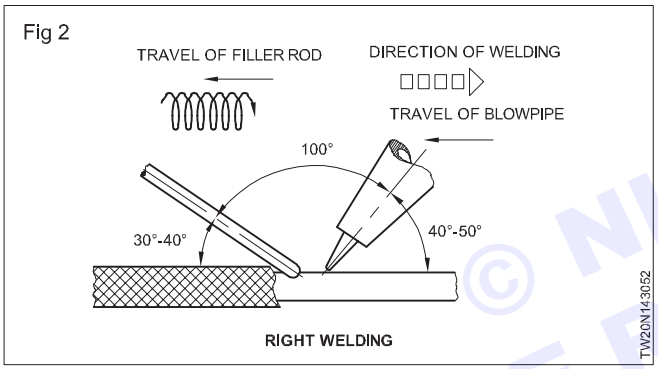
Objectives: At the end of this lesson you shall be able to
- **distinguish between the leftward and the rightward techniques**
- **state the application of the leftward and the rightward techniques.**

Leftward technique (Fig 1)



This is a technique of gas welding in which the welding is carried out from the right side to the left side of the joint.

Rightward technique (Fig 2)



The technique of gas welding in which the welding is carried out from the left side to the right side of the joint is known ad the rightward technique.

Characteristics of leftward and rightward techniques

In leftward technique:

- the flame is directed toward the unwelded part.
- the filler rod, if used, is directed toward the welded part of the joint.
- there less heat concentration for fusion, and hence, it is used for welding thin jobs.

In rightward technique

- the flame is directed toward the welded part.
- the filler rod is directed toward the unwelded part of the joint.
- there is more heat concentration for fusion, and hence, useful for welding thick jobs.

Blowpipe and filler rod angles

In the leftward, the blowpipe and filler rod angles are 60° and 30° respectively with the welding line.

In the rightward technique the blowpipe and filler rod angles are 50° and 40° respectively with the welding line.

Application

The leftward technique is used for welding steel having thickness upto 5mm and for welding of steel pipes.

The rightward technique is economical for welding thick steel plates as more heat is concentrated for fusion.

APPLICATION OF WELDING TECHNIQUES WITH DIFFERENT PARAMETERS

THICKNESS OF METAL	DIAMETER OF FILLER ROD (IN MM)	JOINT EDGE PREPARATION
LESS THAN 0.9 mm	UP TO 1.6 mm	1.2-1.6
0.9 mm TO 3.2 mm	1.6 TO 3.2 mm	FLANGED EDGE COUPLING 0.8-3.2
3.2 mm TO 5.0 mm	3.2 TO 4.0 mm	OPEN SQUARE BUTT 80° 1.6-3.2 SINGLE "V"BUTT
5.0 mm TO 8.2 mm	3.2 TO 4.0 mm	3.2-4
8.2mm 16.2 mm	4.0 TO 6.5 mm	60° 3.2-4
16.2 mm AND OVER	6.5 mm	60° 80° 3.2-4

TW20N143053

Purpose of root gap and tacking the job before welding

Objectives: At the end of this lesson you shall be able to
- **state the purpose of the root gap kept in the joint before welding**
- **state the purpose of tacking the job-pieces before welding.**

Root gap or root opening in welding joints

Before welding, the joining parts of the assembly are kept apart at some specific distance. (Fig 1)

Purpose

The purpose is to obtain the required depth of fusion or complete penetration to the entire depth of the joint during welding. (Fig 2)

Fig 1

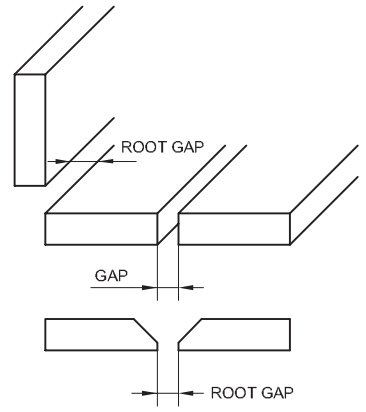
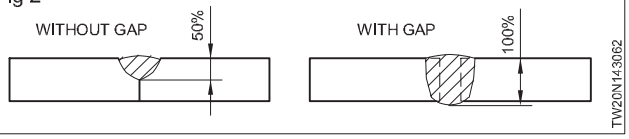


Fig 2



Tack welding the assembly

Small welds of short distance are used to assembly the joining pieces before welding. (Fig 3)

Purpose

The purpose of welding is to maintain the gap and alignment of the assembly for the desired depth of fusion and to control distortion during welding. (Fig 4)

Fig 3

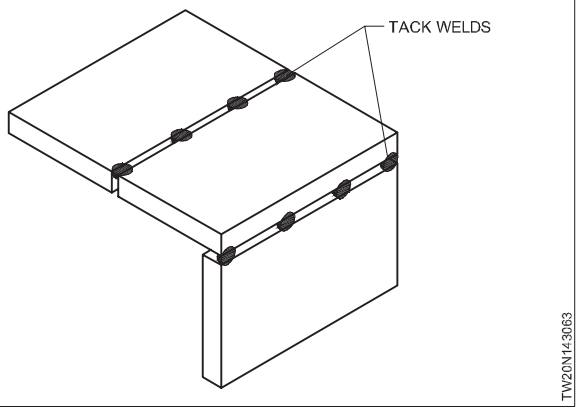
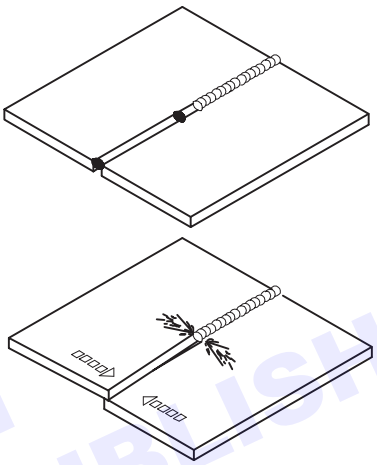


Fig 4



Carpentry hand tools measuring tools and work holding devices

Objective: At the end of this lesson you shall be able to
- **describe carpentry hand tools.**

Carpentry hand tools are listed as per the following

1 Marking and testing tools

(e.g) scriber, spirit level, try squares, marking gauge etc.,

2 Holding and supporting tools

(e.g) mitre box, work table, clamps etc.,

3 Measuring tools

(e.g) Foot rule, tape rule, caliper etc.,

4 Cutting tools

(e.g) saws, chisels etc.,

5 Planning tools

(e.g) Planes, spoke shave etc.

6 Boring tools

(e.g) Hand drill, auger, bits, twist bit, etc.,

7 Striking tools

(e.g), Hammers, mallet etc.,

8 Driving tools

(e.g), Screw driver, spanner's etc.,

9 Miscellaneous tools

(e.g) Punches, Pincer etc.,

10 Abrasion tools

(e.g), Files, oil stone etc.,

Classification and uses of marking, measuring and testing tools

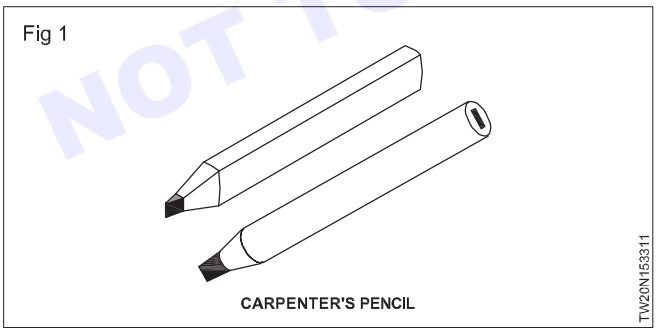
Objectives: At the end of this lesson you shall be able to
- **state the different type of marking, measuring and testing tools**
- **explain the use of marking tools**
- **brief constructional features of marking tools.**

Marking off or layout is carried out to indicate the location of operation to be done and provide guidance during sequence of operations.

– Marking out is done with pencil or scriber etc.,

Carpenter's pencil (Fig 1)

Fig 1



CARPENTER'S PENCIL

– Carpenter's pencil usually is an oval cross-section.

– It is sharpened with a chisel.

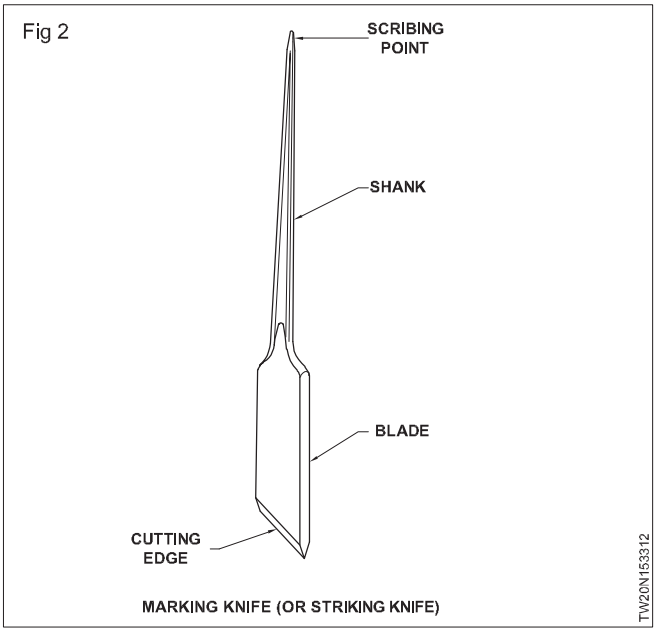
– The pencil is not used for an accurate work.

– Suitable pencil hardness for marking out on 'HB', 'H' and 'F'

Marking knife (Fig 2)

It is made of steel fashioned to a point at one end and a sharp blade at the other end to form a cutting edge. The blade or knife is used for marking cut lines where a vertical shoulder is to be cut with a saw or chisel. The point is used for marking distances and scribing lines.

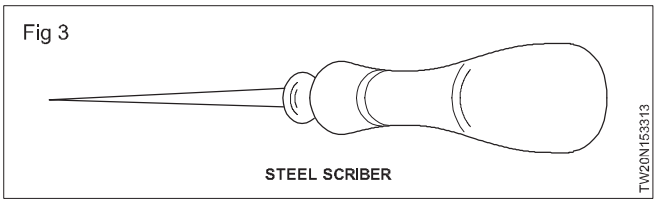
Fig 2



MARKING KNIFE (OR STRIKING KNIFE)

Steel scriber (Fig 3)

Fig 3



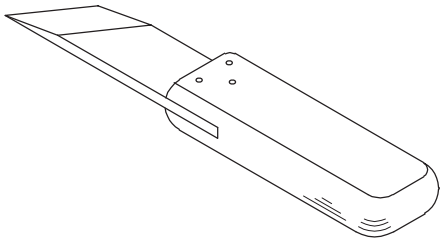
STEEL SCRIBER

A steel scriber should be sharp at its point. It is used for scribing lines on which a chisel cut or a saw cut is made.

The scriber should not be used as an awl. Do not strike the handle with a hammer.

Marking knife is also used for marking and scribing .It is a steel blade fixed in a wooden handle. it serves the same purpose as that of scriber. (Fig 4)

Fig 4

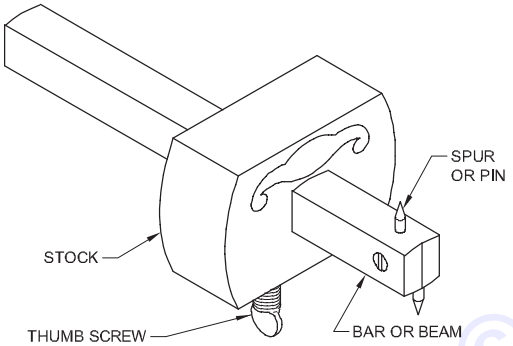


MARKING KNIFE

TW20N153314

Marking gauge (Fig 5)

Fig 5



TW20N153315

Making gauge is used for marking lines parallel to a face and edge (e.g) gauging width and thickness.

The marking gauge can be made of wood or steel. The gauge consists of square, wooden bar or beam on which wooden block or stock is sliding. This block can be fastened at any required measurement by use of a thumb screw.

In better form of gauges the stock is protected from wear by a piece of brass set flush with surface. The bar is graduated in millimeter and provided with a spur or steel point at the end. It is always advisable to measure the distance from the spur to the face of the block, with an 'ordinary rule'.

The gauge is set by loosing the screw and the stock is shifted to the distance required from the spur. Measurement are taken from a rule.

After setting the screw is tightened while gauging the stock is firmly help against the wood and pushed in forward direction. (Fig 6)

Mortise gauge (Fig 7)

A mortise gauge is a making gauge with two spurs. The two spurs can be spaced at different distances and mark two parallel lines at a time.

This is made of hard wood and has an adjusting screw in the end of the beam.

Fig 6

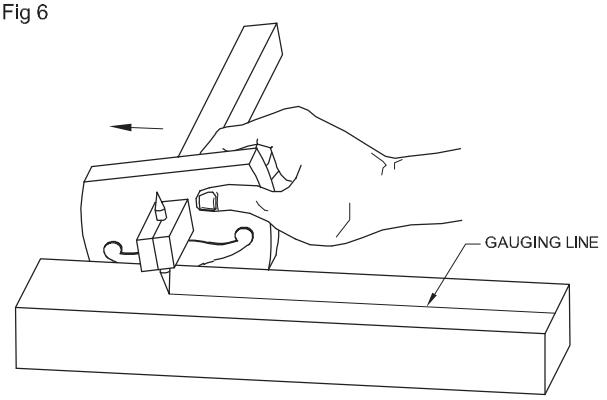


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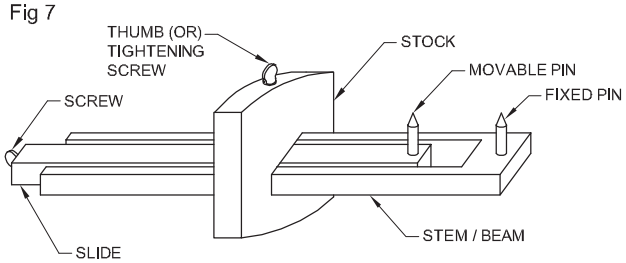
Fig 7



MORTISE GAUGE

TW20N153317

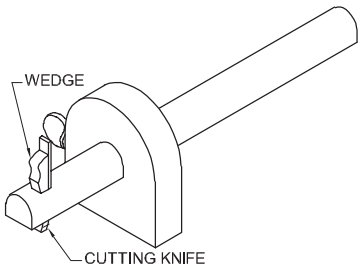
The screw moves one of the spurs up and down or as desired. The other side of the beam is fitted with a single point as no the ordinary marking gauge.

The gauge is used for marking mortises and tenons, and similar joints using parallel lines.

Stem/beam and stock made of beech wood. Thumb screw made of box wood. Pin or spur made of steel.

Cutting gauge (Fig 8)

Fig 8



CUTTING GAUGE

TW20N153318

This is just the construction of a marking gauge.

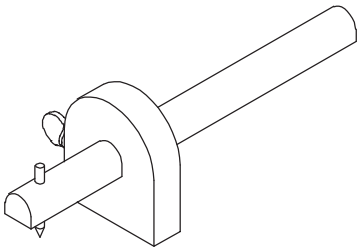
At the end of the stem scribing knife is fixed with aid of one wedge. By loosening the wedge, the length of knife may be increased or decreased. In broad planks scribing marks can be marked with this gauge.

Deep marks can be scribed with this cutting gauge for making grooves, rebates and dovetails. It is possible to cut thin strips of timber and plywood upto 3mm thick.

Panel gauge (Fig 9)

This is just like single marking gauge but the stem and stock are long. The length of stem is 450mm. In planks longer than 150mm scribing marks are made with the panel gauge.

Fig 9

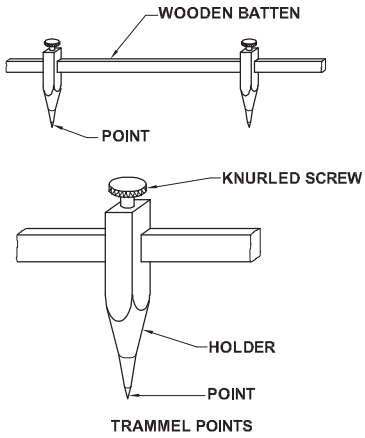


PANEL GAUGE

TW20N153319

Trammel points (Fig 10)

Fig 10



TRAMMEL POINTS

TW20N15331A

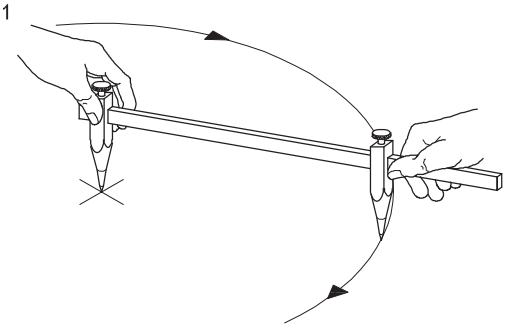
Trammel points are used for laying out larger circles and arcs.

Two sliding points are fastened to a wooden batten or a steel rod at any distance required from each other by turning the knurled screw. The point is fastened to the batten or steel rod.

Sometimes one of the points can be replaced by a pencil lead. (Fig 11)

Wing compass: If consists of a pair of dividers (legs) made of steel.

Fig 11



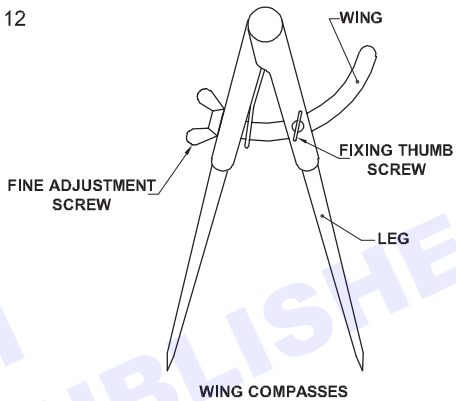
USING THE TRAMMEL POINT

TW20N15331B

The legs are sharpened to points and at the top they are riveted or screwed.

They are fixed at the required radius by means of a set screw. (Fig 12)

Fig 12



WING COMPASSES

TW20N15331C

Uses

1 For setting out arcs of circles.
2 To transfer the measurement from the steel rule to the job.
3 To mark curves.

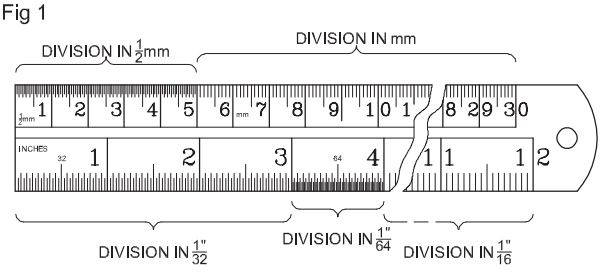
Measuring and testing tools

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

- **state the different types of measuring and testing tools**
- **explain the use of measuring and testing tools**
- **brief the constructional and features of measuring and testing tools.**

The rule (Steel) (Fig 1)

Fig 1



METAL (STEEL) BENCH RULE

TW20N153321

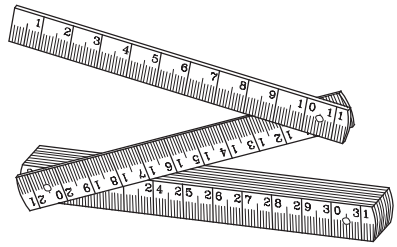
- In the workshop wooden or steel rules are used
- The division in cm is 30cm long and sub divided in mm (2) and half mm (3).
- The division in inches is 12 inches (12”) long twelve inches equals one English foot 12” = 1’
- The Sub division is accurate in 1/16” (4) in 1/32” (5) and In 1/64” (6).
- For the conversion of parts of an Inch in to the metric system (with units: m, cm, mm) a conversion table might be useful.

1/16”	=			1.6 mm
2/16”	=	1/8”	=	3.2 mm
3/16”	=			4.8 mm
4/16”	=	1/4”	=	6.35mm
5/16”	=			8.0mm
6/16”	=	3/8”		9.5mm
7/16”	=			11.1mm
8/16”	=	1/2”	=	12.7mm

9/16”	=			14.3mm
10/16”	=	5/8”	=	15.9mm
11/16”	=		=	17.5mm
12/16”	=	3/4”	=	19.05mm
13/16”	=		=	20.6mm
14/16”	=	7/8”	=	22.2mm
15/16”	=		=	23.8mm
16/16”	=	1”	=	25.4mm

Collapsible carpenter’s rule (Zig-zag) (Fig 2)

Fig 2



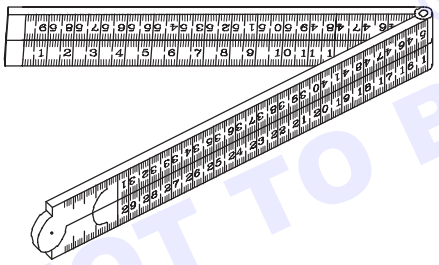
TW20N153322

It is also called Zig-Zag rule. It consists of 10 pieces each loosely riveted to one another. Each piece is 10cm long and total length is 1 metre.

Longer distances can be measured with this rule. Some times it contains British system measurements on the other side.

Folding rule (Foot rule) (Fig 3)

Fig 3

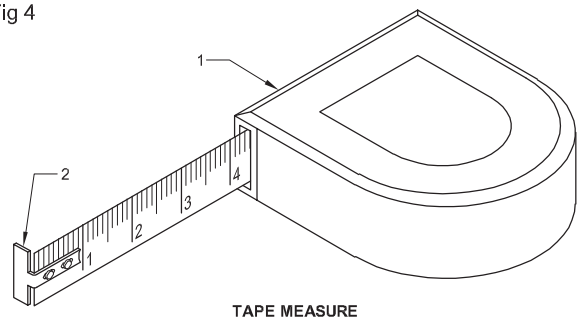


TW20N153323

It is also called foot rule. It has four folds each of which is 6 inches or 150mm long. It is joined in a plastic a metallic hinge. After taking measurement, keep the scale folded and free from dust. It is easily carried in packets. Metal clip is provide at the end of this rule to avoid wear and tear.

Tape measurement rule (Fig 4)

Fig 4



TW20N153324

Tape measures are used for longer measurements. The tape is made of steel and is durable and accurate. When not in use, the tape should be kept in the box. Division are made in centimeters or in inches.

Tape measure has a sliding end piece for inside and outside measurement.

Calipers

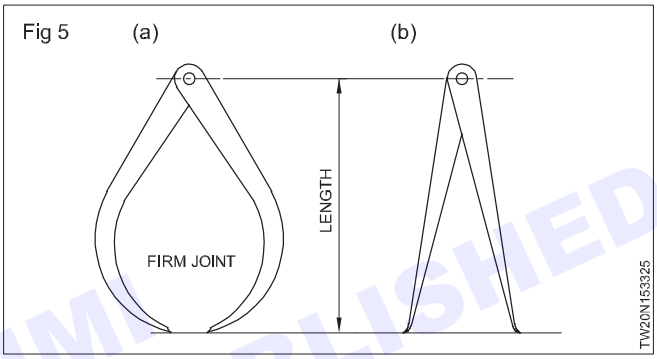
Calipers are simple measuring instruments used to transfer measurements from a steel rule to objects, and vice versa.

Calipers are of different types depending on the type of the joint and the shape of the leg.

Types of Joints: The commonly used calipers are firm joint calipers and spring joint calipers.

Firm joint calipers (Fig 5a & 5b)

Fig 5



TW20N153325

In the case of firm joint calipers, both legs are pivoted at one end. To take measurements of a workpiece, the caliper is opened roughly to the required size. Fine setting is done by tapping the caliper lightly on a wooden surface.

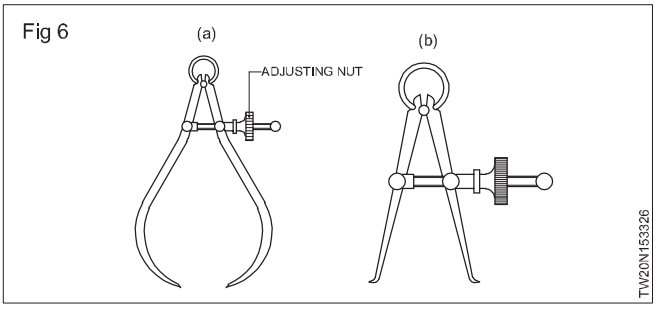
Types of calipers

Outside and inside calipers are differentiated by the shape of the legs.

Calipers used for outside measurements are known as outside calipers. The calipers used for internal measurements are known as inside calipers.

Spring joint calipers (Fig 6a & 6b)

Fig 6



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For this type of calipers, the legs are assembled by means of a pivot loaded with a spring. For opening and closing the caliper legs, a screw and nut are provided.

Spring joint calipers have the advantage of quick setting. The setting made will not change unless the nut is turned. The size of a caliper is specified by its length, which is the distance between the pivot centre and the tip of the leg.

The accuracy of the measurement taken depends very much on the sense of 'feel' or 'touch' while measuring the job. You should get the feel when the legs are just touching the surface.

Try square

The try square is a precision instrument.

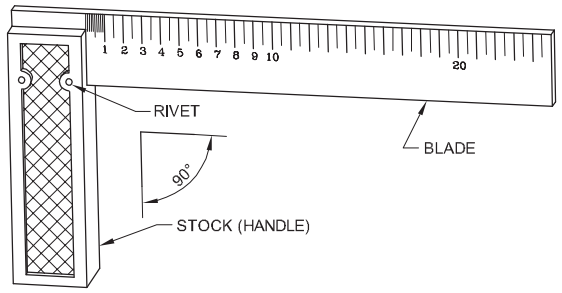
– Which is used to check squareness of a surface.

– the accuracy of measurements by a try square about 0.002mm per 100mm length.

– Which is accurate enough for most work shop purposes.

– The blade is fixed to the stock at 90°. (Fig 7)

Fig 7



Uses

The try square is used

– To check the flatness of the surface.

– To check the squareness of edge.

– To check the inside squareness.

– The blade of try squares are made of hardened steel.

– The stock is made of seasoned hard wood or cast iron, mild steel and aluminium.

– If it is made of wood it must be well seasoned timber.

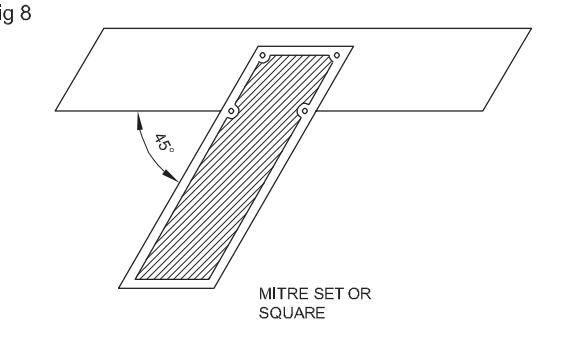
– To prevent the wooden stock from wearing a brass plate is fixed to the inside edge.

– The try squares are specified according to their blade lengths.

– Try square blade lengths are available in 100,150,200,250mm and 300mm.

Mitre square (Fig 8)

Fig 8



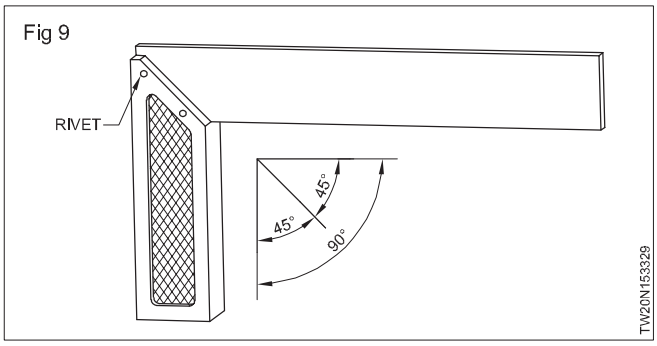
– To mark 45° and to test 45° by mitre square is used at the end of its stock and at the cutting of the blade. It is fixed permanently by rivets, the length of its blade is 200mm to 350mm. There are graduations on its blade.

– The only difference between try square and mitre square is that the blade and stock are fixed at 90° in the try square and 45° in the mitre square.

Try and mitre square

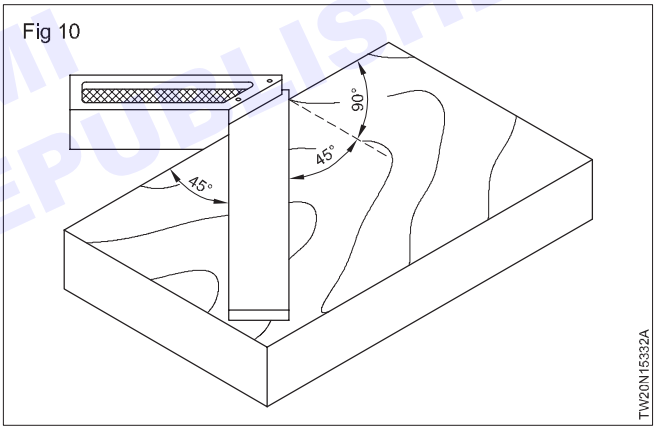
– The try square and mitre square is also useful for angle 45°,90° and 135° (Fig 9)

Fig 9



– The try and mitre square is useful for setting out mitres at 45 testing chamfers and other work 45° or 135°. (Fig 10)

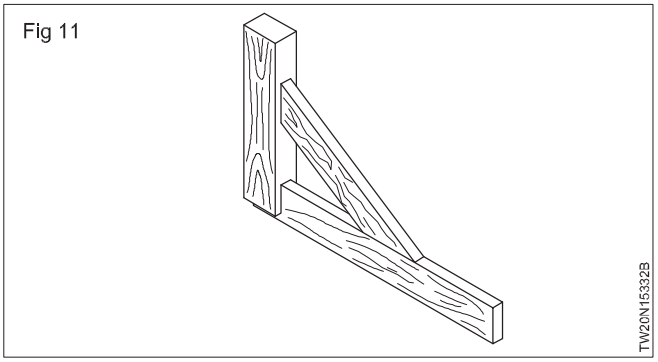
Fig 10



– The blade is permanently fixed so the stock is at an the length of the blade which is 200mm to 350mm.

Wooden try square (Fig 11)

Fig 11



The try square is fully made of wood. Its handle is slightly heavier than blade. The length of blade is 600mm (24") and width is 50mm (2"). The length of the handle is 400mm some times up to the length of 450mm.

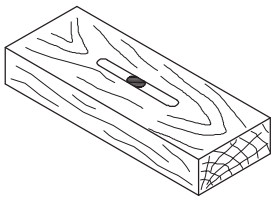
Without changing the angle 90° the handle and the blade are diagonally attached, by a brace. angle of wooden try square is 90°.

Uses

This is used for carpentry works and for building construction works. Large and wide planks are used to scribe the works.

Spirit level (Fig 12): A spirit level is used principally by the carpenter. It consists of a piece of wood (common wood for spirit level is Teak wood) or aluminum into which a spirit level glass is fastened horizontally and vertically. As the glass tube is not filled, a bubble always remains, when the bubble is in the centre of glass indicated by lines marked on it, the structure on which the level rests is absolutely horizontal or vertical.

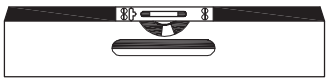
Fig 12



TW20N15332C

In some spirit level there will be two glass tubes perpendicular to the horizontal glass tube. This will be called as plumb glass and is used to test the perpendicularly of walls and windows. (Fig 13)

Fig 13



CARPENTER LEVEL

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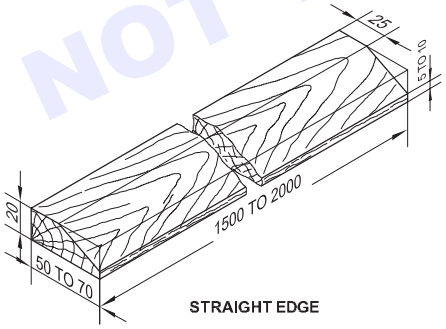
Straight edge (Fig 14): Straight edge made of steel or wood with perfectly straight parallel edges, although some times has only one straight edge.

Fig 14



STRAIGHT EDGE

TW20N15332E

Uses: For testing the straightness of surface and edges.

Its length is 1500mm to 2000mm breadth 50mm to 70mm and thickness 20mm.

'T' bevel or bevel square

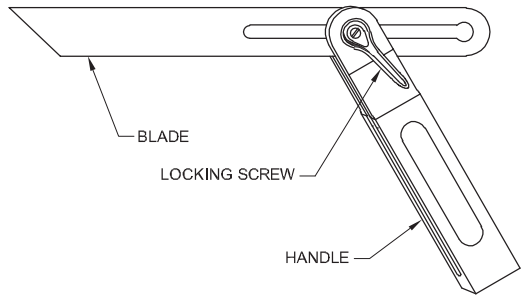
The T- bevel is used to test and transfer angles other than right angles. The bevel is called sliding bevel because it has an adjustable sliding blade. The blade may be locked by a wing nut or set screw.

The required angle is set from a straight edge and the degrees are measured against a protractor.

Uses

The sliding bevel is used for laying out dovetails, side rails for chairs, chamfers, bevels and for transferring angles from the drawing to the work piece. The Parts of the bevel square. (Fig 15)

Fig 15



T BEVELS

TW20N15332F

Handle: Handle is made of hard wood, cast iron and aluminum. The top edge is half rounded and there is a slot to fix the bevel square.

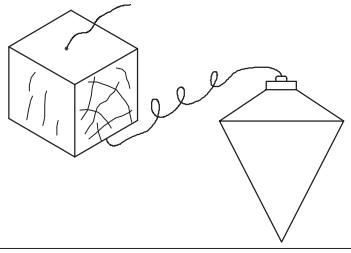
Blade: One edge of the blade is half rounded and their other edge is cut at 45°. There is a longitudinal slot. The handle is fitted with the wing nut in the slot or with a machine screw. The slotted blade passes through a slot in the stock.

On loosening the wing nut the blade can be shifted to any angle. And also the blade can be extended for further length if necessary.

Locking nut: This may be a wing nut or a set screw used for loosening or tightening the blade.

Plumb bob (Fig 16): This tool consists of a solid brass or metal cylinder with a pointed end which is attached to a suspending line so that its tip always pointing vertically down. Its upper part is small wooden block with a hole drilled in its centre so that the line with the cylinder on it can be pulled up on lowered down through the hole.

Fig 16



TW20N15332G

The diameter of the wooden block is slightly greater than the diameter of cylinder so that the cylinder can move freely up and down without touching the work piece.

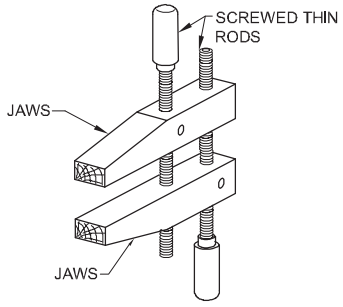
The main use of the plumb bob is a more accurate replacement for the vertical spirit level and also to transfer points down vertically in marking.

Work holding devices

Objectives: At the end of this lesson you shall be able to
- **explain the uses of hand screw**
- **state the uses of bar clamp or 'C' clamp**
- **brief the uses of bench hold fast and the cleat.**

Hand screw (Fig 1)

Fig 1



HAND SCREW

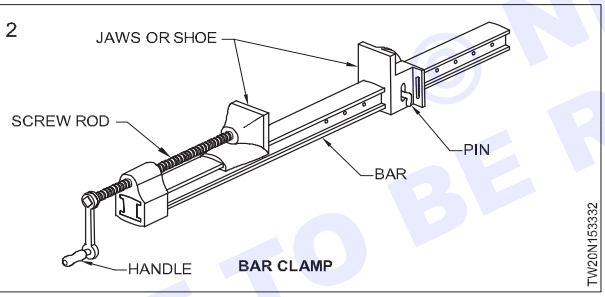
The hand screw is a clamp consisting of a pair of jaws. This is made of either in steel or wood.

It has two jaws one in left and the other in right side. Both the jaws are connected by two screwed thin rods, as shown in figure. Both the screws are to be screwed equally when clamping the job.

This is useful for small jobs and in gluing works.

Bar clamp (Fig 2)

Fig 2



BAR CLAMP

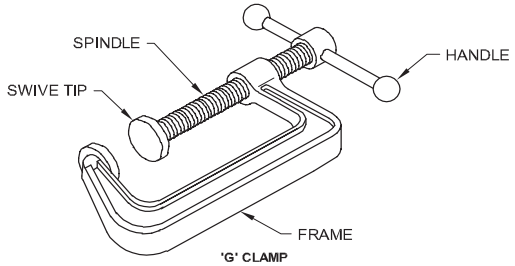
Steel bar clamps are used generally in pairs for gluing purposes. The bar may be of rectangular or 'T' shape.

T-bar clamps are heavier. Extra pressure can be applied to the job by this device. It has two sliding shoes. One shoe is attached to the screw rod and the other is pinned where it is necessary. The screw rod has a strong square thread. These are used for clamping up wide works and large frames.

T-clamps are available in clamping capacity of 160mm to 2500mm.

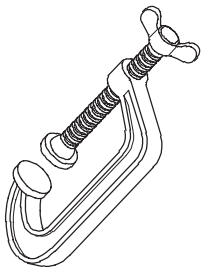
'G' or 'C' clamp (Fig 3 & 4)

Fig 3



'G' CLAMP

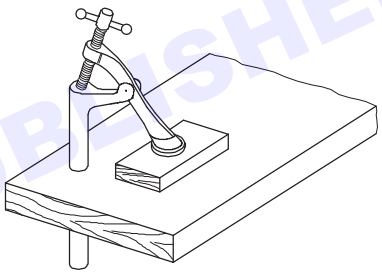
Fig 4



These are frequently used for smaller jobs and where the two hands are employed clamps have 'H' section iron and resists any tendency to distortion. The screw has a strong square thread and a round shoe on a ball which is socked joint in addition to the above there are several other clamps such as Corner clamp, Rope clamp, Flexible band clamps, Wooden gluing device etc.

Bench hold fast (Fig 5)

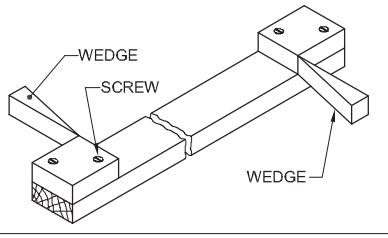
Fig 5



In wooden planks to make holes the planks are help tightly without moving by this equipment. The stem is made of cast iron, screw rod, handle, hand one made of steel. This may be fixed in holes of the work table and planks can be tightened.

The cleat (Fig 6)

Fig 6



This is made of hard wood. This is 50mm longer than the plank to be tightened. Along with this two wooden pieces are screwed on both the ends.

The wood to be placed and tightened is kept in between the wooden pieces and the wedges are tightly inserted. The plank to be lightened is now tightly held.

Bench vice, work bench - clamps types sizes - uses- safety methods

Objectives: At the end of this lesson you shall be able to
- **state the constructional features various types of bench vices**
- **explain the uses quick release vice and saw vice**
- **brief the uses of bench vice.**

Wood must be held steadily. If it is to be accurately sawn, chiselled and planed.

- For this reason carpenter's work bench consist different types of vice.
- Most commonly fitted bench vice consist of two metal Jaws to hold the work
- One Jaw of the vice is fixed to the work bench
- The other Jaw is movable parallel to the fixed jaw
- To operate this there is a threaded shaft and a handle.
- Two wooden blocks are used inside the Jaws to protect the work from damage

There are three types of vice

1 Quick release vice (or) wood worker's vice.

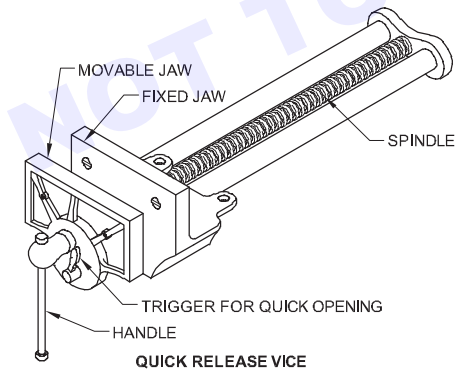
2 Saw vice

3 Bench vice

Quick release vice

- In the quick release vice moveable jaw is quickly released and get clamped with fixed Jaw.
- A box nut is provided in its threaded shafts for the quick release system (Fig 1).

Fig 1



- The jaw is made of cast iron.
- The threaded shaft is made of steel.
- The vice is specified by the width of the Jaw.

Precautions

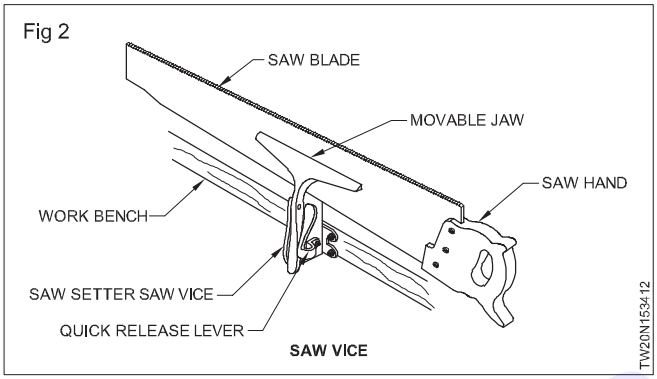
1 Vices should not be used as ANVIL.

2 The thread shaft and box nut should lubricated.

3 The handles should not be hammered to tighten the jaw.

Saw vice (Fig 2)

Fig 2



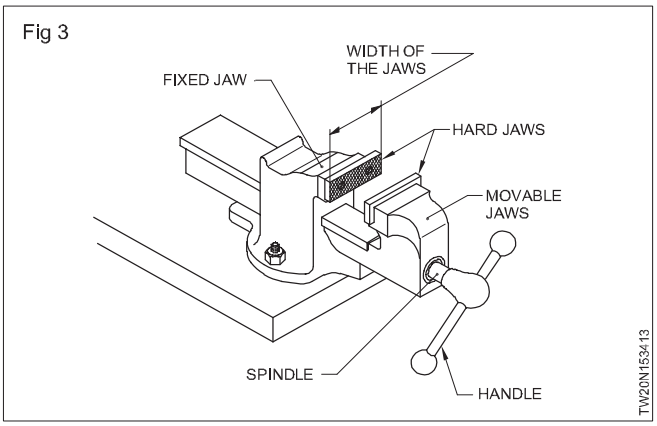
- It is made of wood or steel the Jaws are long enough to hold the saws while sharpening as teeth.
- The Jaws are hinged so as to make ways to close and open the Jaw.
- It is not useful for any other kind of works.

Purpose of saw vice

- The sharpening of saw teeth the shaping of saw teeth and setting of teeth are done with the aid of this vice
- The Jaws of the saw clamp , should grip the saw 2-3 mm below gullet teeth.

Bench vice (Fig 3)

Fig 3



Vice 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.

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

Work bench

Objectives: At the end of this lesson you shall be able to
- **state construction feature of work bench**
- **explain the uses of work bench.**

Work bench (Fig 1)

It is a heavy table of rigid construction made of hard wood. Two or four carpenters vices are fitted on the opposite sides to hold the jobs. One jaw of the vice is secured to the table and the other is kept movable.

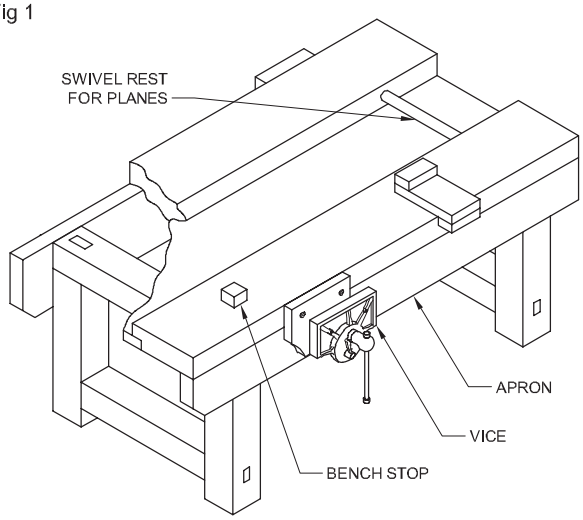
Shelves or racks can also be provided on the table.

The length is 120cm to 180cm and width 90cm for single man work bench and the width is 120 cm for double man work bench.

The bench is mostly useful to cut and saw the woods, to plane the woods, ripping tenons, chiselling out wastes and for all other wood working purposes.

The tool well is in the middle for the work bench and is slightly in lower level to accommodate the working tools.

Fig 1



WORK BENCH

Plane types - setting sharpening - uses etc.,

Objectives: At the end of this lesson you shall be able to
- **name the various types of planes**
- **state the uses of the various planes**
- **state constructional feature of various planes**
- **specify the planes.**

A plane is a hand tool used for smoothing or shaping pieces of wood.

Common types are

1 Jackplane

2 Smoothing plane

3 Trying plane

4 Toothing plane

5 Finishing plane

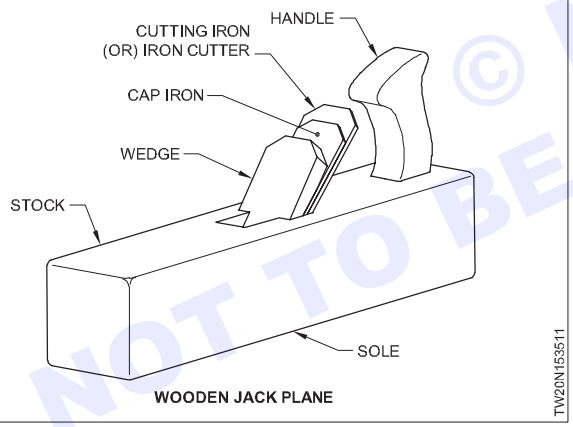
6 Router plane

7 Plough plane

8 Adjustable metal jack plane.

1 Jack plane (Fig 1)

Fig 1



WOODEN JACK PLANE

This plane is used for planing the job to size quickly and truly. Stock is made of wood or steel. Handle is fixed behind the cutting iron.

The size is 375 mm x 66mm x 47mm. The angle of cutting iron is 45° and the cutting iron is sharpened in a curve. The mouth of the plane is big enough to accommodate thicker wood shavings. The cutting iron further projects outside than in other planes.

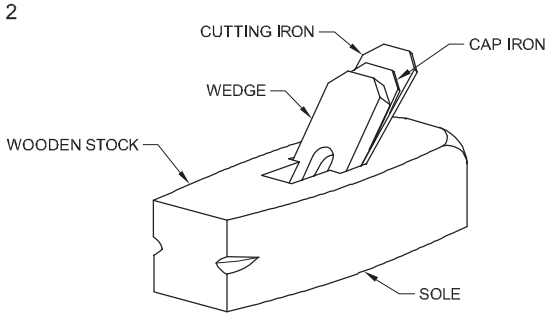
2 Smoothing plane (Fig 2): This is used when the surface has to be planed further to smoothness.

– The size is 240 x 66 x 65mm

– The width of cutting iron is 48mm

– The cutting edge is sharpened slightly oval across the iron. The angle of the cutting iron is 30°. The wooden smoothing plane has no handle.

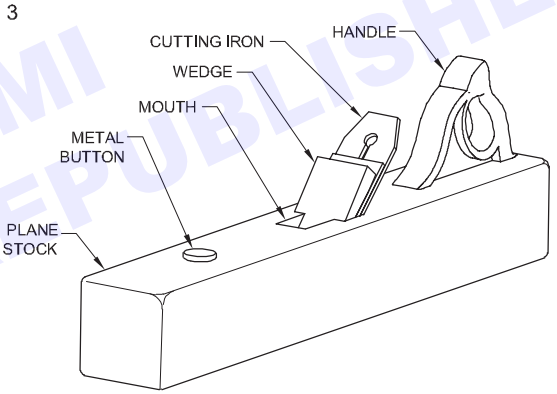
Fig 2



SMOOTHING PLANE

3 Trying plane (Fig 3)

Fig 3

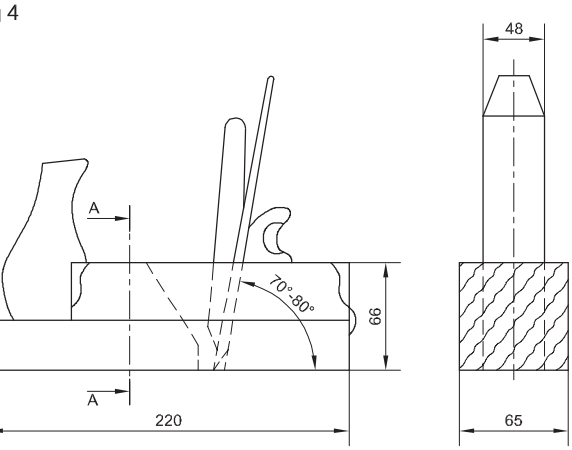


TRYING PLANE

It is larger and longer than other planes. Its length is 600 to 700mm. The blade is 46 to 56mm wide. It has double iron. This is used for producing a true and straight surface. The handle of wooden stock is usually of the closed type.

4 Toothing plane (Fig 4)

Fig 4

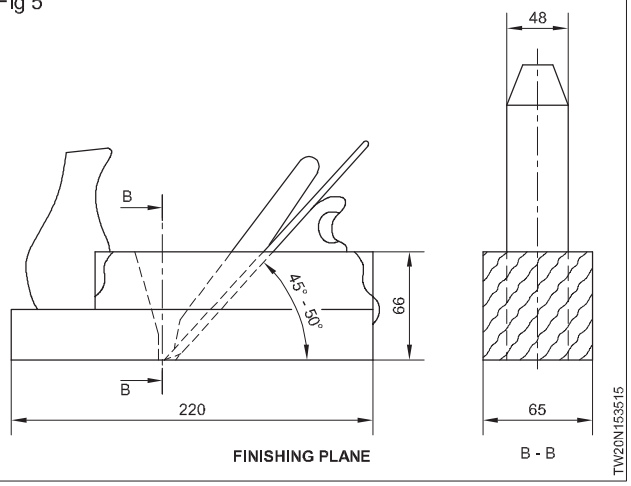


TOOTHING PLANE
SECTION A - A

The purpose of this is to prepare a rough gluing surface. The cutting angle is set at 70° to 80°. The cutting edge is a series of teeth formed like 'V'. The plane is used diagonally across the work in both directions and in along the grain.

5 Furnishing plane/Finishing plane (Fig 5)

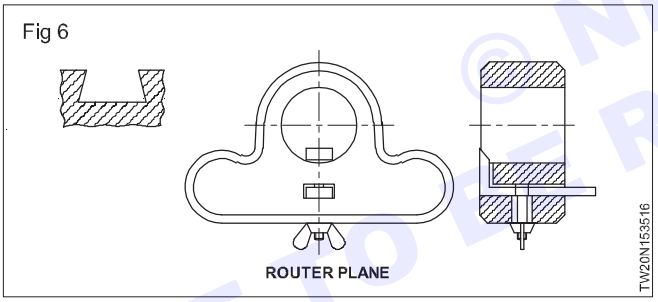
Fig 5



This is slightly smaller than smoothing plane. Its cutting angle is 45 to 50°. It prevents the tearing of wood and gives a good finish. This is also called reform-finishing planes.

6 Router planes (Fig 6)

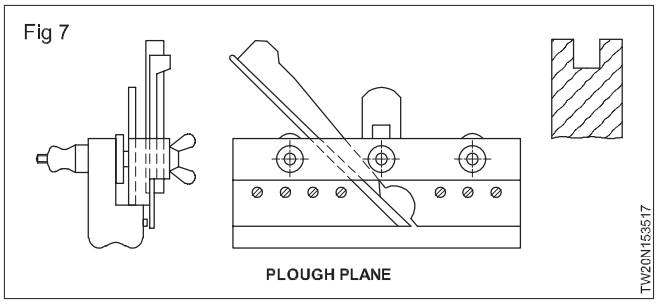
Fig 6



It is used to clean and level grooves and recesses. It is used across the grain. The cutting iron is lowered after each cut until required depth is reached.

7 Plough plane (Fig 7)

Fig 7



This is used to form grooves parallel with grain. The cutting-irons are available from 3mm to 16mm wide. It has no cap iron. The depth of groove can be adjusted by a thumb screw. A guide parallel to the plane controls the distance of the groove from the edge of the work.

8 Adjustable metal jack plane (Fig 8 & 9)

Fig 8

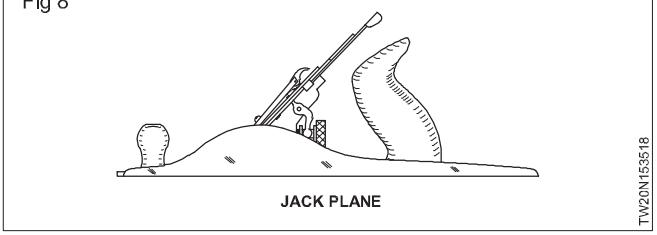
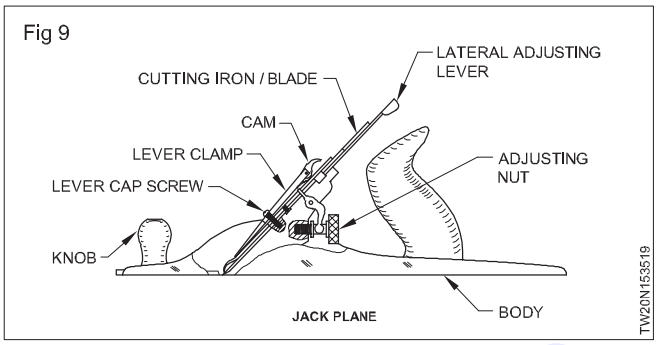


Fig 9



- This is just like wooden jack plane but the cutting iron adjustable.
- This plane is used for planing of timber to bring the size nearer to the required measurements.
- The size is body length 360mm and cutter width 50mm.

These parts are made of different materials as listed below.

Body	- Cast iron
Handle	- Rose wood
Knob	- Rose wood
Cutting iron/blade	- Tungsten steel
All other parts	- Metal

Advantages of adjustable metal bench plane

- Easier to use than wood plane owing to low position of handle.
- Simple adjustments by means of adjustment screw and lateral adjustment lever.
- Cutting iron thinner speeding up grinding and sharpening.
- Body retains shape little wear.

A smear oil or wax on the sole of the plane reduces friction and makes planing easier.

Setting up the jack plane blade

Objectives : At the end of this lesson you shall be able to
- **explain about sharpening of the jack plane.**

Setting a jack plane blade: A jack plane is used to plane the wood to the required dimensions with smooth surface finish.

Setting and adjusting the plane blade is necessary for even and uniform cuts while planing.

Step in setting: The two steps in setting the plane blade are:

– Setting the plane blade to the required depth of cut

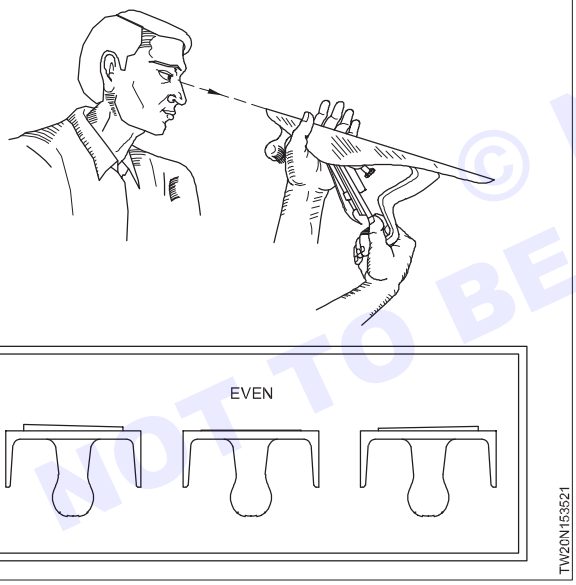
– Adjusting the cutting edge of the plane blade parallel to the plane sole or bottom face.

Setting the plane blade to the required depth of cut

Hold the plane in the left hand keeping the sole of the plane in line with your sight at a convenient distance.

Turn the adjusting nut in an anticlockwise direction to the required depth of cut until the cutting edge of the blade projects above the sole or bottom face of the plane. (Fig 1)

Fig 1



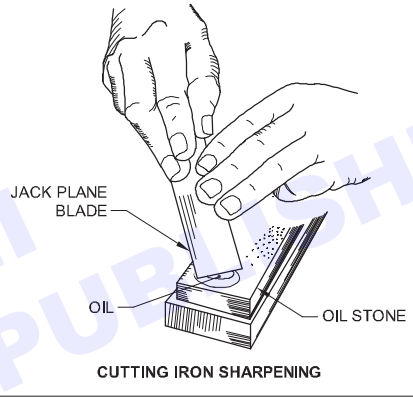
Adjust the plane blade parallel to the sole of the plane: Check whether the cutting edge of the blade is parallel to the bottom face of the plane. If not, move the adjusting lever gently to the left or right until it is parallel.

While setting the plane blade, face the source of light. For protection of the cutting edge of the blade, with draw the plane blade into the plane before keeping the jack plane in the tool kit.

Sharpening of plane blade/cutter: Sharpening of a plane blade or cutter is necessary to produce a keen cutting edge for good surface finish, and perfect planing with minimum effort.

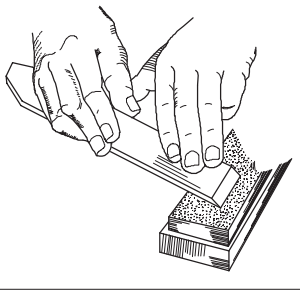
Sharpening and honing: The process of sharpening is carried out on oilstone by rubbing the blade with its bevel down, maintaining a constant and correct angle,25° to 30°. This rubbing is continued until a burr or wire edge is produced. (Fig 2)

Fig 2



The burr is removed by rubbing the back of the flat face of the plane blade on the oilstone, keeping its bevel up. (Fig 3)

Fig 3



During sharpening, oil is used to minimise the heat caused due to friction and to float off the metal particles from the pores of the oilstone so as to prevent clogging of the oilstone.

Different types of saws - saw setting - types

Objectives: At the end of this lesson you shall be able to
- **state the various types of saws**
- **brief the specific uses of straight cutting saws.**

There are several types of saws for cutting wood. some are used to make straight cuts and others are used make curved cuts. As its name suggests, a cross cut saw is used cut wood perpendicular or at an angle to the wood grain.

Types of saw

1 Straight cutting saws

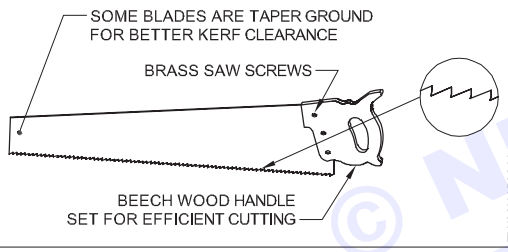
2 Curve cutting saws (or) special saws.

Straight cutting saws

1	Rip saw	2	Cross cut saw
3	Hand saw	4	Panel saw
5	Tenon saw	6	Dove tail saw

Rip saw (Fig 1)

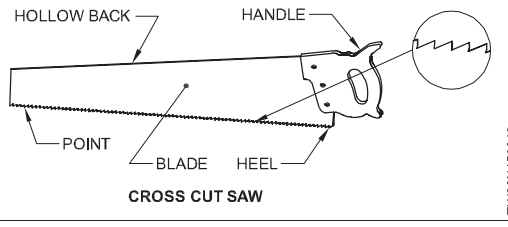
Fig 1



- Blade is made of thin spring steel.
- Used for sawing along the grain
- Blade is fixed to the wooden handle by riveting or screwing
- Teeth of rip saw vary in size as per the need of the fitness of work to be done
- Handle is made of beech (or) apple wood
- It has two teeth per centimetre length
- length of the blade is 60 to 70cm
- Specified by its length
- Teeth angle is less than 90°
- It has 3 to 6 teeth per 25mm.

Cross cut saw (Fig 2)

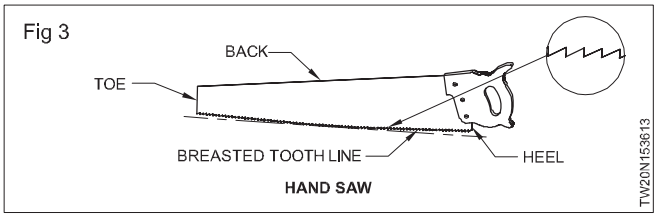
Fig 2



- Used for cutting across the grains of timber
- Length of blade is 56 to 70cm
- It has 5 to 9 teeth per 25mm
- Teeth cutting angle 90°.
- Teeth has different shape to that of rip saw
- Finer pitch blade is preferred for hard wood. Blade with course pitch is used for soft wood.

Hand saw (Fig 3)

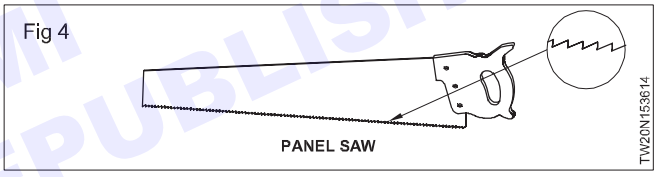
Fig 3



- Length of the blade is less in hand saw than in the rip saw.
- Which is used for lighter work.

Panel saw (Fig 4)

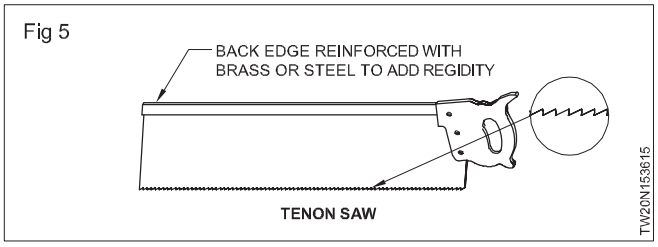
Fig 4



It is the most commonly used saw
- It is available in many sizes
- It has 10 to 12 teeth per 25mm
- length is 50cms
- Specifically used for cutting panels for door shutters.

Tenon saw (Fig 5)

Fig 5



- It is rectangular in shape
- Length is 25 to 40cm long
- It has 12 to 14 teeth per 25mm.
- It is used for finer works like tenon
- Main use is making short and straight cuts
- A reinforcing strip on back is provided at the top to avoid bending of blade.
- Closed handle.

Dove tail saw (Fig 6)

- By appearance is like tenon saw
- Its blade is thinner and narrower

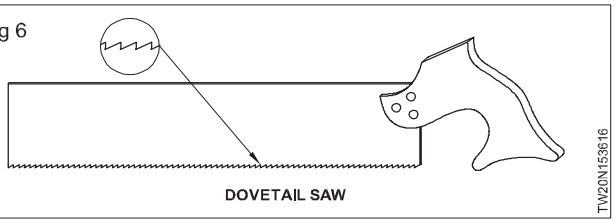
– Its wooden handle is open and free to move to full length of blade

– It is used for finer work

– Specifically used for cutting tongues for dove tail joints

– Length of blades is 20 to 30cm and carries 6 points/cm.

Fig 6



DOVETAIL SAW

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Types of special saw and its uses

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

- **state the various type of special saws**
- **explain the specific uses of special saws.**

Curve cutting Saw (or) special saws

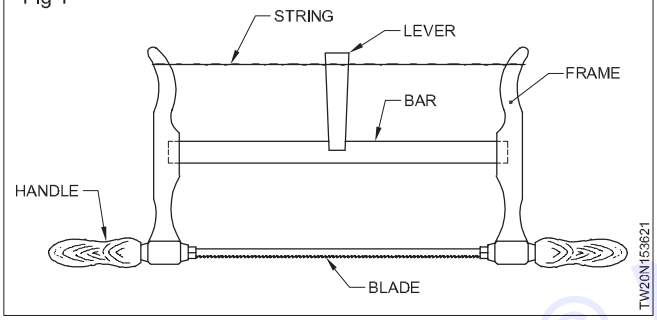
1 Bow saw 2 Coping saw

3 Fret saw 4 Compass saw

5 Nest saw 6 Key hole saw

Bow saw (Fig 1)

Fig 1



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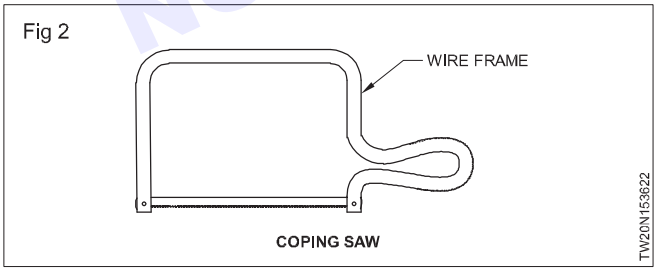
– It consists of frame made of wood, carrying, connecting bar a string ,lever and two handles on both sides

– Used to cut thin curves and profiles having quick bends

– Length of blades 20 to 30 cm and carries 6 points /cm.

Coping saw (Fig 2)

Fig 2



COPING SAW

TW20N153622

– Has very fine blade held in stiff wire frame

– Used for cutting sharp and quick curves internal and externally

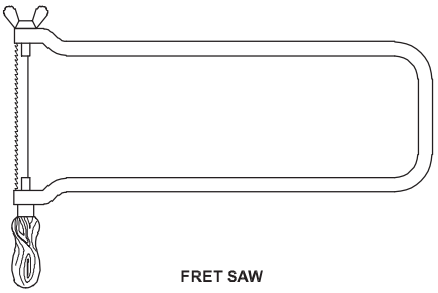
– Length of blade is 25cm.

Fret saw (Fig 3)

– Has very fine blade 150mm to 180mm long help in a steel frame of 300mm to 500mm.

– Used for cutting thin woods.

Fig 3



FRET SAW

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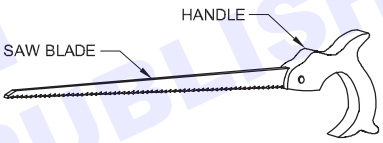
Compass saw (Fig 4)

Fig 4



COMPASS SAW

TW20N153624

– Has a narrow tapering blade 300mm to 450mm fitted in a handle..

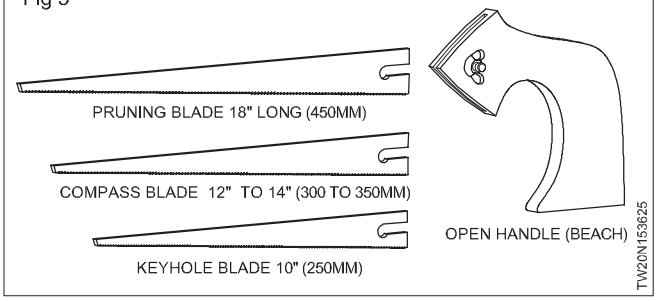
– Used for cutting large interior curves

– It is necessary to bore a hole in the job to start the saw

– 8 to 12 teeth per 2.5cm length.

Nest of saw (Fig 5)

Fig 5



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– It consists of three blades with detachable handles

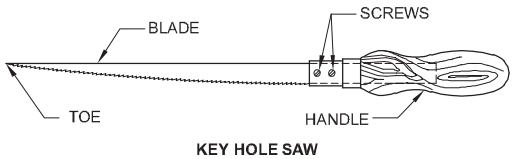
– The blades are pruning blade, compass blade and key way hole blade, which are used cutting curve

– Length of blade is 25 to 40cm.

Key hole saw (Fig 6)

- It has 20 to 30cm long blade
- It is 6mm wide near handle and 3mm wide at the toe
- Used for intricate and internal works
- Length of blade is 25 to 35cm.

Fig 6



KEY HOLE SAW

Saw sharpening and re-sharpening tools

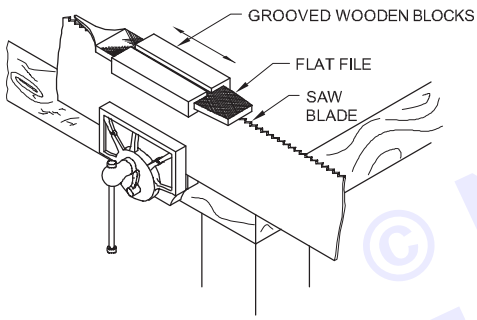
Objectives: At the end of this lesson you shall be able to
- **describe the steps involved in 'sharpening and setting' of the saw teeth**
- **state the sharpening tools.**

To perform the sawing operations with ease and accuracy the saw must be in good condition with its teeth sharpened and well set.

Sharpening of a saw involves 4 steps which are as follows.

Topping: This is done to bring down the points of all the teeth to the same level. A flat file is held in a wooden block and rubbed over the teeth until the lowest tooth touches the file face. (Fig 1)

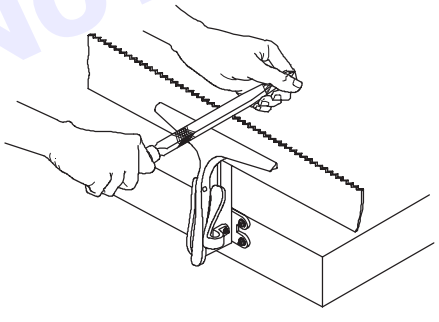
Fig 1



TOPPING A SAW

Reshaping: It is necessary to restore the tips of the teeth. Therefore the gullet of each tooth is filed down using a suitable size triangular file. Care is taken to maintain a uniform depth of gullets, pitch and angles of teeth. (Fig 2)

Fig 2



Setting : Setting is a process of bending every alternate tooth to the opposite direction. This is carried out by using a saw - set pliers. (Fig 3)

Sharpening : This is the final step in which the gullet of each tooth of the saw is filed to produce a keen cutting edge, using a suitable size of a triangular file. (Fig 4)

Topping is necessary only when the saw teeth have become uneven in their height, and re-sharpening follows it.

Fig 3

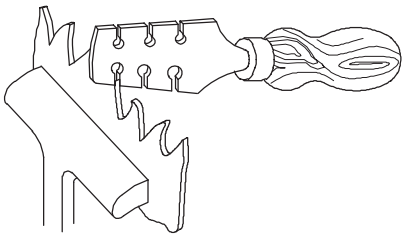
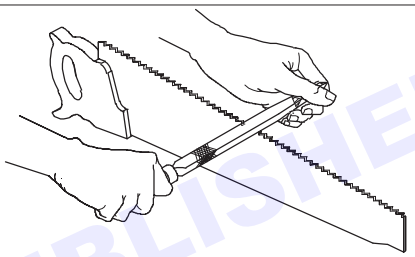


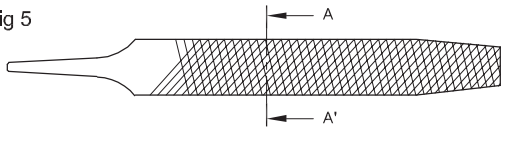
Fig 4



Sharpening tools

Flat file (Fig 5)

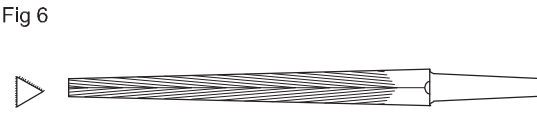
Fig 5



Flat file is used for over the topes of saw teeth level

Slim taper triangular saw file (Fig 6)

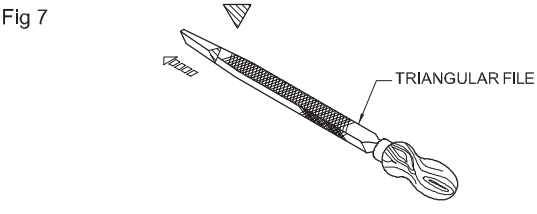
Fig 6



File is used for all saw teeth to their correct shape and size.

Triangular saw file (Fig 7)

Fig 7

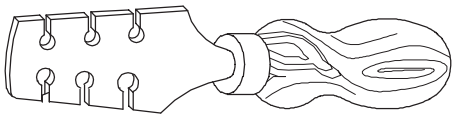


File is used for sharp the teeth of the saw at 30° to 45°

Saw set (Fig 8)

Saw set used for bending over the teeth alternately to one side and then to the other.

Fig 8



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Types of joints

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

- **state the various classification of joint used in wood work and uses.**

The most common forms of joints are the majority of joints used in wood work were designed years ago to perform certain duties and by experience their proportions have become standard to maintain a maximum of strength with the parts they connect. Variations of these joints are occasionally necessary and designed to suit special jobs.

Lengthening joints: These joints are used for joining small lengths of wood pieces end-to-end to obtain large lengths many lap, butt and scarf joints come under this category.

Widening joints: These joints are used for joining wood pieces along their edges in order to obtain increased width. Rebate, butt, tongue and groove are quite commonly used for this purpose.

Framing joints : These joints are used to connect wood pieces at desired inclinations and commonly employed in frame work. This category includes, mortise and tenon, bridle, rafter, mitre, lap dovetail, notched and scarf joints.

Box joints: These joints enable joining of wooden planks and scantlings at desired inclination so as to obtain box shaped structures and wooden cases. Lap rebated open and secret dovetail, corner having mitre haunched mortise and tenon and corner locking joints are commonly used for this purpose.

Circular joint: These joints are used for connecting wood pieces to form a hollow cylindrical structure. The joints commonly used for this purpose are butt, hammer head key, blind mortise tenon scarf and dowelled joints.

Some common joints

Dowel joint: Dowels are thin small round sticks made from hard wood and are employed in various ways. Some common uses of dowels include their use as reinforcements for butt and mitre joints as a substitute for mortise and tenon joints in small articles in securing loose parts to a product and as strengtheners to circular, square and irregular forms. While making a dowel joint it should be ensured that the locations in the dowel holes in the two mating part are in perfect alignment.

Grooved joints: Many types of grooved joints are used in wood work. In some other the grooves run parallel to the grains and in other across the grains called 'dadoes'. some of the grooved joints are concealed and some are open. A common example of this is tongue and grooved joint, which you can easily notice in filling of door panels. Other grooved joints include rebate and spline joints.

Mitre joints: These joints can be readily noted on the corners of picture frames. Their use facilitates such joints at which no end grains of the wood pieces are visible. Apart from glueing, these joints are usually strengthened by means of dowels, nails or hard wood splines etc.

Different types of joints

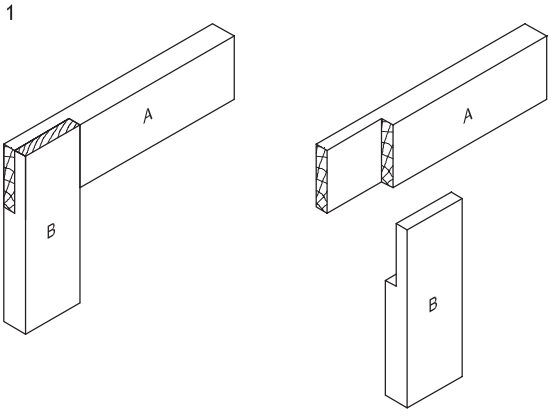
Objectives: At the end of this lesson you shall be able to

- **state meaning of half lap joints**
- **explain various types half-lap joints**
- **state the uses of half lap joints.**

Half lap joints

- A half lap joint consists of half the thickness cut away from one component and half the thickness cut away from the other.
- **Corner half lap joint**: In flat frame construction, leg and rail construction for lengthening posts, when building sheds, the corner half lap joints is stronger than the tee-half lap.
- Half lap joints are frequently used to connect two wooden pieces such as boards, frames where an even surface is required.
- When the intersecting member cross each other at centre they are known as centre half lap joint or cross half lap joint.
  – When it is fixed at the ends it is known corner half lap joint. (Fig 1)

Fig 1



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– If it is in dovetail joint it is called half-lap dovetail joint.

– Dove tail joints are always stronger and offer greater resistance to tension.

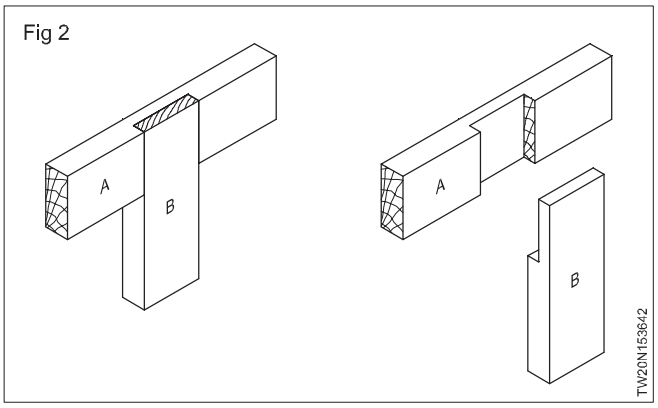
– Half lap joints are glued and if needed are reinforced by means of concealed screws.

– It is to be noted that a halved joint is always lapped but a lapped joint is not always halved.

Tee-half lap joint: It is used in frames where the end of a rail meets another piece some distance from the end both faces of the pieces finishing flush.

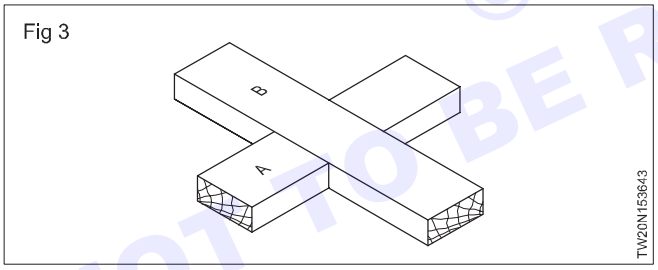
The joint is used in cabinet frames and where a strong joint is not required. (Fig 2)

Fig 2



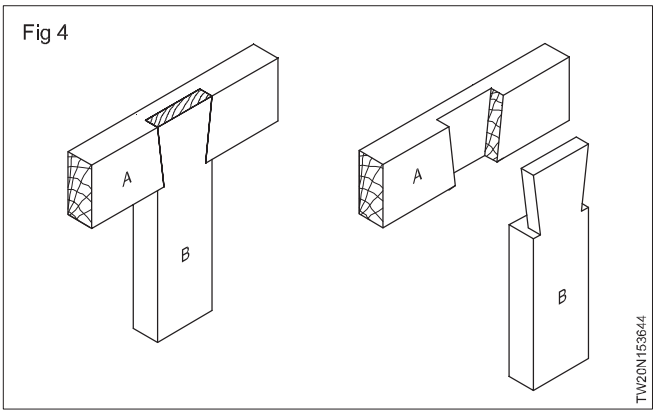
Cross half-lap joint : It is used where the members cross each other and the faces of the pieces are required to be flush as in diagonal stays of tables and chairs, and frames of cheap panelled doors. (Fig 3)

Fig 3



The dovetailed half lap: It is used for connecting the ends of cross rails in frame like construction where an outside strain occurs. This joint can be separated in only one direction. (Fig 4)

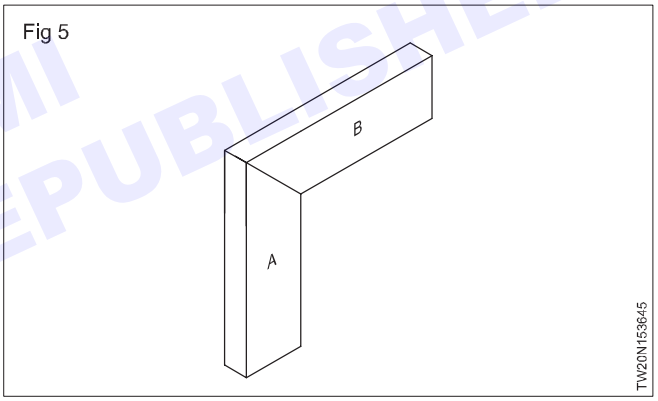
Fig 4



Mitre half lap joint : The mitre- half lap joint is used to hide end grains of woods in picture frames, mouldings rafter and drip caps etc.

There are some heavy duty half lap joints which will resist pulling stresses in one direction. Straight bevel half laps are used for lengthening wall plates, joints and rafters. (Fig 5)

Fig 5



Mortise and tenon joints

Objectives: At the end of this lesson you shall be able to
- **state the various types of mortise and tenon joints**
- **identify the types of mortise and tenon**
- **state the uses of mortise and tenon.**

The most common and strongest form of framing joint. There are many forms of mortise and tenon joints. These are mainly used parallel frames of doors, carcasses of cabinets and for joining rails to leg of table and chairs.

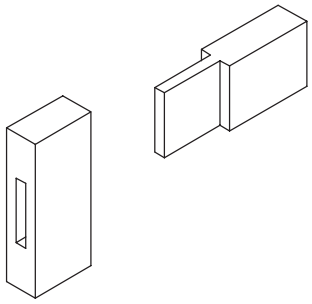
The main parts the tenon cut on the end of the member generally called rail, then the mortise, a recess or hole cut in the edge of the second member called the stile, into which tenon fits. The tenon is usually glued into the mortise.

Common mortise and tenon joint : They are used in same thickness and where a rail meets stile some distance from the end. The tenon is the full width of the rail and passes through the stile. Wedges may be used to strengthen the joint. The thickness of the tenon is usually about 1/3 the thickness of the timber depending upon the size of the mortise. As a general rule the width of the tenon is limited to six times its thickness as wide tenons may buckle when wedged and split the stile. (Fig 1)

Haunched mortise and tenon: It is used where the rail meets the stile or leg at the end. To prevent the tenon from slipping out of the end of the mortise, the tenon is cut narrower and the mortise reduced to suit. A small portion of the base of the tenon is left the full width of rail to form a haunch which fits into a recess called a haunching. The length of the haunch is usually equal to

the thickness of the tenon and its purpose is to prevent the rail from twisting. (Fig 2)

Fig 1



THROUGH MORTISE AND TENON

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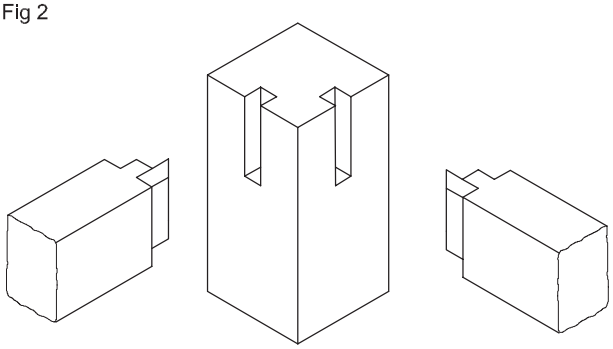
Fig 2



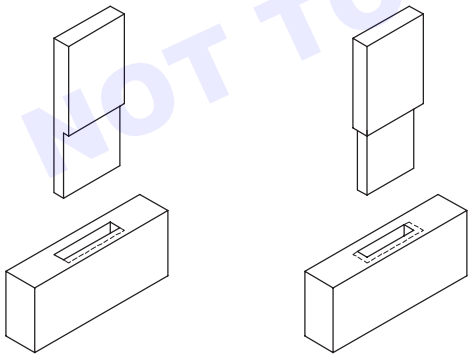
HAUNCHED AND MITRED MORTISE AND TENON

TW20N153652

Barefaced mortise and tenon joint : This joint is used where the rail is of thinner material than the stile or the leg of ordinary table. The tenon has only one shoulder and is approximately half the thickness of the rail.

When two rails meet the adjacent faces of the table legs etc it is necessary mitre the ends of tenon so that each tenon is cut as long as possible. (Fig 3)

Fig 3



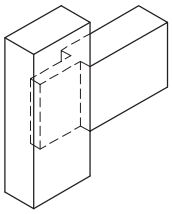
BAREFACED M&T (HAUNCHED)

TW20N153653

Stub mortise and tenon or (stump): When the tenon does not pass right through the material it is know as stump or stub tenon. It is used in high class cabinet work, so that the end grain is not seen on the edge of the stile. The length of the tenon is usually only about 2/3 of the width of the stile, depending upon the required strength for the joint. The mortise is cut to suit added strength may be obtained by using fox wedges. (Fig 4)

Double mortise and tenon: Where the joining rail is wide, it is usual to divide the width of the rail in to two tenons so that the width of each tenon does not exceed 6 times its thickness. A haunch is used on the outside tenon for top or bottom rails and a tongue is usually left between the tenons to prevent the rail from warping and light showing through if the stile sinks. (Fig 5)

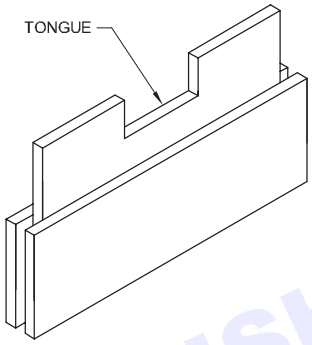
Fig 4



STUB MORTISE AND TENON

TW20N153654

Fig 5



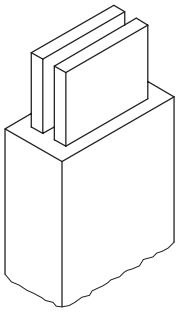
DOUBLE MORTISE AND TENON

TW20N153655

Twin mortise and tenon

These are used on very thick timber where a very strong joint is required. The thickness of the rail is divided into five parts to produce two tenons side by side. (Fig 6)

Fig 6



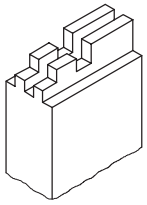
TWIN TENONS

TW20N153656

Compound tenon

It is used where the timber is wide and thick as in the middle rails of some doors, where lock is mortise in the stile. It consists two double tenons side by side. (Fig 7)

Fig 7



COMPOUND TENONS

TW20N153657

Uses of joints

Objective: At the end of this lesson you shall be able to
- **state the uses of framing joints, angle joints and lengthening joint.**

Framing joints: These joints are mostly used with windows, doors, table, chair and photo frames etc.

The four corners of the wooden frames are cut and joined together, by either bridle, mitre, dovetail or notched & scarf method.

Joints used in frame-like constructions, where the members are usually jointed end to edge, with their edges at right angles

Angle joints : These made in the corners of two wooden planks or in between a long wooden plank, the corners are joined with 90° angle, (e.g) Book shelf, cup board, lengthening box.

These joint generally used for fixing together pieces. which have their faces at right angles and edges flush.

- Corner angle joints chiefly used in box like construction, such as solid cabinets, boxes, drawers etc.
- Housed joint - consists of sinking the end or edge of one member into a trench or groove in the face of another member used chiefly for fixing shelves or divisions in book cases, cabinets, treads of step ladders, stairs etc.

Lengthening joints: These are made when the sufficient wooden pieces are not available to increase their length. These are made with lap and scarf joint (e.g) Beam.

These joints are used for joining small lengths of wood pieces end - to -end obtain large lengths. This joint is generally used for building construction roof table legs, rails, banner and frames.

Wood working machine specification and their uses

Objectives: At the end of this lesson you shall be able to
- **state the different types of portable power machine**
- **state the use of different types portable power machine in modular kitchen making.**

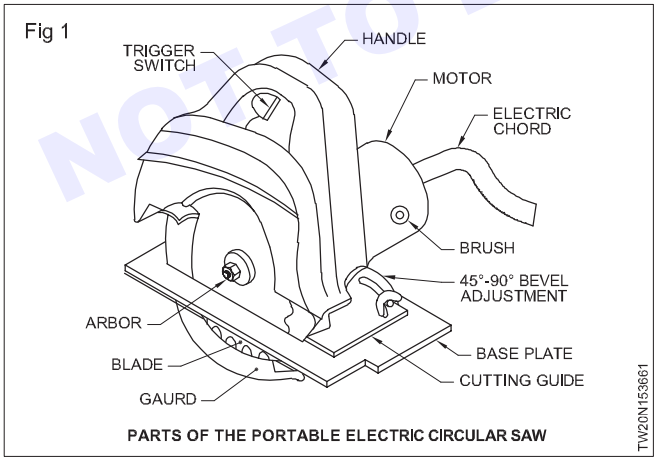
Portable power machine are made in different shape and sizes.

They differ from each other in appearance, construction and operation

Types and uses.

The most important portable power machine used in modular kitchen making

Portable power circular saw (Fig 1)

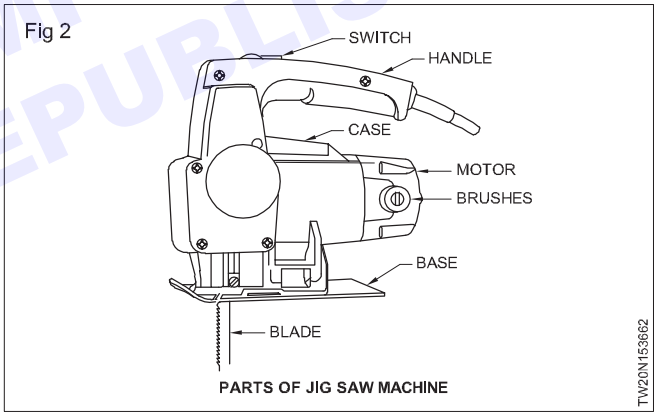


It is used extensively in modular kitchen making, modular furniture making and building construction. Works on the site and wood working workshops

This power machine has been improved with the development of built in blade brake.

It is also useful to cut plywood, plank and sun mica cutting, grooves and re bates.

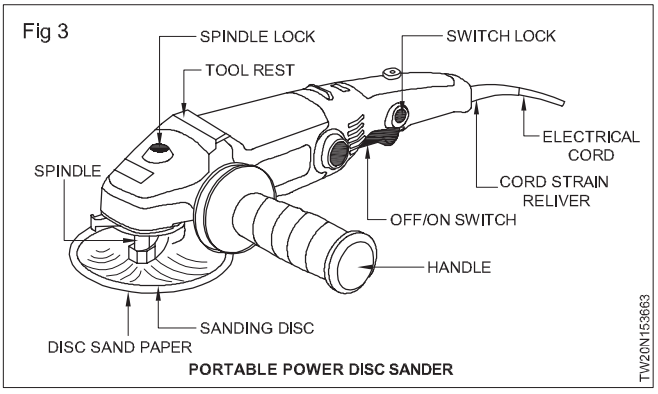
Portable electric jig saw machine (Fig 2)



The portable jig saw is a very component machine for cutting wood, composition board veneer, plastics card boards

These broad ranges of possibilities are it is ideal portable electric saw for use in cabinet making shops, modular furniture factories.

Portable power disc sander machine (Fig 3)

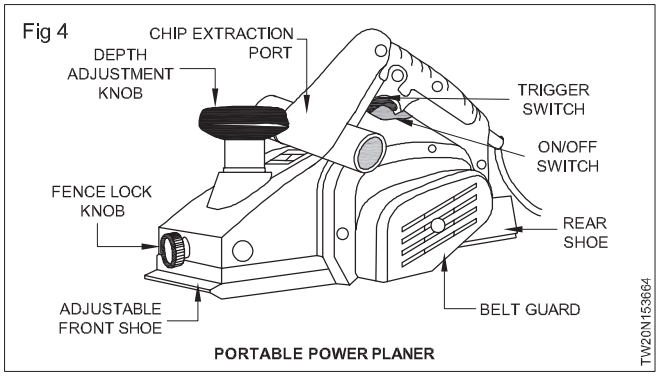


Sanding is a general term applied to the smoothing of work using a coated abrasive.

Portable power tool used smoothing, polishing, or cleaning a surface as of wood, plastic, or metal.

Sanders are also used to rough surface in preparation for finishing. It is useful for removing old paint, varnish and polish. Smoothing for groove, curves, convex surface quickly.

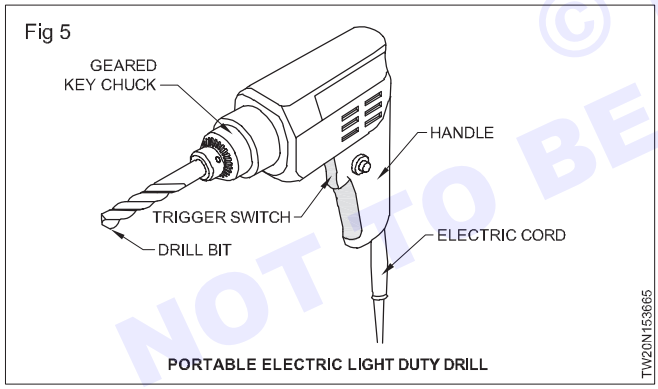
Portable power planer machine (Fig 4)



The portable power planer used for make sure the surface to be smooth planned in face and edge levelling joists, making stubborn doors close easily and for building projects in your workshop.

It is important that the planer should always be planning in the same direction as the grain of the wood.

Portable electric drill light duty (Fig 5)



The portable electric drill is usually the first power tool selected for the home workshop.

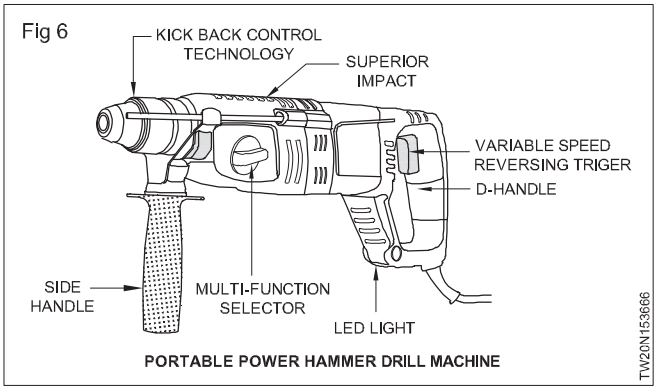
These are available in different forms.

The portable drilling machines are used to drill small holes and are commonly used in the entire work shop this type of drill machine is operated by holding in a hand

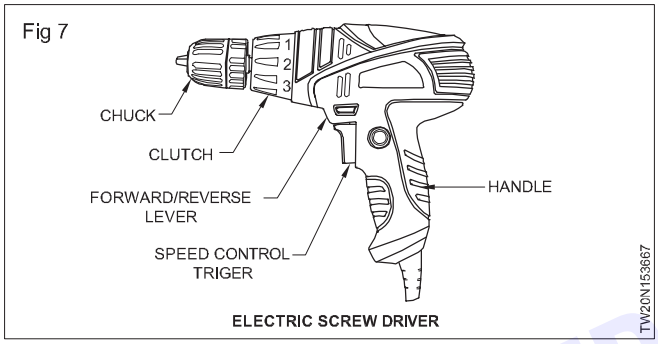
Portable power heavy duty hammer drill machine (Fig 6): Hammer drill is a convenient device to have in your tool box as you can use it for several different applications

These tools are handy and help in carrying out relatively light duty jobs. They are competent to drill holes in concrete, brick, wood, stone, and other hard materials.

Hammer drill machine uses a standard drill chuck and round shank bits it can be used in the drill only mode to penetrate wood and metal as well as in the hammer and drill mode to penetrate concrete and brick.



Portable electric screw driver (Fig 7)

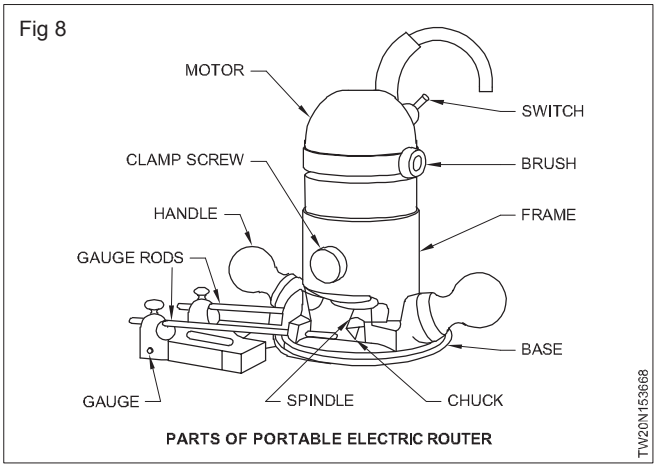


Electric screw driver is a portable electric driver that allows you to screw and unscrew effortlessly. The head of the screw driver is equipped with a bit holder which can be magnetic or have a quick release system. The bit holder allows you to quickly insert the bit that corresponds to the screw head.

Electric screw drivers also come with reverse action to remove screws if needed. Torque control on electric screw drivers is possible to change the rotating force (known as torque) for more control bigger, heavier screws often read more force behind them than smaller lighter ones.

Pull the caller towards the body of the screw driver with your fingers hold it against the front of the screw driver. This releases the bit. Pull the bit out of the screw driver.

Portable electric router (Fig 8)



It is a most versatile machine and is used for ornamental work-edge mouldings and chamfers, surface. fluking “V” grooving, veining low relief carving, inlay recesses.

Adjustable fence is provided and the machine itself in adjustable for depth of cut.

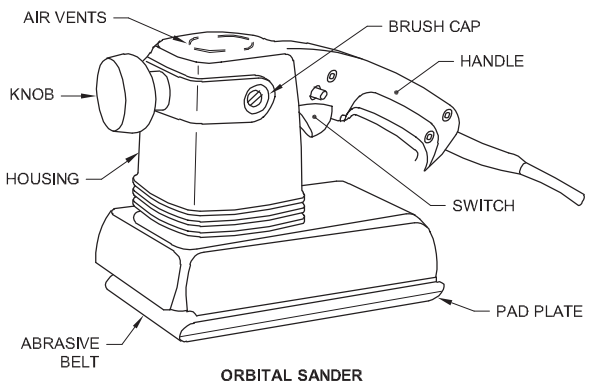
It operates at very high speed from 16,000 to 27,000 rpm

While cutting the handles are held with both hands and moved.

Attachments: jigs and templates and a wide range of cutters are available for use, with the router for shaped work.

Orbital sander (Fig 9)

Fig 9

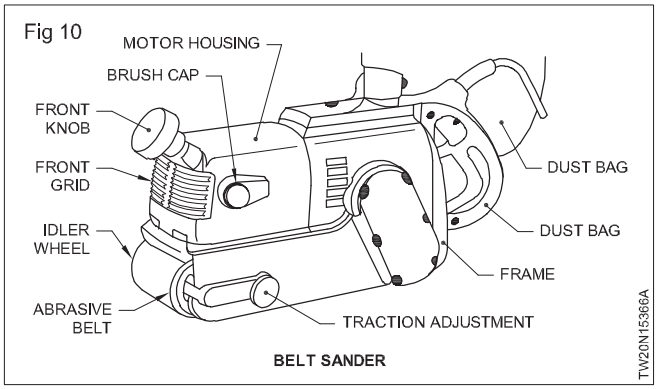


ORBITAL SANDER

This machine is suitable for sanding ,flat and curve surfaces. The sanding paper is fitted to a flexible base and is ideal for finishing work as it reproduces at high speed the action of sanding in either the horizontal or vertical positions.

Belt sander (Fig 10)

Fig 10



BELT SANDER

The belt sander is suitable for sanding flat surface and consists of a continuous abrasive bond fitted over rollers at each end of the machine.

Sanding of framed joinery works with grain can be actually carried out and scratching at joints avoided. A dust collecting bag is fitted to the back end of the machine.

Adhesives type and uses

Objectives: At the end of this lesson you shall be able to
- **name different types of glue**
- **explain the preparation of glue and uses.**

It is essential for the wood worker to know the adhesive power of glue especially, with regard to the weather condition of the places, where he carries out his work how to prepare and apply it.

There are various types

1 Animal glue

2 Casein glue

3 Resin glue

4 Vegetable glue

5 Blood albumen glue

1 Animal glue

Animal glue is a mixture of skin, bone and acid.

Preparation of animal glue

- The animal glue ought to be prepared as follows.
- Break up the glue into small pieces, wash them thoroughly put the pieces into the double boiler glue pot containing sufficient cold water to cover the glue.
- Allow it to soak for about fourteen hours, after which time, a good grade of glue, should have absorbed, most of the water and swollen into a jelly form.
- The more water it has absorbed the better it is. Heat now the glue, stirring well every now and then. When it is ready it should run like thick oil.

Glue loses some of its strength at every reheating. It would be very convenient if the pot could be covered in order to prevent the dust and smoke from getting in.

2 Casein glue

- Casein glue is a chemical extract from the curds of skimmed milk and other ingredients reduced to a fine light yellow powder.
- A quality for this powder is mixed by pouring in an equal quantity of cold water and stirring the mixture briskly. The glue is thus got ready.

Casein glue should be consumed within 8 hours at most; after this time it losses its adhesive power.

- Casein glue is water resistant. As this glue sets slowly timber glued with it should be left untouched for about 16 hours.

3 Resin glue

Resin glue is a product of certain white powders mixed, with cold water and used like casein glue as explained above.

- It is stain less and water proof and makes a perfect joint. It is used extensively in the manufacture of plywood, in plane and cabinet workers.

4 Vegetable glue

It is made from the starch, obtained from roots, grains and corn of trees by treating the same, with acid and by grinding to a powdered form.

This glue is used cold, but its viscosity is so high that it can be applied only by sponging machine.

It is therefore not suitable for general wood work. But used only in plywood industries.

5 Blood albumen glue

- It is made by adding an alkali to beef blood and is commercially available in the form of flakes.
- While using, these flakes are dissolved in water about an hour earlier, to form a liquid solution.
- It is a strong bond and is water proof.

Advantage of adhesives use and their types

Objectives: At the end of this lesson you shall be able to
- **state the advantage of adhesives**
- **explain the uses of adhesive and types.**

Advantage of adhesives

- The adhesives materials allows joint substrates with different geometries, sizes and composition. With the adhesives we can joint wood, glass, plastics, metals, ceramics.
- The use of adhesives eliminates the corrosion.
- The use of adhesives as bonding material does not produce any deformation in the materials, reducing the manufacturing cost and improving the aesthetics of the product.

- Adhesives do not produce any mechanical aggression to the substrate and avoid any damage to the structure of the material.
- Adhesives reduce the product weight.
- Increasing the resistance to impact and fatigue resistance using elastic adhesives, increasing reliability and product life cycle.
- Homogeneous distribution of tension throughout the union.
- Adhesives joint reduce noise and vibration.
- To reduce the manufacturing cost adhesive joints reduces the number of components such as screw, nuts, washers, rivets, etc..,
- Sealing function and protection against corrosion is possible by adhesives.

Types of adhesives and uses

- **Structural adhesives**

  This adhesives can carry significant stresses, and land themselves of structural applications.

  Pressure sensitive adhesives.

  Durable bonds for lightly loaded application.

- **Synthetic rubber adhesives**

  Use in furniture industry.

  Synthetic rubber adhesives.

  Use in ventilated surroundings.

- **Synthetic rubber adhesives (Heat roof adhesives)**

  To bond plywood, mdf, particle board to laminate.

  Used in furniture upholstery and foot wear industries.

  Used in bus body building industries.

- **Instant adhesives**

  Used PVC door assembling.

Atom & atomic structure electrons

Objectives: At the end of this lesson you shall be able to
- **define electricity and atom**
- **explain about the atomic structure**
- **define the fundamental terms and definition of electricity**
- **state the conductors, insulators, wires - size measurement methods.**

Introduction: Electricity is one of the today's most useful sources of energy. Electricity is of utmost necessity in the modern world of sophisticated equipment and machinery.

Electricity in motion is called electric current. Whereas the electricity that does not move is called static electricity.

Examples of static electricity

- Shock received from door knobs of a carpeted room.
- Attraction of tiny paper bits to the comb.

Structure of matter: Electricity is related to some of the most basic building blocks of matter that are atoms (electrons and protons). All matter is made of these electrical building blocks, and, therefore, all matter is said to be 'electrical'.

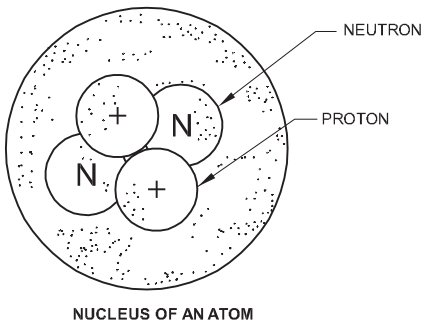
Atom: Matter is defined as anything that has mass and occupies space. A matter is made of tiny, invisible particles called molecules. A molecule is the smallest particle of a substance that has the properties of the substance. Each molecule can be divided into simpler parts by chemical means. The simplest parts of a molecule are called atoms.

Basically, an atom contains three types of sub-atomic particles that are of relevance to electricity. They are the electrons, protons and neutrons. The protons and neutrons are located in the centre, or nucleus, of the atom, and the electrons travel around the nucleus in orbits.

Atomic structure

The nucleus: The nucleus is the central part of the atom. It contains the protons and neutrons in equal numbers shown in Fig 1.

Fig 1

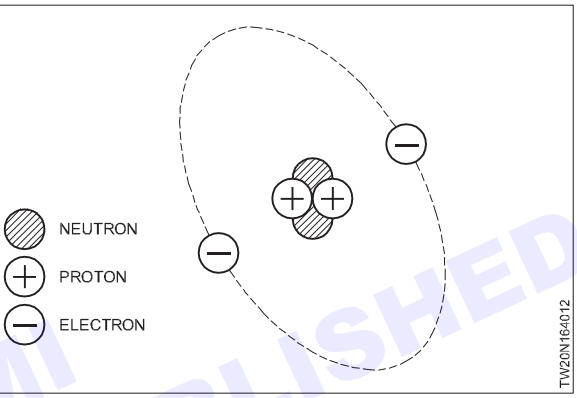


NUCLEUS OF AN ATOM

Protons: The proton has a positive electrical charge. (Fig 1) It is almost 1840 times heavier than the electron and it is the permanent part of the nucleus; protons do not take an active part in the flow or transfer of electrical energy.

Electron: It is a small particle revolving round the nucleus of an atom (as shown in Fig 2). It has a negative electric charge. The electron is three times larger in diameter than the proton. In an atom the number of protons is equal to the number of electrons.

Fig 2

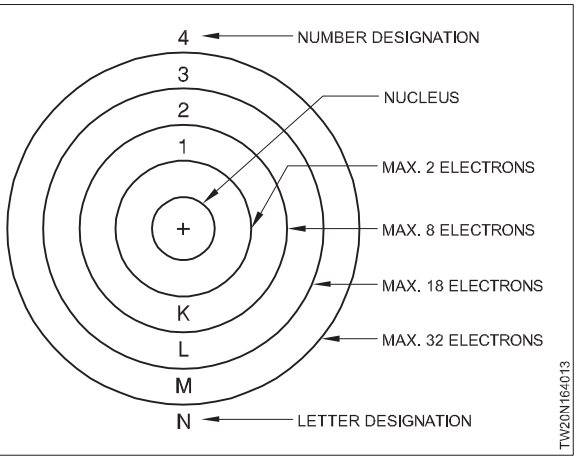


Neutron: A neutron is actually a particle by itself, and is electrically neutral. Since neutrons are electrically neutral, they are not too important to the electrical nature of atoms.

Energy shells

In an atom, electrons are arranged in shells around the nucleus. A shell is an orbiting layer or energy level of one or more electrons. The major shell layers are identified by numbers or by letters starting with 'K' nearest the nucleus and continuing alphabetically outwards. There is a maximum number of electrons that can be contained in each shell. Fig 3 illustrates the relationship between the energy shell level and the maximum number of electrons it can contain.

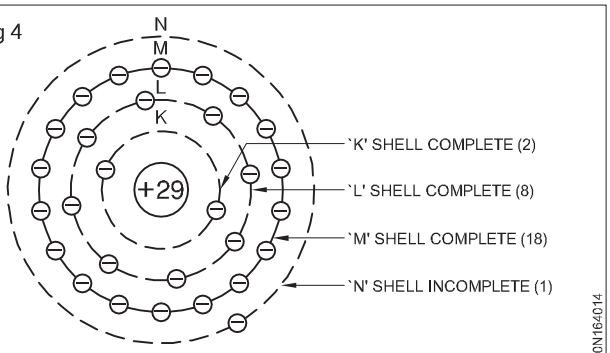
Fig 3



If the total number of electrons for a given atom is known, the placement of electrons in each shell can be easily determined. Each shell layer, beginning with the first, is

filled with the maximum number of electrons in sequence. For example, a copper atom which has 29 electrons would have four shells with a number of electrons in each shell as shown in Fig 4.

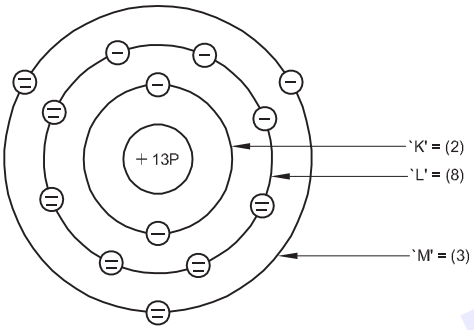
Fig 4



COPPER ATOM

Similarly an aluminium atom which has 13 electrons has 3 shells as shown in Fig 5.

Fig 5



ALUMINIUM ATOM

Electron distribution: The chemical and electrical behaviour of atoms depends on how completely the various shells and sub-shells are filled.

Atoms that are chemically active have one electron more or one less than a completely filled shell. Atoms that have the outer shell exactly filled are chemically inactive. They are called inert elements. All inert elements are gases and do not combine chemically with other elements.

Conductors, insulators and semiconductors

Conductors: A conductor is a material that has many valance electrons permitting electrons to move through it easily. Generally, conductors have many valence shells of one, two or three electrons. Most metals are conductors.

Some common good conductors are Copper, Aluminium, Zinc, Lead, Tin, Eureka, Nichrome, are conductors, where as silver and gold are very good conductors

Insulators: An insulator is a material that has few, if any, free electrons and resists the flow of electrons. Generally, insulators have full valence shells of five, six or seven electrons. Some common insulators are air, glass, rubber, plastic, paper, porcelain, PVC, fibre, mica etc.

Semiconductors: A semiconductor is a material that has some of the characteristics of both the conductor and insulator. Semiconductors have valence shells containing four electrons.

Common examples of pure semiconductor materials are silicon and germanium. Specially treated semiconductors are used to produce modern electronic components such as diodes, transistors and integrated circuit chips.

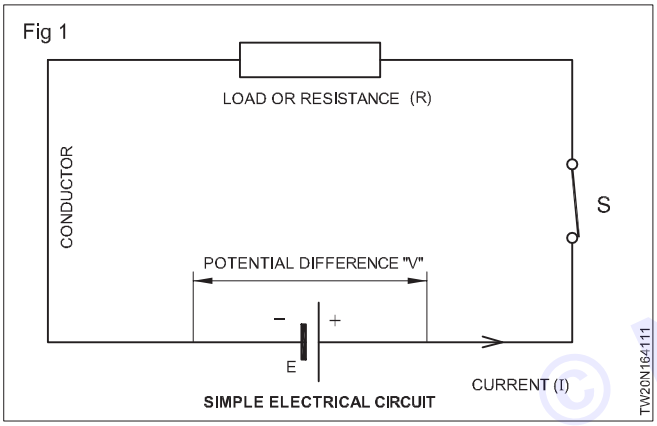
Fundamental terms of work, power, energy units, voltage, current, resistance & colour code

Objectives: At the end of this lesson you shall be able to
- **state Ohm's law**
- **apply Ohm's law in an electric circuit**
- **define electrical power and energy and calculate related problems.**

Simple electric circuit: In the simple electric circuit shown in Fig 1, the current completes its path from the positive terminal of the battery via the switch and the load back to the negative terminal of the battery.

The circuit shown in Fig 1 is a closed circuit. In order to make a circuit to function normally the following three factors are essential.

Fig 1



- Electromotive force (EMF) to drive the electrons through the circuit.
- Current (I), the flow of electrons.
- Resistance (R) - the opposition to limit the flow of electrons.

Ohm's law: Ohm's law states that in any electrical closed circuit, the current (I) is directly proportional to the voltage (V), and it is inversely proportional to the resistance 'R' at constant temperature

$$I \propto \frac{V}{R}$$

It means I = V/R

V = Voltage applied to the circuit in 'Volt'

I = Current flowing through the circuit in 'Amp'

R = Resistance of the circuit in Ohm (Ω)

The above relationship can be referred to in a triangle as shown in Fig 2. In this triangle whatever the value you want to find out, place the thumb on it then the position of the other factors will give you the required value.

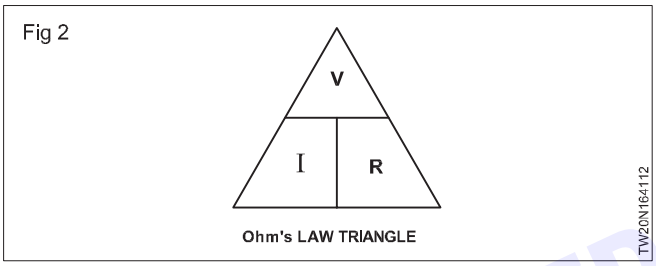
For example for finding 'V' close the value V then, readable values are $I = \frac{V}{R}$

IR so, V = IR

R = V/I

I = V/R

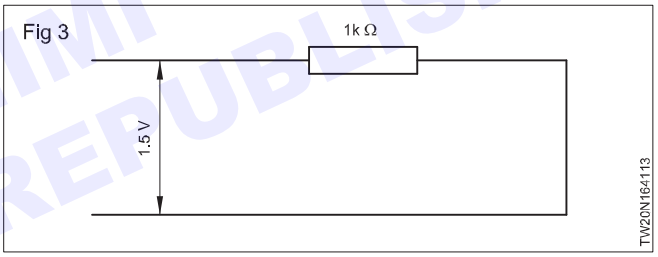
Fig 2



Example 1

How much current (I) flows in the circuit shown in Fig 3.

Fig 3



Given

Voltage (V) = 1.5 Volts

Resistance (R) = 1 kOhm

= 1000 Ohms

$$I = \frac{V}{R}$$

Solution

$$I = \frac{1.5\ V}{1000\ Ohms} = 0.0015\ amp$$

Electrical power (P) & Energy (E) : The product of voltage (V) and current (I) is called electrical power. Electrical power (P) = Voltage x Current P=V x I

The unit of Electrical power is 'Watt' It is denoted by the letter 'P' It is measured by Watt meter. The following formulae can also be derived from formula of power (P) as

i P = V X I

= IR x I

P = I^2R

ii $P = V \times I$

$= V \times \frac{V}{R}$

$P = \frac{V^2}{R}$

Electrical energy (E)

The product of power (P) and time (t) is called as electrical energy (E)

Electrical energy (E) = Power x time

$E = P \times t$

$= (V \times I) \times t$

$E = V \times I \times t$

The unit of electrical energy is "Watt hour" (Wh)

The commercial unit of Electrical energy is "Kilo watt hour" (KWH) or unit

B.O.T (Board of Trade) unit / KWH/Unit

One B.O.T (Board of Trade) unit is defined as that one thousand watt lamp is used for one hour time, it consumes energy of one kilowatt hour (1kWH). It is also called as **"unit"**

Energy = 1000W x 1Hr = 1000WH (or) 1kWH

Example 1

How much electrical energy is consumed in an electric iron rated as 750W/250V used for 90 Minutes

Given

Power (P) = 750W

Voltage (V) = 250V

Time = 90min (or) 1.5Hr

Find

Electrical Energy (E) = ?

Solution:

Electrical Energy (E) = P x t

= 750 w x 1.5Hr

= 1125 WH (or)

E ⟶ = 1.125 kWH

Work, power and energy

Work is said to be done, when a force (F) displaces a body from one distance (s) to another (or)

Work done = Force x distance moved

w.d = F x S

It is generally denoted as "W"

The unit of work done is

i In Foot Pound Second (F.P.S) System is "Foot Pound (Ib.ft)"

ii In Centimetre Gram Second (C.G.S) System "Gram Centimetre (gm.cm)"

or

1 gm.cm = 1 dyne

1 dyne = 10^7 ergs

The smallest unit of work done is **"Erg"**

iii In Metre - Kilogram - Second (M.K.S.) System is "Kilogram Metre (Kg-M)'

1 Kilogram = 9.81Newton

iv In system of international unit (S.I. Unit) is 'Joule'

1 Joule = 1 Newton Metre (Nw-M)

Power (P)

The rate of doing work is called as Power (P)

Power (P) = work done / time taken

$P = \frac{F \times S}{t}$

It's unit is Lb.ft/sec in FPS system

gm-cm/sec is in C.G.S. System

(or)

Dyne/sec

(or)

Kg-M/sec in M.K.S System (or) NW - M/ sec

(1kg = 9.81 Newton)

Joule/sec in (S.I)

1 Joule/Sec = 1 watt

Electrical Power = VI Watt

The unit of Mechanical power is "Horse Power" (H.P)

Horse Power (HP) further classified into two:

They are

Indicated Horse Power - (IHP)

Brake Horse Power - (BHP)

Indicated Horse Power (IHP)

The power developed inside the engine (or) pump (or) motor is called Indicated Horse Power (IHP)

Brake Horse Power (BHP)

The useful Horse Power which is available at the shaft of the engine/motor/pump is called Brake Horse Power (BHP)

So, IHP is always greater than

BHP due to friction losses

IHP > BHP

The relation between mechanical and electrical power

(ie) 1 HP (British) = 746 Watt

1 HP (Metric) = 735.5 Watt

One HP (Metric)

The amount of Mechanical Power required to move/ displace a body/substance by force of 75 Kg to one metre distance in one second is called as one HP (metric)

HP (Metric) = 75kg - M/Sec

One HP (British)

The amount of Mechanical power required to move/ displace a body/substance of force 550lb to one foot (ft) distance in one second is called as one HP (British)

1 HP (British) = 550 lb.ft/sec

Energy

The capacity for doing work is called as electrical Energy

(or)

The product of power and time is known as Electrical energy

(ie) Energy = Power x time

= VI x t

S.I unit of energy is "Joule"

(ie) Energy = (Joule/sec) x sec

$$= \frac{\text{Joulle}}{\text{Sec}} \times \text{Sec} = \text{joule}$$

(ie) The S.I of unit of work done and energy is same (Joule)

The energy can be divided into two main categories (ie)

i Potential Energy (eg. Loaded gun, energy (stored in spring etc)

ii Kinetic Energy (eg. Moving of car, raining etc).

Example

In a house, the following electrical loads are daily used

i 5 Nos of 40W Tube Lights used for 5 hours/day

ii 4 Nos of 80W fans used for 8 hours/day

iii 1 No of 120W T.V. receiver used for 5 hours/day

iv 4 No of 60W lamps used for 4 hours/day

Calculate the total energy consumed in unit's per day and also the cost of electric bill for the month of January If the cost of energy is 1.50/unit

Given

Load details per day

Electric Device	Power	Numbers	Time in hours
i Tube light	- 40W	- 5	- 5 hr/day
ii Fans	- 80W	- 4	- 8 hr/day
iii T.V.	- 120W	- 1	- 6 hr/day
iv Lamps	- 60W	- 4	- 4 hr/day

cost of energy - Rs.1.50/unit

Find

i Energy consumption in unit per day = ?

ii Cost of energy for the month of January = ?

Solution

Energy consumption/day

1 Tube light = 40W x 5 x 5 hr /day

$$= \frac{1000\ \text{wh}}{1000} = 1\text{Kwh/day}$$

2 Fans = 80W x 4x8 hr/day

$$= \frac{2560}{1000} = 2.56\text{Kwh/day}$$

3 T.V. = 120W x 1x6 hr/day

$$= \frac{720\ \text{wh}}{1000} = 0.72\text{Kwh/day}$$

4 Lamp = 60W x 4x4 hr/day

$$= \frac{960}{1000} = \text{Kwh} = \frac{0.96\,\text{kwh/day}}{5.24\,\text{kwh/day}}$$

(i) Total energy consumption in unit per day
= 5.24 unit

(ii) Total energy consumption for the month of January (i.e 31 days)
= 5.24 x 31
= 162.44 units

Cost of energy = Rs.1.50/unit

Total electric bill for the month of January = 162.44 x 1.50
= Rs.243.66

Electricity bill for the month = Rs. 244/-

Resistors

Objective: At the end of this lesson you shall be able to
- **explain the construction and characteristics of various types of resistors.**

Resistors: These are the most common passive component used in electrical and electronic circuits. A resistor is manufactured with a specific value of ohms (resistance). The purpose of using a resistor in circuit is either to limit the current to a specific value or to provide a desired voltage drop (IR). The power rating of resistors may be from fractional walts to hundreds of watts.

There are five types of resistors

1 Wire-wound resistors

2 Carbon composition resistors

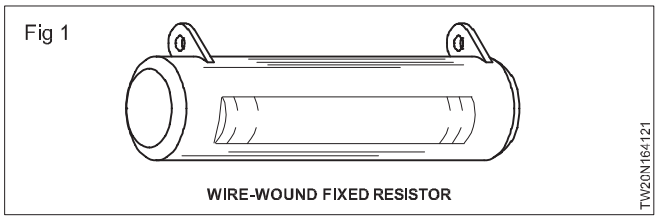
3 Metal film resistors

4 Carbon film resistors

5 Special resistors

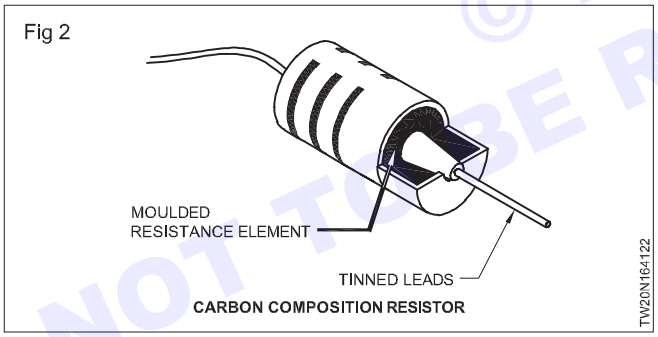
1 Wire-wound resistors

Wire-wound resistors are manufactured by using resistance wire (nickel-chrome alloy called Nichrome) wrapped around an insulating core, such as ceramic porcelain, bakelite pressed paper etc. Fig 1, shows this type of resistor. Wire wound resistors are used for high current application. They are available in wattage ratings from one watt to 100 watts or more.



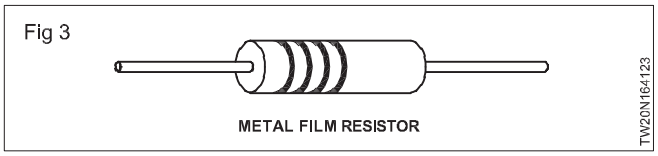
2 Carbon composition resistors

These are made of fine carbon or graphite mixed with powdered insulating material as a binder in the proportion needed for the desired resistance value. Fig 2 shows the construction of carbon composition resistor.



Carbon resistor are available in values of 1 ohm to 22 megohms.

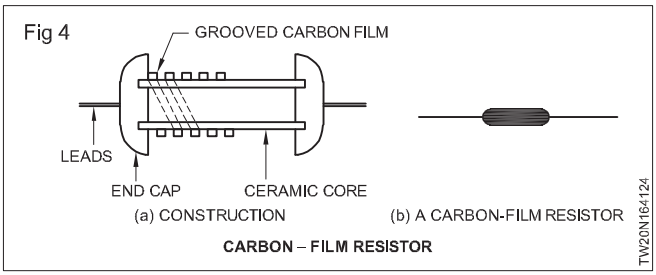
3 Metal film resistors (Fig 3)



Metal film resistors are manufactured by two processes. Thick film resistors are pasted with metal compound and powdered glass which are spread on the ceramic base and then backed (Fig 3).

Metal film resistors are available from 1 ohm to 10 MΩ, upto 1W.

4 Carbon film resistors (Fig 4)



In this type, a thin layer of carbon film is deposited on the ceramic base/tube. A spiral groove is cut over the surface to increase the length of the foil by a specialised process.

Carbon film resistors are available from 1 ohm to 10 meg ohm and up to 1 W and can work from 85°C to 155°C.

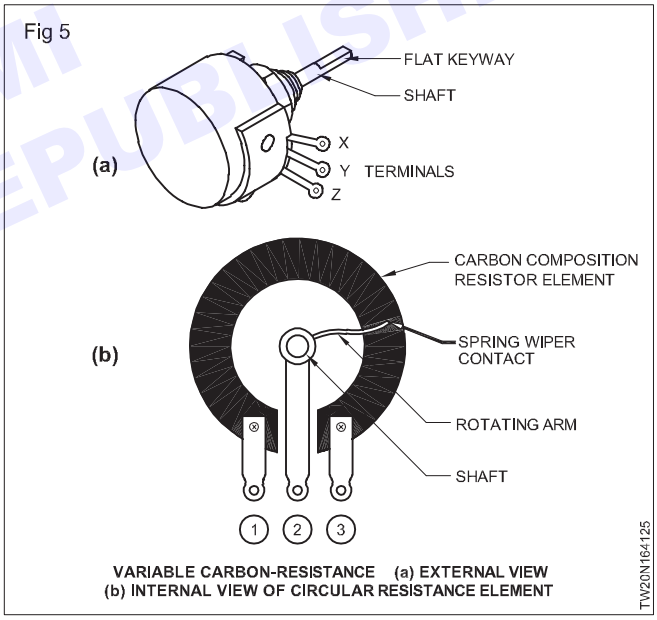
The resistors can also be classified with respect to their function as

1 Fixed resistors

2 Variable resistors

Fixed resistors : The fixed resistors is one in which the is nominal value of resistance is fixed. These resistors are provided with pair of leads. (Fig 1 to 4)

Variable resistors (Fig 5)



Variable resistors are those whose values can be changed. Variable resistors includes those components in which the resistance value can be set at the different levels with the help of sliding contacts. These are known as potentiometer resistors or simply as a potentiometers.

Resistance depends upon temperature, voltage, light: Special resistors are also produced whose resistance varies with temperature, voltage, and light.

Marking codes for resistors

Objectives: At the end of this lesson you shall be able to
- **interpret the coded marking of colours on the resistors**
- **interpret the letter and digit codes for resistance values**
- **state the tolerance value for resistors.**

Resistance and tolerance value of colour coded resistors : Commercially, the value of resistance and tolerance value are marked over the resistors by colour codes (or) letter and digital codes.

The colour codes for indicating the values to two significant figure and tolerances are given in Table 1 as per IS 8186.

Table 1

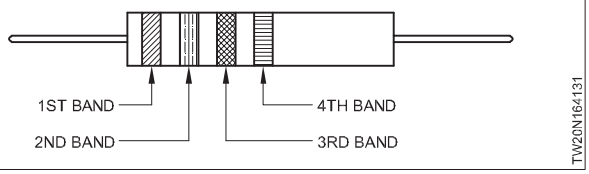
Values to two significant figures and tolerances corresponding to colours

Colour	First Band/ Dot	Second Band/ Dot	Third Band/ Dot	Fourth Band/ Dot
	First Figure	Second Figure	Multiplier	Tolerance
Silver	-	-	10^{-2}	± 10 %
Gold	-	-	10^{-1}	± 5 %
Black	-	0	1	
Brown	1	1	10	± 1 %
Red	2	2	10^{2}	± 2 %
Orange	3	3	10^{3}	-
Yellow	4	4	10^{4}	-
Green	5	5	10^{5}	-
Blue	6	6	10^{6}	-
Violet	7	7	10^{7}	-
Grey	8	8	10^{8}	-
White	9	9	10^{9}	-
None	-	-	-	± 20 %

The two significant figures and tolerances colour coded resistors have 4 bands of colours coated on the body as in Fig 1.

The first band shall be the one nearest to one end of the component resistor. The second, third and four colour bands are shown in Fig 1.

Fig 1



The first two colour bands indicate the first two digits in the numeric value of resistance. The third colour band indicates the multiplier. The first two digits are multiplied by the multiplier to obtain the actual resistance value. The forth colour band indicates the tolerance in percentage.

Example

Resistance value: If the colour band on a resistor are in the order- Red, Green, Orange and Gold, then

First colour	Second colour	Third colour	Fourth colour
Red	Violet	Orange	Gold
2	7	1000(10^{3})	± 5%

the value of the resistor is 27,000 ohms with +5% tolerance.

Tolerance value: The fourth band (tolerance) indicates the resistance range within which is the actual value falls. In the above example, the tolerance is ± 5%. ± 5% of 27000 is 1350 ohms. Therefore, the value of the resistor is any value between 25650 ohms and 28350 ohms. The resistors with lower value of tolerance (precision) are costlier than normal value of resistors.

Types of cables, standard wire gauge, Ohm's law and Kirchhoff's law

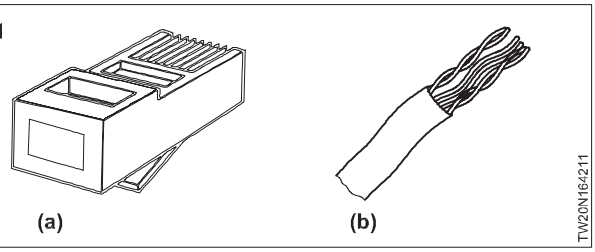
Objectives: At the end of this lesson you shall be able to
- **prepare straight cable**
- **prepare the cross-over network cable.**

Straight cable to connect computer with network switch

1 Collect and check all the tools and RJ45 connectors required for making network cables.

2 Take the CAT6 cable, mark 2.5 cm from one end of the cable as shown in Fig 1 a,b and remove the cable jacket/insulation using cable stripper / crimping tool.

Fig 1



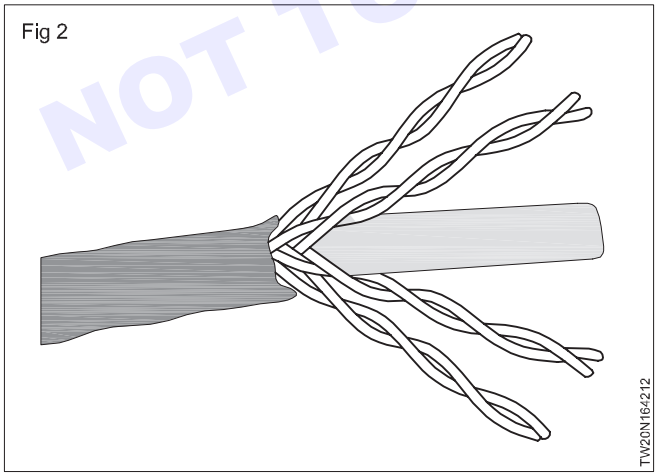
Note

1 If strain relief boot is to be used, insert and slide on the strain, relief boot into the CAT6 cable before crimping.

2 Do not remove any insulation from the conductors of the cable pairs.

3 Bend each twisted pairs on four sides and cut-off the soft supporting member-spleen and the string as shown in Fig 2.

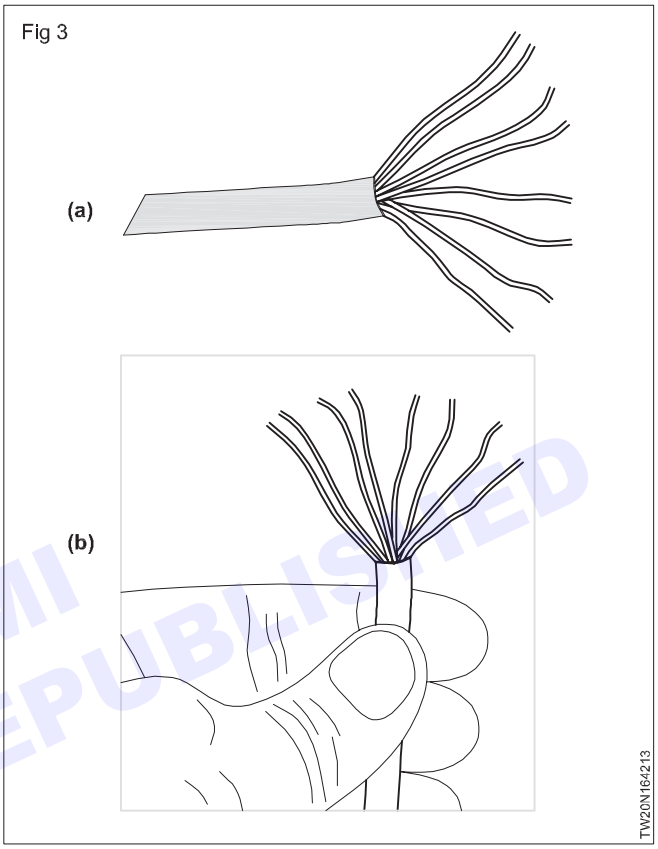
Fig 2



4 Untwist the wire pairs and separate all the wires as shown in Fig 3a & 3b.

5 Straighten the wires and arrange them from left to right in the order as shown in cable colour Chart-1 for straight cable crimping.

Fig 3



Wire colour chart-1 for straight cable

Pin no.	Cable end-A Wire colour	Cable end-B Wire colour
1	White-green	White-green
2	Green	Green
3	White-orange	White-orange
4	Blue	Blue
5	White-blue	White-blue
6	Orange	Orange
7	White-brown	White-brown
8	Brown	Brown

6 Grasp the wires firmly between your fingers flatly and cut a few mm so that all the wires are of the same length as shown in Fig 4.

7 Insert the prepared wires into the RJ45 plug as shown in Fig 5a & 5b.

8 Get the colours of wires inserted into RJ45 plug for crimping straight cable checked by the Instructor.

Fig 4

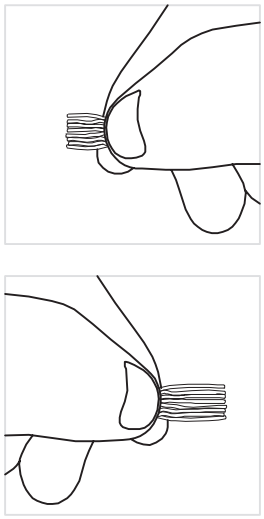


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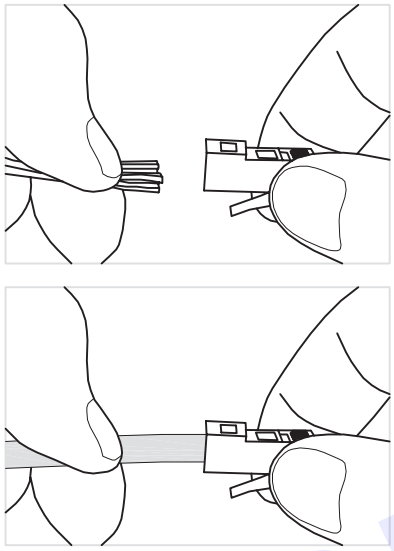
Fig 5



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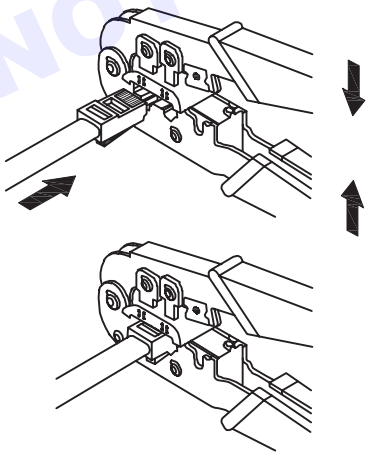
9 Insert the jack and wire combo into RJ45 slot of the crimping tool as shown in Fig 6.

Fig 6



CRIMPING

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Note: The crimping tool may come with additional slots for crimping RJ11-telephone wires also.

10 Press the crimping tool a bit harder so that the pins of the jack go inside and contacting the core of each wire simultaneously.

Note: Pins should not be protruding after crimping.

11 Get the crimped RJ45 plug checked by the Instructor.

12 Take the other end of the CAT6 cable, follow steps 2 to 10 and crimp the RJ45 plug.

13 Connect the prepared straight cable into the Network cable tester, switch ON.

Cross-over cable to connect two computers

1 Take the CAT6 cable and repeat step 2 to 4 of straight cable to connect computer with network switch.

2 Straighten the wires and arrange them from left to right in the order as shown in wire colour Chart-2 for cross-over cable.

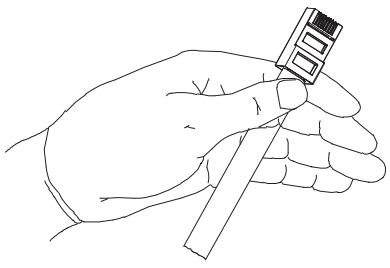
Wire colour Chart-2 for cross-over cable

Pin No.	Cable end-A Wire colour	Cable end-B Wire colour
1	white-green	white-orange
2	green	orange
3	white-orange	white-green
4	blue	white-brown
5	white-blue	brown
6	orange	green
7	white-brown	blue
8	brown	white-blue

Note: If strain relief boot is to be used, slide on the strain relief boot into the CAT6 cable.

3 Grasp the wires firmly between the fingers flatly and cut a few mm so that all the wires are of the same length.

Fig 7



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Types of cables - Standard wire gauge

Objectives: At the end of this lesson you shall be able to
- **define UG cable**
- **explain the construction of UG cables**
- **list and state the insulating materials used in cables**
- **list out and state the types of UG cables used for 3 phase service**
- **state the types of cable joints and laying methods**
- **explain the faults and testing procedures of cables.**

Under Ground (UG) cables

"A cable so prepared that it can withstand pressure and can be installed below the ground level and normally two or more conductors are placed in an UG cable with separate insulation on each conductor"

Electric power can be transmitted (or) distributed either by over-head lines system or by underground cable system. The underground cable system have several advantage, such

Advantages

- Less chance to damage through storms or lightning.
- Low maintenance cost.
- Less chances of fault.

Disadvantages

However, their major draw back / disadvantages are

- Initial cost of UG cable system is heavy.
- The cost of joints are more.
- Introduce insulation problems at high voltages compared with O.H lines.

For these reasons UG cables are employed where it is impracticable to use O.H lines like

i Thickly populated areas, where municipal authorities prohibit O.H lines for the reason of safety.

ii Around plants

iii In Substations,

iv Where maintenance conditions do not permit the use of O.H construction.

General construction of UG cables

An underground cable essentially consists of one or more conductors covered with suitable insulation and surrounded by a protecting cover.

Necessity requirements for cables

In general, a cable must fulfill the following necessary requirements.

i The conductor used in cables should be tinned stranded copper or aluminum of high conductivity. (Strands of cable gives flexibility and carry more current).

ii The size of the conductor should be selected, so that the cable carries the desired load current without overheating and limits the voltage drop to a permissible value.

iii The cable must have proper thickness of insulation to ensure the safety and reliability for the designed voltage.

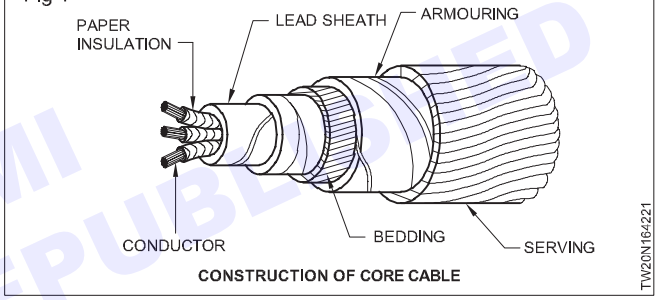
iv The cable must be provided with suitable mechanical protection so that it may withstand the rough use in laying it.

v The materials used in cables should be with complete chemical and physical stability throughout.

Construction of cables

Fig 1 shows the general construction of a 3-core cable. The various parts are

Fig 1



CONSTRUCTION OF CORE CABLE

i Cores or conductors: A cable may have one or more than one core (conductor) depending upon the type of service for which it is intended. For instance, the 3-conductor cable shown in Fig 1 is used for 3-phase service. The conductors are made of tinned copper or aluminium and are usually stranded in order to provide flexibility to the cable and having high conductivity.

ii Insulation: Each core or conductor is provided with a suitable thickness of insulation, the thickness of layer depending upon the voltage to be withstood by the cable. The commonly used materials for insulation are impregnated paper, varnished cambric or rubber mineral compound. Petrolium jelly is applied to the layers of the cambric to prevent damage.

iii Metallic sheath: In order to protect the cable from moisture, gases or other damaging liquids (acids or alkalies) in the soil and atmosphere, a metallic sheath of lead or aluminium is provided over the insulation as shown in Fig 1. The metallic sheath is usually a lead or lead alloy.

iv Paper belt: Layer of impregnated paper tape is wound round the grouped insulated cores. The gap in the cores is filled with fibrous insulating material (jute etc.)

v Bedding: Over the metallic sheath is applied a layer of bedding which consists of a fibrous material like jute or hessian tape. The purpose of bedding is to

protect the metallic sheath against corrosion and from mechanical injury due to armouring.

vi **Armouring:** Over the bedding, armouring is provided which consists of one or two layers of galvanized steel wire or steel tape. Its purpose is to protect the cable from mechanical injury while laying it and during the course of handling. Armouring may not be done in the case of some cables.

vii **Serving:** In order to protect armouring from atmospheric conditions, a layer of fibrous material (like jute) similar to bedding is provided over the armouring. This is known as serving.

It may not be out of place to mention here that bedding, armouring and serving are only applied to the cables for the protection of conductor insulation and to protect the metallic sheath from mechanical injury.

The principal insulating materials used in cables are

i Rubber

ii Vulcanized India rubber

iii Impregnated paper

iv Varnished cambric and

v Polyvinyl chloride.

Table - Conversion table SWG to mm/inch

SWG No.	mm	inch
0	8.23	0.324
1	7.62	0.300
2	7.01	0.276
3	6.40	0.252
4	5.89	0.234
5	5.38	0.212
6	4.88	0.192
7	4.47	0.176
8	4.06	0.160
9	3.66	0.144
10	3.25	0.128
11	2.95	0.116
12	2.64	0.104
13	2.34	0.092
14	2.03	0.080
15	1.83	0.072
16	1.63	0.064
17	1.42	0.056
18	1.22	0.048
19	1.02	0.040
20	0.91	0.036
21	0.81	0.032
22	0.71	0.028
23	0.61	0.024
24	0.56	0.022
25	0.51	0.020
26	0.46	0.018
27	0.42	0.0164
28	0.38	0.0148
29	0.34	0.0136
30	0.31	0.0124
31	0.29	0.0116
32	0.27	0.0108
33	0.25	0.0100
34	0.23	0.0092
35	0.21	0.0084
36	0.19	0.0076

To measure the size of conductors, a electrician can use normally a standard wire gauge or an outside micrometer for more accurate results.

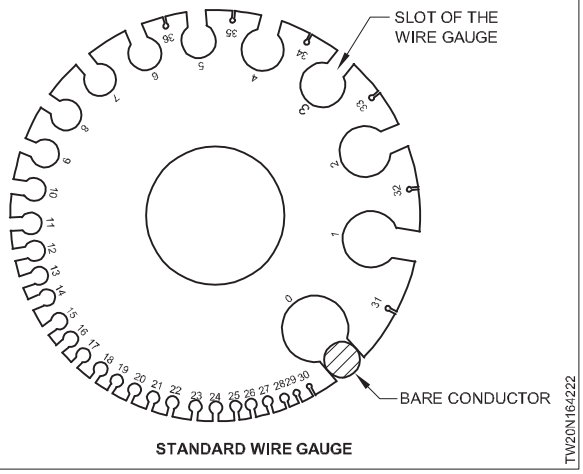
Standard Wire Gauge (SWG)

The size of the conductor is given by the standard wire gauge number. According to the standards each number has an assigned diameter in inch or mm. This is given in Table 1. The standard wire gauge, shown in Figure 1 could measure the wire size in SWG numbers from 0 to 36. It should be noted that the higher the number of wire gauge the smaller is the diameter of the wire.

For example, SWG No. 0 (zero) is equal to 0.324 inch or 8.23 mm in diameter whereas SWG No.36 is equal to 0.0076 inch or 0.19 mm in diameter.

While measuring the wire, the wire should be cleaned and then inserted into the slot of the wire gauge to determine the SWG number.

Fig 2



Kirchhoff's law and its applications

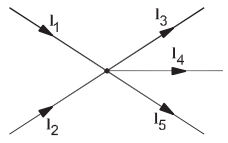
Objectives: At the end of this lesson you shall be able to
- **state Kirchhoff's first law**
- **apply Kirchhoff's first law to find the circuit current**
- **state Kirchhoff's second law and apply the same to find the voltage drop in branches**
- **solve problems by applying kirchhoff's laws.**

Kirchoff's laws are used in determining the equivalent resistance of a complex network and the current flowing in the various conductors.

Kirchhoff's laws

Kirchhoff's first law: At each junction of currents, the sum of the incoming currents is equal to the sum of the outgoing currents. (Fig 1) (or) The algebric sum of all branch currents meeting at a point/node is zero.

Fig 1



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If all inflowing currents have positive signs and all outflowing currents have negative signs, then we can state that

$$I_1 + I_2 = I_3 + I_4 + I_5$$

$$+ I_1 + I_2 - I_3 - I_4 - I_5 = 0$$

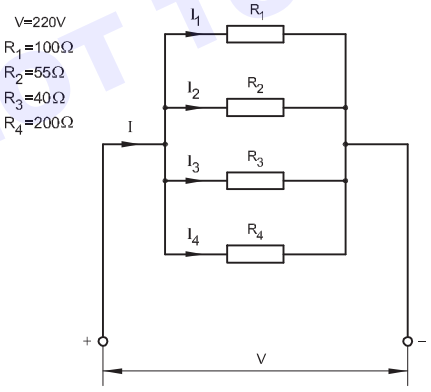
In the above example the sum of all the currents flowing at the junction (node) is equal to zero.

$$\Sigma I = 0$$

$$I = I_1 + I_2 + I_3 + ...$$

Example: Apply Kirchhoff's First Law to find the current shown in circuit.(Fig 2)

Fig 2



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Find current

$$I, I_1, I_2, I_3, I_4$$

Solution

$$I_1 = \frac{V}{R_1} = \frac{220\ V}{100\ ohms} = 2.2A$$

$$I_2 = \frac{V}{R_2} = \frac{220\ V}{55\ ohms} = 4A$$

$$I_3 = \frac{V}{R_3} = \frac{220\ V}{40\ ohms} = 5.5A$$

$$I_4 = \frac{V}{R_4} = \frac{220\ V}{200\ ohms} = 1.1A$$

$$I = I_1 + I_2 + I_3 + I_4$$

$$= 2.2A + 4A + 5.5A + 1.1A = 12.8A$$

Checking the calculation

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$= \frac{1}{100} + \frac{1}{55} + \frac{1}{40} + \frac{1}{200}$$

$$= \frac{22 + 40 + 55 + 11}{2200} = \frac{128}{2200} = \frac{16}{275}$$

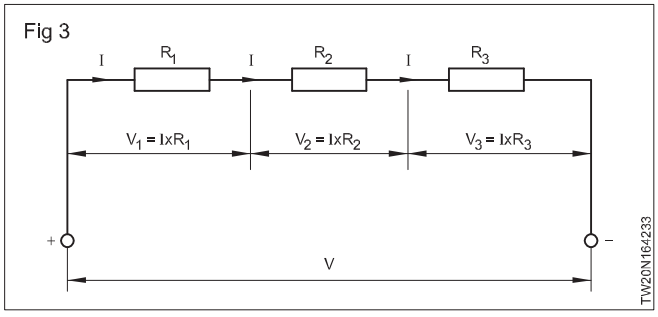
$$\frac{1}{R_{TOT}} = \frac{16}{275}$$

$$R_{TOT} = 17.19\ ohms$$

$$I = \frac{V}{R_{TOT}} = \frac{220V}{17.19\ ohms} = 12.798\ A$$

Kirchhoff's second law : In closed circuits, the applied terminal voltage V is equal to the sum of the voltage drops V_1+V_2 and so forth. (Fig 3)

Fig 3



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If all the generated voltages are taken as positive, and all the consumed voltages are taken as negative, then it can be stated that:

in each closed circuit the sum of all voltages is equal to zero.

$$\Sigma V = 0$$

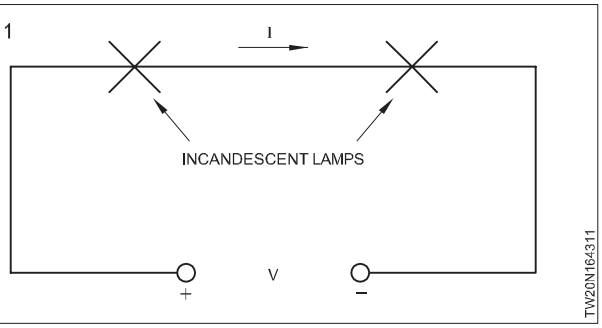
Series and parallel connection - simple problems

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

- **state the characteristics of series circuit and determine the current and voltage across each resistors**
- **determine the total voltage sources in series circuit**
- **state the relation between EMF potential difference and terminal voltage.**

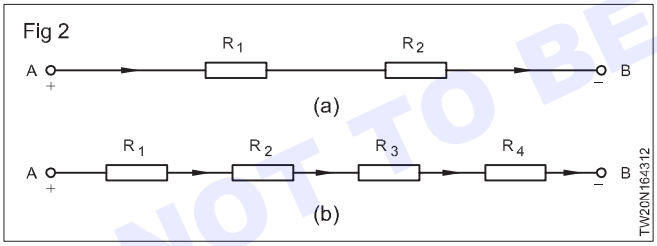
The series circuit: If more than one resistors are connected one by one like a chain and if the current has only one path is called as series circuit. It is possible to connect two incandescent lamps in the way shown in Fig 1. This connection is called a series connection, in which the same current flows in the two lamps.

Fig 1



The lamps are replaced by resistors in Fig 2. Fig 2 (a) shows two resistors are connected in series between point A and point B. Fig 2(b) shows four resistors are in series. Of course, there can be any number of resistors in a series connection. Such connection provides only one path for the current to flow.

Fig 2



Current in series circuits

The current will be the same at any point of the series circuit. This can be verified by measuring the current in any two points of a given circuit as shown in Figs 3a and 3b. The ammeters will show the same reading.

The current relationship in a series circuit is

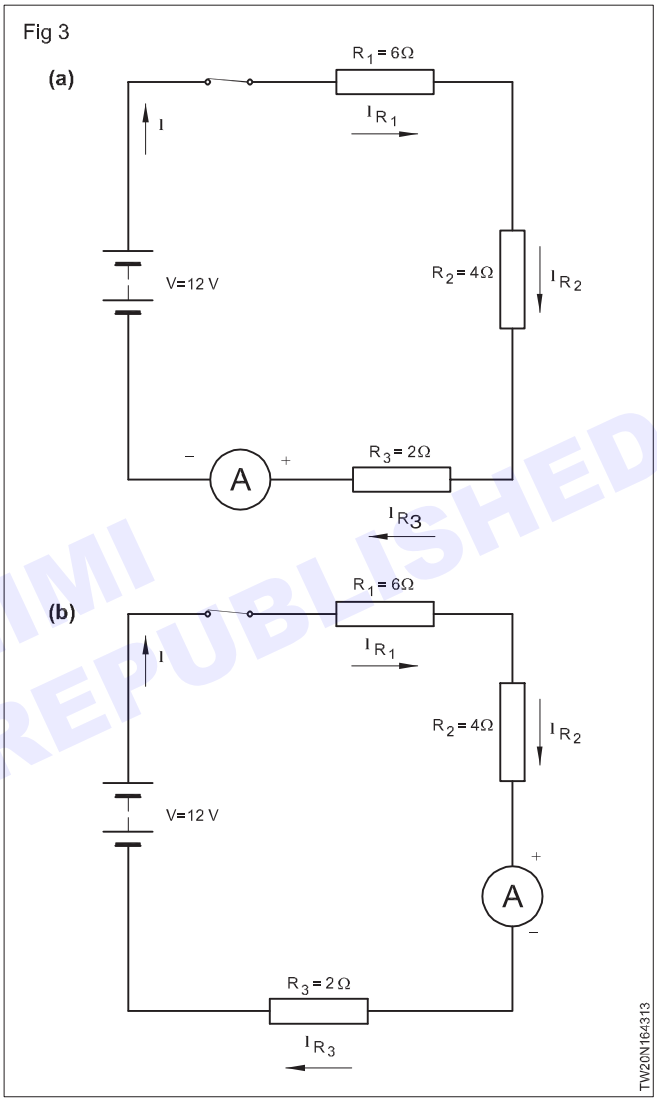
$$I = I_{R1} = I_{R2} = I_{R3}.$$ (Refer Fig 3a & 3b)

We can conclude that there is only one path for the current to flow in a series circuit. Hence, the current is the same throughout the circuit.

The total resistance in a series circuit is equal to the sum of the individual resistances around the series circuit. This statement can be written as

$$R = R_1 + R_2 + R_3 + ...R_n$$

Fig 3



where R is the total resistance

$R_1, R_2, R_3, ...R_n$ are the resistors connected in series.

When a circuit has more than one resistor of the same value in series, the total resistance is R = r x N

where 'r' is the value of each resistor and N is the number of resistors in series.

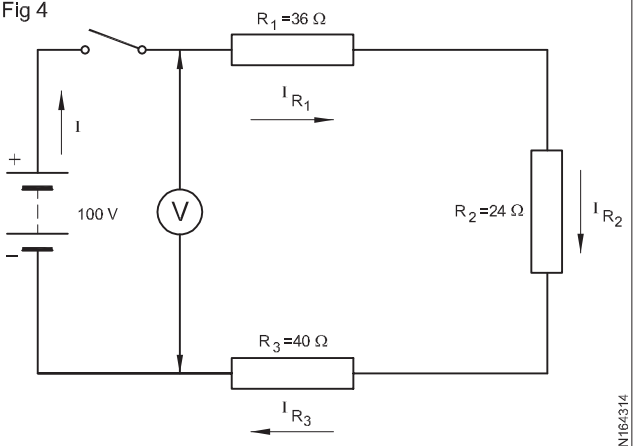
Voltage in series circuits: In DC circuit voltage divides up across the load resistors, depending upon the value of the resistor so that the sum of the individual load voltages equals the source voltage.

As the source voltage divides/drops across the series resistance depending upon the value of the resistances

$$V = V_{R1} + V_{R2} + V_{R3} + ...V_{RH}$$

The total voltage of a series circuit must be measured across the voltage source, as shown in Fig 4.

Fig 4



MEASURIING THE TOTAL VOLTAGE OF SERIES CIRCUIT

When Ohm's law is applied to the complete circuit having an applied voltage V, and total resistance R, we have the current in the circuit as

$$I = \frac{V}{R}$$

Application of Ohm's law to DC series circuits

Applying Ohm's law to the series circuit, the relation between various currents could be stated as below

$$I = I_{R1} = I_{R2} = I_{R3}$$

This could be stated as $\frac{V}{R} = \frac{V_{R1}}{R_1} = \frac{V_{R2}}{R_2} = \frac{V_{R3}}{R_3}$

You can use any of the above formulae to calculate current in a series circuit.

$V = V_{R1} + V_{R2} + V_{R3}$

i.e.IR = $R_1 I_{R1} + R_2 I_{R2} + R_3 I_{R3}$

and total resistance $R = R_1 + R_2 + R_3$.

Use of series connection

1 Cells in torch light, car batteries, etc.

2 Cluster of mini-lamps used for decoration purposes.

3 Fuse in circuit.

4 Overload coil in motor starters.

5 Multiplier resistance of a voltmeter.

Definitions

Electromotive force (emf)

We have seen that the electromotive force (emf) of a cell is the open circuit voltage, and the potential difference (PD) is the voltage across the cell when it delivers a current. The potential difference is always less than the emf.

Potential difference

PD = emf – voltage drop in the cell

Potential difference can also be called by another term, the terminal voltage, as explained below.

Terminal voltage

It is the voltage available at the terminal of the source of supply. Its symbol is V_T. Its unit is also the volt. It is given by the emf minus the voltage drop in the source of supply,

i.e. V_T = emf – IR

where I is the current and R the resistance of the source.

Voltage drop (IR drop)

The voltage lost by resistance in a circuit is called the Voltage drop or IR drop.

DC parallel circuit

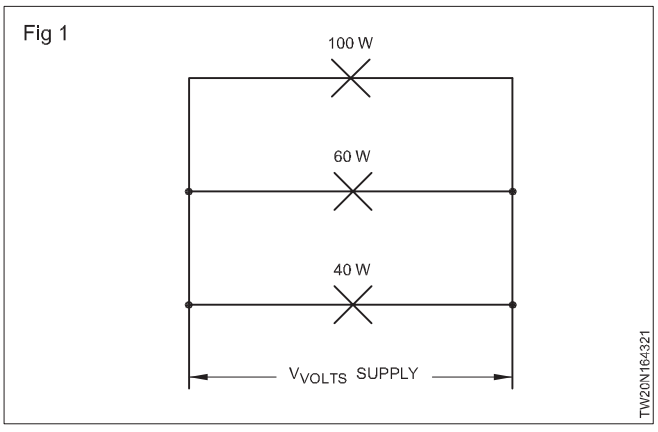
Objectives: At the end of this lesson you shall be able to

- **explain a parallel circuit**
- **determine the voltages in a parallel circuit**
- **determine the current in a parallel circuit**
- **determine the total resistances in a parallel circuit**
- **state the application of a parallel circuit.**

In an electrical circuit, if the current has more than one paths and equal voltage in each branch is called parallel circuit.

It is possible to connect three incandescent lamps as shown in Fig 1. This connection is called parallel connection in which, the same source voltage is applied across all the three lamps.

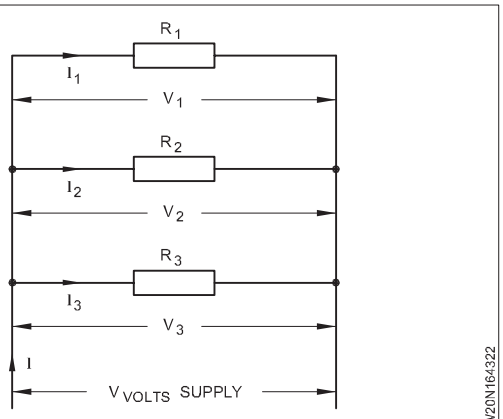
Fig 1



Voltage in parallel circuit: The lamps in Fig 1 are replaced by resistors in Fig 2. Again the voltage applied across the resistors is the same and also equal to the supply voltage.

We can conclude that the voltage across the parallel circuit is the same as the supply voltage.

Fig 2



Mathematically it could be expressed as $V = V_1 = V_2 = V_3$.

Current in parallel circuit: Again referring to Fig 2 and applying Ohm's law, the individual branch currents in the parallel circuit could be determined.

Current in resistor $R_1 = I_1 = \frac{V_1}{R_1} = \frac{V}{R_1}$.

Current in resistor $R_2 = I_2 = \frac{V_2}{R_2} = \frac{V}{R_2}$.

Current in resistor $R_3 = I_3 = \frac{V_3}{R_3} = \frac{V}{R_3}$

as $V_1 = V_2 = V_3$.

Refer to Fig 2 in which the branch currents I_1, I_2 and I_3 are shown to flow into resistance branches R_1, R_2 and R_3 respectively.

The total current I in the parallel circuit is the sum of the individual branch currents.

Mathematically it could be expressed as $I = I_1 + I_2 + I_3 + ... I_n$.

Resistance in parallel circuit

In a parallel circuit, individual branch resistances offer opposition to the current flow though the voltage across the branches will be same.

Let the total resistance in the parallel circuit be R ohms.

By the application of Ohm's law

we can write

$R = \frac{V}{I}$ ohms or $I = \frac{V}{R}$ amps.

where

R is the total resistance of the parallel circuit in ohms

V is the applied source voltage in volts, and

I is the total current in the parallel circuit in amperes.

We have also seen

$I = I_1 + I_2 + I_3$

or $\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

As V is the same throughout the equation and dividing the above equation by V, we can write

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The above equation reveals that in a parallel circuit, the reciprocal of the total resistance is equal to the sum of the reciprocals of the individual branch resistances.

Applications of parallel circuits

The electric system used in homes consists of many parallel circuits.

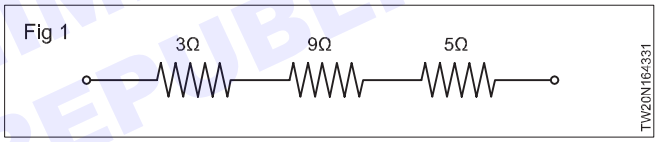
An automobile electric system uses parallel circuits for lights, horn, motor, radio etc. Each of these devices operates independent of the others.

Individual television circuits are quite complex. However, the complex circuits are connected in parallel to the main power source. That is why the audio section of television receivers can still work when the video (picture) is inoperative.

Problems

1 Three resistance of 3 ohms, 9 ohms and 5 ohms are connected in series. Find their resultant resistance.

Fig 1



Solution

$$R = R_1 + R_2 + R_3$$
$$= 3\ \Omega + 9\ \Omega + 5\ \Omega$$

Total resistance $= 17\ \Omega$

2 Three resistance of 4 ohms, 6 ohms, and 8 ohms respectively are connected in parallel. Find the equivalent resistance.

Solution

Resistance are connected in parallel connection

Total resistance $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6} + \frac{1}{8}$$

$$= \frac{(6+4+3)}{24} = \frac{13}{24}$$

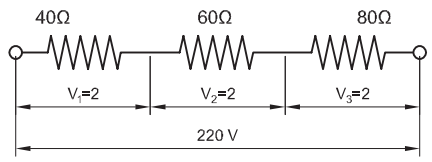
$$\frac{1}{R} = \frac{13}{24}$$

$$R = \frac{24}{13}$$

$$= 1\frac{11}{13} \text{ ohm's}$$

3 Three resistance of 40, 60 and 80 ohms are in series across a supply of 202 volt. Find the current in the circuit and voltage across each resistance.

Fig 2



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Solution

Resistance are connected in series connection

Total resistance R $= R_1 + R_2 + R_3$ ohm

$= 40 + 60 + 80$ ohm

$= 180$ ohm

Current I $= \frac{V}{R}$

$= \frac{202}{180}$

$= 1.222$ amp.

Voltage V_1 in 40 Ω resistance $= I\,R_1$ volt

$= 1.222 \times 40$

$= 48.88$ volt.

Voltage V_2 in 60 Ω resistance $= I\,R_2$ volt

$= 1.222 \times 60$

$= 73.32$ volt

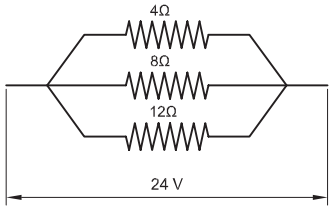
Voltage V_3 in 80 Ω resistance $= I\,R_3$ volt

$= 1.222 \times 80$

$= 97.76$ volt

4 Three resistance 4, 8 and 12ohms are connected in parallel across a 24 volt battery supply. Find the current flowing through each resistance and the current delivered by the battery.

Fig 3



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Solution:

Total resistance $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12}$

$= \frac{6+3+2}{24} = \frac{11}{24}$

$\frac{1}{R} = \frac{11}{24}$

$R = \frac{24}{11}$

$= 2.18$ ohm's

Current from battery, $I = \frac{V}{R}$

Current in 4 Ω resistance $I_1 = \frac{V}{R_1}$

$= \frac{24}{4} = 6$ amp

Current in 8 Ω resistance $I_2 = \frac{V}{R_2}$

$= \frac{24}{8} = 3$ amp

Current in 12 Ω resistance $I_3 = \frac{V}{R_3}$

$= \frac{24}{12} = 2$ amp

Properties of conductor, semi - conductor and insulator

Objectives: At the end of this lesson you shall be able to
- **differentiate between conducting and insulating materials**
- **state the electrical properties of conducting materials**
- **state the characteristics of copper and aluminium conductors**
- **state the types and properties of insulating materialss**
- **describe the method of measurement of wire size using SWG**
- **explain the method of measure wire size by outside micrometer.s**

Conductors and insulators

Material with high electron mobility (many free electrons) are called conductor.

Materials that contain many free electrons and are capable of carrying an electric current are known as conductors.

Examples - silver, copper, aluminium and most other metals.

Materials with low electron mobility (few (or) no free electron) are called insulators

Materials that have only a few electrons and are incapable of allowing the current to pass through them are known as insulators.

Examples - wood, rubber, PVC, porcelain, mica, dry paper and fibreglass.

Copper and aluminium

In electrical work, mostly copper and aluminium are used for conductors. Though silver is a better conductor than copper, it is not used for general work due to higher cost.

Copper used in electrical work is made with a very high degree of purity, say 99.9 percent.

Characteristics of copper

1 It has the best conductivity next to silver.

2 It has the largest current density per unit area compared to other metals. Hence the volume required to carry a given current is less for a given length.

3 It can be drawn into thin wires and sheets.

4 It has a high resistance to atmospheric corrosion: hence, it can serve for a long time.

5 It can be joined without any special provision to prevent electrolytic action.

6 It is durable and has a high scrap value.

Next to copper, aluminium is the metal used for electrical conductors.

Characteristics of aluminium

1 It has good conductivity, next to copper. When compared to copper, it has 60.6 percent conductivity. Hence, for the same current capacity, the cross-section for the aluminium wire should be larger than that for the copper wire.

2 It is lighter in weight.

3 It can be drawn into thin wires and sheets. But loses its tensile strength on reduction of the cross-sectional area.

4 A lot of precautions needs to be followed while joining aluminium conductors.

5 The melting point of aluminium is low, hence it may get damaged at points of loose connection due to heat developed.

6 It is cheaper than copper.

Table 1 shows the properties of copper compared with those of aluminium.

Table 1

Characteristics of conductor materials

Sl. No.	Properties	Copper (Cu)	Aluminium (Al)
1	Colour	Reddish	White brown
2	Electrical conductivity in MHO/metre	56	35
3	Resistivity at 20°C in ohm/metre (Cross-sectional area in 1 mm^2)	0.01786	0.0287
4	Melting point	1083°C	660°C
5	Density in kg/cm^3	8.93	2.7
6	Temperature coefficient of resistance at 20°C per °C	0.00393	0.00403
7	Coefficient of linear expansion at 20°C per °C	17×10^{-6}	23×10^{-6}
8	Tensile strength in Nw/mm^2	220	70

Properties of insulating materials

Two fundamental properties of insulation materials are insulation resistance and dielectric strength. They are entirely different from each other and measured in different ways.

Insulation resistance

Megohmmeter (Megger) is the instrument used to measure insulation resistance. It measures high resistance values in megohms without causing damage to the insulation. The measurement serves as a guide to evaluate the condition of the insulation.

Dielectric strength

It is the measure of how much potential difference the insulation layer can withstand without breaking down. The potential difference that causes a breakdown is called the breakdown voltage of the insulation.

Every electrical device is protected by some kind of insulation. The desirable characteristics of insulation materials are

- high dielectric strength
- resistance to temperature
- flexibility
- mechanical strength.

No single material has all the characteristics required for every application. Therefore, many kinds of insulating materials have been developed.

Measurement of wire sizes - standard wire gauge - outside micrometer

Necessity of measuring the wire sizes

A proper estimate involves determination of current in different loads, correct selection of the type of cable, size of the cable and the required quantity. Any error will result in defective wiring, fire accidents and bring unhappiness to both the house owner and the electrician.

A sound knowledge about the area of the cross-section of the core, the diameter of the single strand of the conductor and the number of conductors in each core of the stranded conductor is essential for a wireman to be successful in his career.

Primary cells and secondary cells

Objectives: At the end of this lesson you shall be able to
- **state the principle and construction of primary cells**
- **state the principle and construction of secondary cells (lead acid, nickel iron and nickel cadmium)**
- **compare the primary cells and secondary cells.**

Type of cells

Cell: A cell is an electrochemical device consisting of two electrodes made of different materials and an electrolyte. The chemical reaction between the electrodes and the electrolyte produces a voltage.

Cells are classified as

- dry cells
- wet cells.

A dry cell is one that has a paste or gel electrolyte. With newer designs and manufacturing techniques, it is possible to completely (hermetically) seal a cell. With complete seals and chemical control of gas build-up, it is possible to use liquid electrolytes in dry cells. Today the term `dry cell' refers to a cell that can be operated in any position without electrolyte leakage.

Wet cells are cells that must be operated in an upright position. These cells have vents to allow the gases generated during charge or discharge to escape. The most common wet cell is the lead-acid cell.

Cells are further classified as primary and secondary cells.

Primary cells: Primary cells are those cells that are not rechargeable. That is, the chemical reaction that occurs during discharge is not reversed. The chemicals used in the reactions are all converted when the cell is fully discharged. It must then be replaced by a new cell.

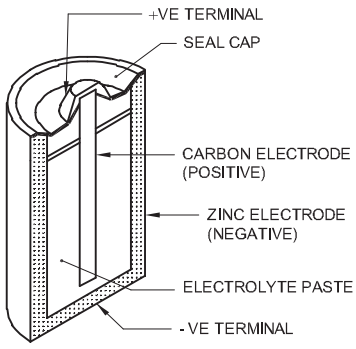
Types of primary cells

- Voltaic cell
- Carbon-zinc cell (Leclanche cell and Dry cell)
- Alkaline cell
- Mercury cell
- Silver oxide cell
- Lithium cell

Dry cell (Carbon-Zinc cell): The danger of spilling the liquid electrolyte from a Leclanche type of cell led to the invention of another class of cells called dry cells.

The most common and least expensive type of a dry cell is the carbon-zinc type (Fig 1). This cell consists of a zinc container which acts as the negative electrode. In the centre is a carbon rod which is the positive electrode. The electrolyte takes the form of a moist paste made up of a solution containing ammonium chloride.

Fig 1



CARBON-ZINC DRY CELL

As with all primary cells, one of the electrodes becomes decomposed as part of the chemical reaction. In this cell the negative zinc container electrode is the one that is used up. As a result, cells left in equipment for long periods of time can rupture, spilling the electrolyte and causing damage to the neighboring parts.

Carbon-zinc cells are produced in a range of common standard sizes. These include 1.5 V AA,C and D cells .(AA Pen type cell, `C' medium size and 'D' large/economy size).

Uses: Primary cells are used in electronic products ranging from watches, smoke alarms, cardiac pacemakers, torches, hearing aids, transistor radios etc.

Internal resistance: The output voltage from a cell varies as the load on the cell changes. Load on a cell refers to the amount of current drawn from the cell. As the load increases, the voltage output drops. The change in output voltage is caused by the internal resistance of the cell. Since materials from which the cell is made are not perfect conductors, they have resistance. Current flowing through the external circuit also flows through the internal resistance of the cell.

Defects of a simple cell: With a simple voltaic cell, the strength of current gradually diminishes after some time. This defect is mainly due to two causes.

- Local action
- Polarisation

Local action: In a simple voltaic cell, bubbles of hydrogen are seen to evolve from the zinc plate even on open circuit. This effect is termed local action. This is due to the presence of impurities like carbon, iron, lead, etc. in the commercial zinc. This forms small local cells on the zinc plate and reduces the strength of current of the cell.

The local action is prevented by amalgamating the zinc plate with mercury. To do so, the zinc plate is immersed in dilute sulphuric acid for a short time, and afterwards, mercury is rubbed over its surface.

Polarisation: As current flows, bubbles of H_2 evolve at the copper plate on which they gradually form a thin layer. Due to this the current strength falls and finally stops altogether. This effect is called the polarization of the cell.

Polarisation can be prevented by using some chemicals which will oxidize the hydrogen to water before it can accumulate on the plate. The chemicals used to remove polarisation are called de-polarisers.

Secondary cell: A cell that can be recharged by sending electric current in the reverse direction to that of a discharge mode is known as a secondary cell.

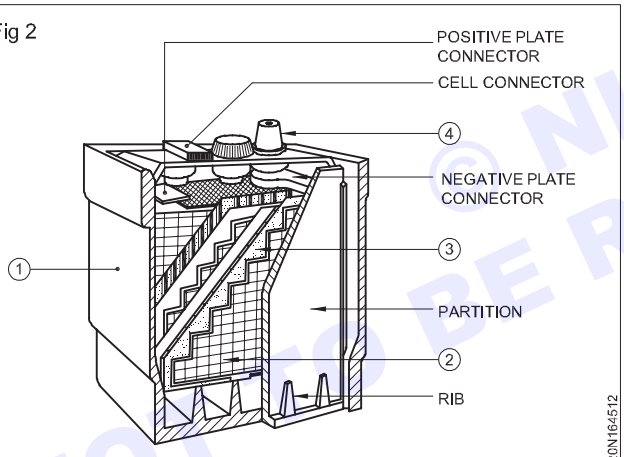
The secondary cell is also called a storage cell since after it is charged it stores the energy until it is used up or discharged.

Types of secondary cells

- Lead acid cell
- Alkaline cell or nickel-iron cell

Parts of lead acid cell (Fig 2)

Fig 2



PARTS OF LEAD ACID CELL

1 Container

2 Plates

3 Separators

4 Post terminals

Container: The container is made of hard rubber, glass or celluloid to accommodate the active plates, separators and the electrolyte. The plates rest on ribs provided at the bottom of the container and the space between ribs is known as sediment chamber.

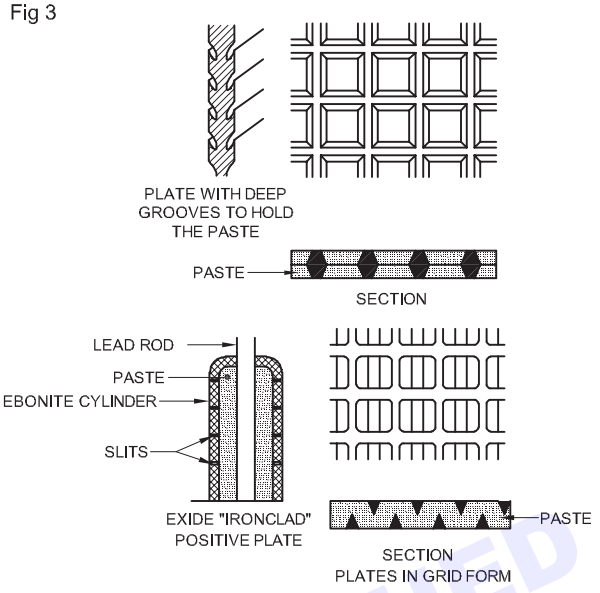
Plates: Positive plates are of two types.

- Plante plate or formed plates
- Faure plate

Plante plates: These are prepared by the process of repeated charging and discharging. They are made of pure lead at the beginning which changes to lead peroxide after charge.

Faure plate: Pasted or Faure plates are made of rectangular lead grid into which the active material i.e. lead peroxide ($Pb O_2$) is filled in the form of a paste (Fig 3).

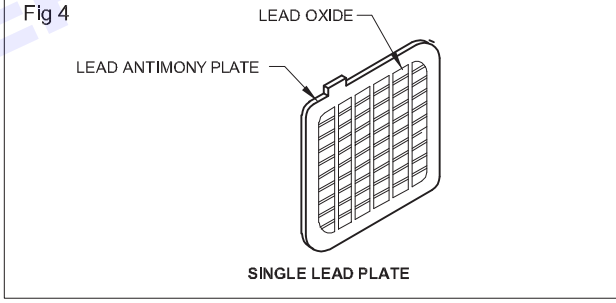
Fig 3



CONSTRUCTION OF PASTED-TYPE ACCUMULATOR PLATES

Negative plates are made of rectangular lead grid, and the active material is spongy lead (Pb) which is in the form of a paste (Fig 4).

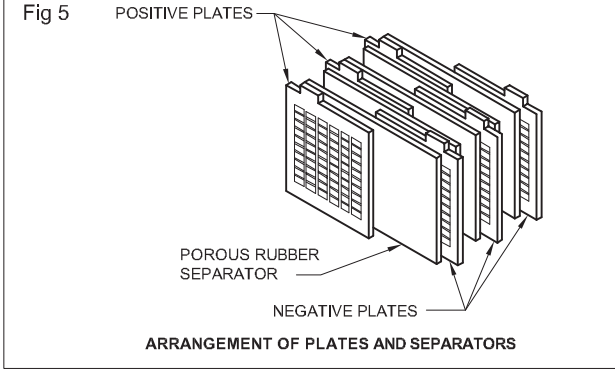
Fig 4



SINGLE LEAD PLATE

Separators: These are made of thin sheets of chemically treated porous wood or rubber. They are used to avoid short in between the positive and negative plates (Fig 5).

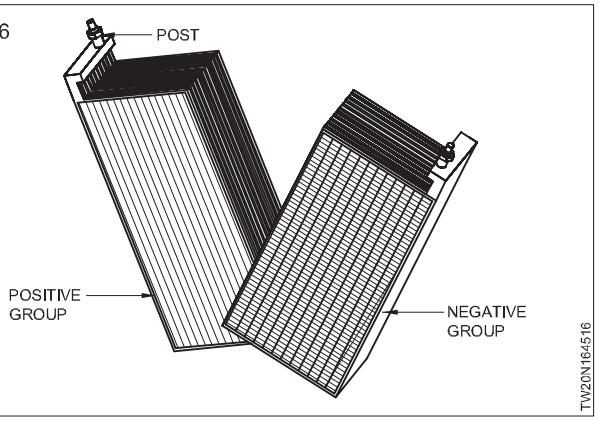
Fig 5



ARRANGEMENT OF PLATES AND SEPARATORS

Post terminal: A small pole extended upward from each group of welded plates from the plate connecter (Fig 6) forms the post terminal.

Fig 6



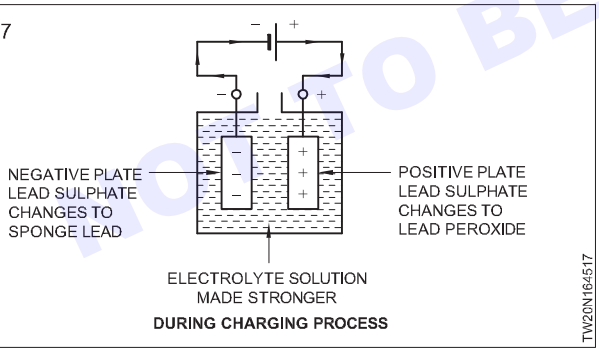
Electrolyte: The electrolyte used in a lead acid cell is dilute sulphuric acid (H_2SO_4). The specific gravity of the electrolyte is 1.24 to 1.28. It varies according to the manufacturer's specification.

Working principle

The secondary cell has no significant electrochemical energy at the start. The energy must first be charged into secondary cell. Then the cell retains the stored energy until it is used up. That is,both cell electrodes are basically lead sulphate (Pb SO_4).When the cell is charged, due to chemical reaction taking place in it, the lead sulphate eletctrode change to soft or sponge lead, (Pb - negative plate) and the other electrode changes to lead peroxided(Pb O_2 - positive plate).

At the same time the electrolyte solution is strengthened and becomes strong sulphuric acid (H_2SO_4) (Fig 7).

Fig 7



Voltage of a fully charged cell is 2.1 to 2.6V and the voltage falls to 1.8V after discharge.

Capacity: The unit of capacity of a storage cell is ampere-hour (AH). It is the product of the rated current of a cell/battery in amperes and the time in hours at which it can discharge that rated current,

Capacity = Current x Time - AH

Temperature and specific gravity: The temperature of the electrolyte must be kept at 27°C and the specific gravity at 1.250 ± 0.010.

Excess temperature will cause more sulphation and buckling of the positive plate.

Defects

- Hard sulphation
- Buckling
- Partial short

Hard sulphation: Over discharging or the cell being left in a discharged condition for a long time cause sulphation on both electrodes and offers high internal resistance. The sulphation (hard) can be removed by recharging the cell for a longer period at a low rate called a trickle charge.

Buckling: The bending of electrodes due to overcharging and discharging, improper electrolyte and temperature is known as buckling.

Partial short: The sediments falling from the plates (electrodes) short- circuiting the positive and negative electrodes cause overheating of the particular cell during both charging and discharging periods. Such a cell may be replaced with a new one.

Efficiency: It is considered in two ways.

- Ampere-hour (AH) efficiency
- Watt-hour (WH) efficiency

$$\text{H efficiency} = \frac{\text{Output in AH discharge}}{\text{Input in AH charge}}$$

The watt-hour efficiency is always less than the ampere-hour efficiency because the potential difference during discharge is less than that during charge.

$$\text{Watt - hour efficiency} = \frac{\text{H efficiency x Average volts WH discharge}}{\text{Average volts WH charge}}$$

The chemical action which takes place in the cell during charge and discharge cycle is given below for your reference.

During discharge

positive plate

Lead peroxide	+	Hydrogen	+	Sulphuric Acid	→	Lead sulphate	+	water
PbO_2	+	H_2	+	H_2SO_4	→	$PbSO_4$	+	$2H_2O$

Negative plate

	Pure lead	+	Sulphate	=	Lead sulphate	
	Pb		+	SO_4	=	$PbSO_4$

During charge

positive plate

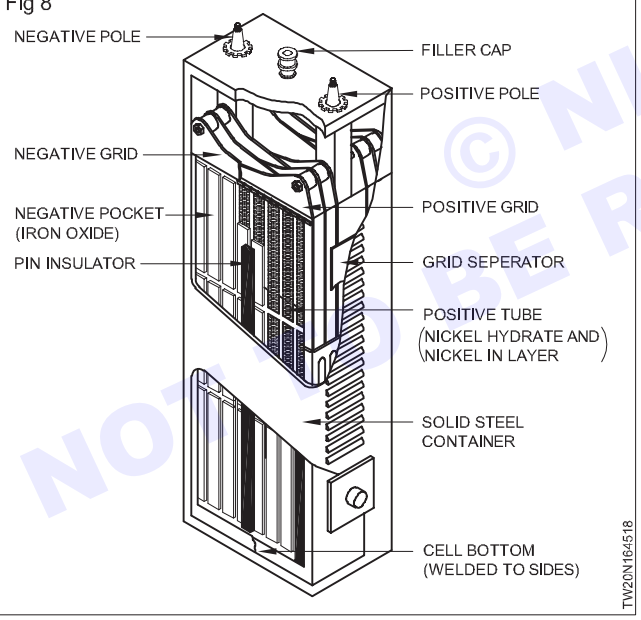
Lead sulphate	+	Sulphate	+	Water	→	Lead peroxide	+	Sulphuric acid
$PbSO_4$	+	SO_4	+	$2H_2O$	→	PbO_2	+	$2H_2SO_4$

Negative plate

	Lead sulphate	+	Hydrogen	→	Lead	+	Sulphuric acid	
	$PbSO_4$	+	H_2	→	Pb	+	H_2SO_4	

The nickel iron cell (Fig 8)

Fig 8



Parts

- Positive plate
- Negative plate
- Electrolyte
- Container
- Separators

The positive plate is made of Nickel hydroxide($Ni(OH)_4$) tubes and perforated steel ribbon wound spirally and held together by steel ribs, and the whole lot is nickel-plated.

The negative plate is made of a nickel steel strip with fine perforation. The electrolyte is 21% solution of potassium hydroxide (KOH) along with some quantity of lithium hydrate (LiOH).

The container is made of nickel-plated steel. The separators are made of hard rubber strips and held in the nickel-plated container.

Chemical changes: On discharge, potassium hydroxide (KOH) splits up into K and (OH)ions. i.e. into potassium and hydroxide ions. OH ions travel towards the negative and oxidise the iron. K ions go to the anode and reduce Ni $(OH)_1$ to Ni $(OH)_2$. During charging, the opposite reactions take place. The chemical changes during charging and discharging can be represented by a reversible equation.

It is seen from the equation that the electrolyte acts merely as a source for transfer of OH ions from one plate to another. It does not take part in any chemical change. As a result the density does not change to the same extent as in an ordinary lead acid cell. Thus, the density of the electrolyte remains almost the same during the action.

Characterristics: The Emf of the cell when fully charged is 1.4V, and it reaches to 1.2 on discharge. If the voltage falls below 1.15, the cell is fully discharged.

- The mechanical strength of plates is good since they are made of steel.
- The cell can withstand heavy charge and discharge currents, and does not deteriorate even if left discharged.
- It is superior to a lead acid cell in mechanical strength, durability and robustness.

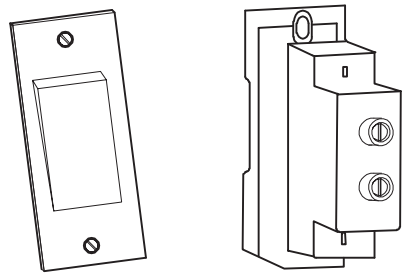
Moreover, as compared to lead-acid cells, the alkaline cells operate much better at low temperatures, do not emit obnoxious fumes, have very small self-discharge and their plates do not buckle or smell.

Common electrical accessories and their specifications

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

Single pole, one-way switch: This is a two terminal device, capable of making and breaking a single circuit only. It is used for controlling light or fan or 6 amps socket. (Fig 1)

Fig 1

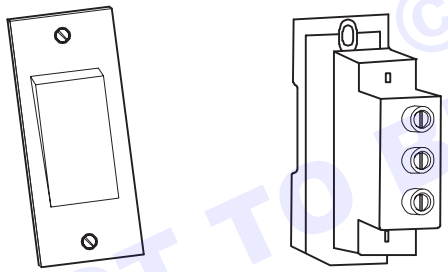


SINGLE POLE ONE WAY SWITCH

TW20N164611

Two-way switch: This is a three terminal device capable of making or breaking two connections from a single position (Fig 2). These switches are used in staircase lighting where one lamp is controlled from two different places.

Fig 2

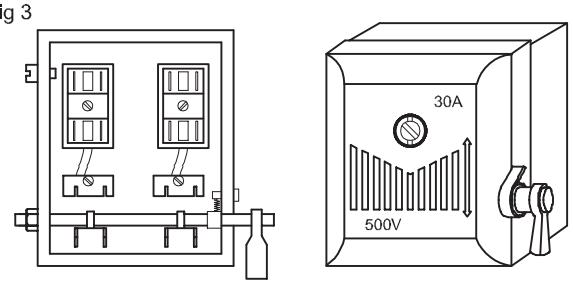


TWO WAY SWITCH

TW20N164612

Iron - Clad Double pole (ICDP) main switch : This switch is also referred to as DPIC switch and is mainly used for single phase domestic installations, to control the main supply. It controls phase and neutral of the supply simultaneously (Fig 3).

Fig 3



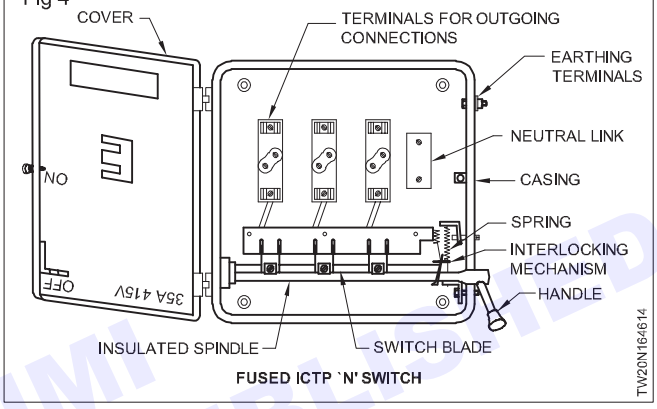
DPIC MAIN SWITCH

TW20N164613

The current rating of the switch varies from 16 amps to 32 amperes.

Iron - Clad Triple pole (ICTP) main switch: This is also referred to as TPIC switch and is used in large domestic installation and also in 3-phase power circuits, the switch consists of 3 fuse carriers, one for each phase. Neutral connection is also possible as some switches are provided with a neutral link inside the casing (Fig 4).

Fig 4

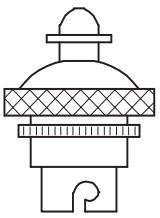


FUSED ICTP `N' SWITCH

TW20N164614

Pendent lamp-holders: This holder (Fig 5) is used in places where the lamps are required in a hanging position. These holders are made of either brass or bakelite.

Fig 5



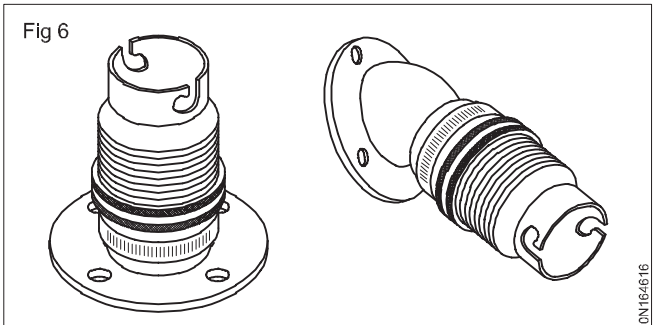
PENDENT HOLDER

TW20N164615

Batten lamp-holders: The straight batten holder (Fig 6a) is used on a flat surface on the round block, wooden board etc. These holders are made of either brass or bakelite.

Angle holders: The angle bottom holder, (Fig 6b) is to hold the lamp in a particular angle. These are made of either brass or bakelite. These are used for advertising boards, window display, kitchens etc.

Fig 6

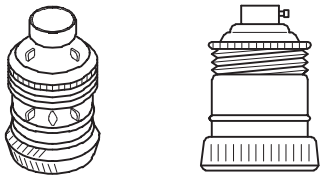


(a) BRASS BATTEN HOLDER (b) ANGLE HOLDER

TW20N164616

For lamps with wattage above 200W and not exceeding 300W, Edison screw-type holders are used. (Fig 7).

Fig 7



EDISON SCREW TYPE HOLDER

TW20N164617

Goliath Edison screw (GES) type holders (Fig 8): The cover of this type of holder is made of porcelain.

Fig 8

GOLIATH EDISON SCREW LAMP HOLDER

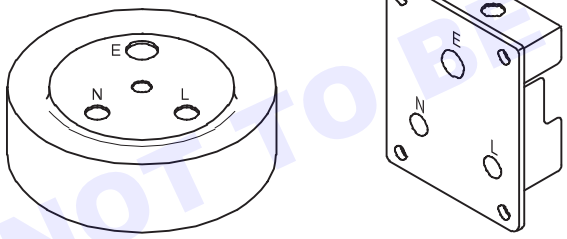
TW20N164618

These holders are used for more than 300W lamps.

Two-pin plug top: It is used for taking the supply from the socket. It has got two pins of the same size.

Three-pin socket: This type of socket is suitable for light and power circuits. These sockets are rated as 6A, 250V or 16A, 250V, and are available as surface-mounting type and flush type (Fig 9). There are three terminals marked as Line (L) Neutral (N) and Earth (E).

Fig 9



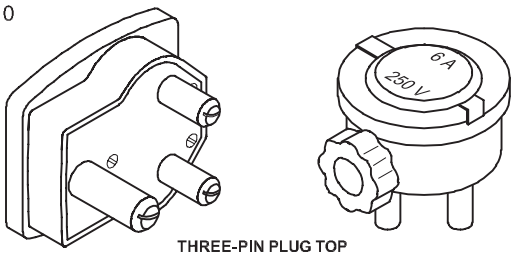
3-PIN 16 AMP SOCKET WITH TOP COVER

FLUSH TYPE SOCKET

TW20N164619

Three-pin plug top : It is used for taking the supply from the socket. It has three pins. Two are similar in size and the third one is bigger and longer which is for earth (Fig 10). These are also rated as 6A,250V or 16A, 250V. These are made of bakelite, PVC materials.

Fig 10

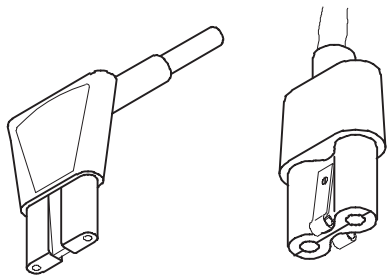


THREE-PIN PLUG TOP

TW20N164614A

Appliance connectors or iron connectors : These are used as female connectors to supply current to electric kettles, electric iron, hotplate, heaters etc. It is made of bakelite or porcelain. These are rated as 16A, 250V (Fig 11).

Fig 11



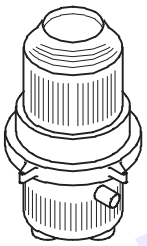
FLAT CONNECTOR WITH SIDE ENTRY

IRON CONNECTOR DIRECT ENTRY

TW20N164618

Adaptor (Fig 12): They are used for taking supply from a lamp holder for small appliances. They are made out of bakelite. They are available in ratings up to 6 A 250 V.

Fig 12

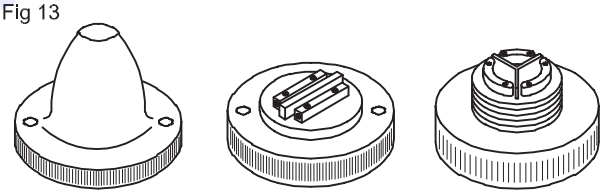


ADAPTOR

TW20N164614C

Ceiling roses: Ceiling roses are used to provide tapping points from the wiring for supplying power to fans, pendent-holders, tube lights etc. Normally flexible wires are used for tapping from the ceiling roses.(Fig 13)

Fig 13



(a) TOP COVER LOOKS THE SAME FOR (b) & (c)

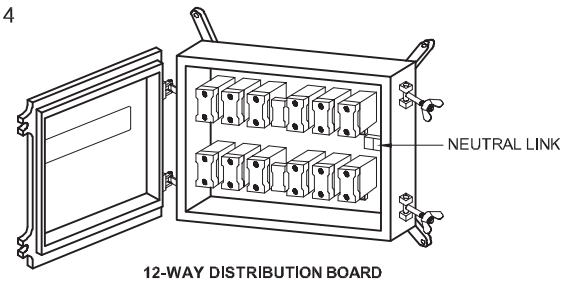
(b) BASE OF TWO PLATE CEILING ROSE

(c) BASE OF THREE PLATE CEILING ROSE

TW20N164614D

Distribution board (Fig 14): These are used where the total load is high and is to be divided into a number of circuits. These are used where the load is more than 800W. The number of fuses in the board is according to the number of circuits, and a neutral link is also provided so that the neutral wire can be taken for different circuits. All these branch fuses are enclosed in a metal box. These boards are available as two-way, three-way, 4,6,12-way types.

Fig 14

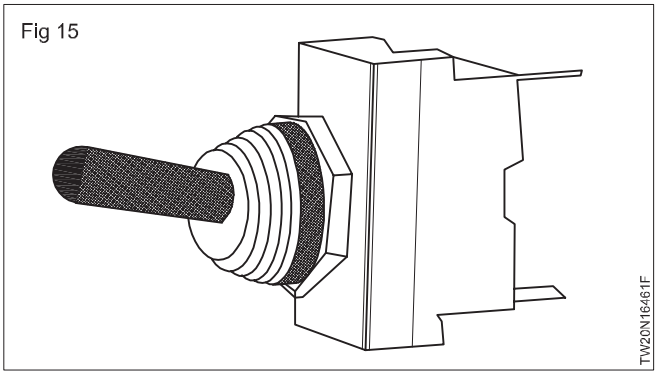


12-WAY DISTRIBUTION BOARD

TW20N164614E

Toggle switches (Fig 15)

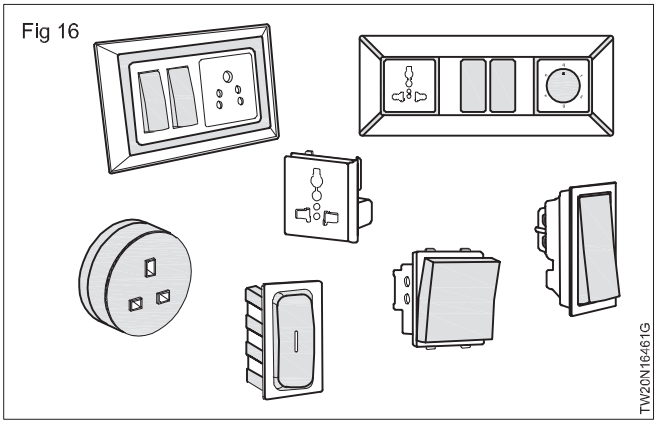
Fig 15



It is an electric switch operated by means of a projecting lever that can be moved upward and downward and is also called as snap switches .

Modular switches (Fig 16)

Fig 16



The latest version of modular switch of different sizes and colours along with sockets combined and switches with indicators are available in market.

Demonstration and description of domestic appliances

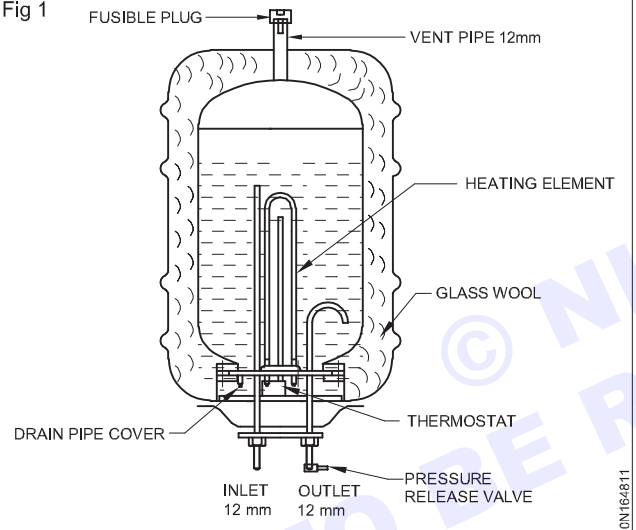
Objectives: At the end of this lesson you shall be able to
- **explain geyser**
- **list the parts of a geyser from the schematic and constructional diagrams**
- **explain the construction and operation of a geyser**
- **explain the possible faults in a geyser and their remedies.**

Geyser: It is an electric water heater which heats and maintains the temperature of the water stored in it.

There are several types of water heaters. The most usual one is the geyser, which is more efficient as the hot water can be directly drawn through a tap at different points.

Construction of geysers: The construction of a hot water geyser or storage water heater is simple (Fig 1).

Fig 1



CONSTRUCTION OF GEYSER

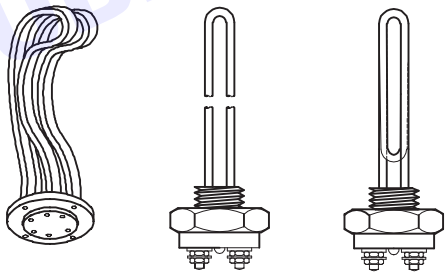
The outer casing is made of mild steel sheet. The inner tank is made of heavy gauge copper which is tinned to prevent corrosion. The space between the outer casing and the inner tank is filled with glass wool as heat insulation to avoid excess heat losses. Heating elements, thermostat, inlet and outlet pipes are fitted to the tank.

Heating elements are similar to those of immersion heaters but with different shapes to suit the tank sizes and the screw base. Fig 2 shows a few shapes of heating elements.

The rating of the heating elements depends on the capacity of the geyser. For up to 25 litres capacity, 1 KW elements are used while for 50 litres capacity 2 KW are used, for 100 litres capacity 3 KW are used.

Thermostats: Thermostats are used in water heaters to control the current to the heating elements and thereby regulate and maintain the water temperature between 32°C to 88°C.

Fig 2



DIFFERENT SHAPES OF HEATING ELEMENTS

Washing machine

Objectives: At the end of this lesson you shall be able to
- **explain the washing machine**
- **state the types of washing machines and wash techniques.**

Washing machine

It is a domestic electric appliance which is used to soak, rinse, wash, wringle /dry the cloth/fabrics etc.

Types of washing machines: The modern washing machines can be divided roughly into three main groups according to their function.

They are

– Ordinary

– Semi automatic

– Fully automatic.

i Ordinary type

Ordinary without timer: This machine uses the pulsator type technique in which a disc is fitted to the motor.

It has only one tub and one motor the dirty cloth is loaded in the tub, water is filled manually in the tub, detergent is added. The motor is switched on the pulsator disc moves the cloth around the tub and the time duration of washing is decided by the operator.

Ordinary with timer: Similar to the ordinary type, but added with a clock timer to select the time of wash from 1 to 15 minutes.

ii Semi-automatic type

This type has two tubs. One for washing and rinsing, the other for spin drying the cloths. The washing tub operates at lower speed whereas the spin drier tub operates at a higher speed. The machine may contain either one or two motors.

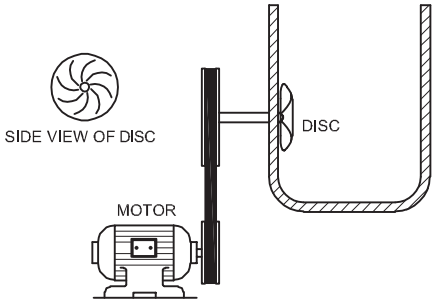
iii Fully automatic type

In this type, the micro processor enables to programme the wash cycle. There will be only one tub. The machine could be programmed for wash cycle, detergent intake and water input. The machine does washing, rinsing and also dry the cloth and stops.

Further to the above types the washing machine could be further divided by the type of loading i.e. top loading and front loading. In some machines the water used for washing could be preheated with the help of an electric heater.

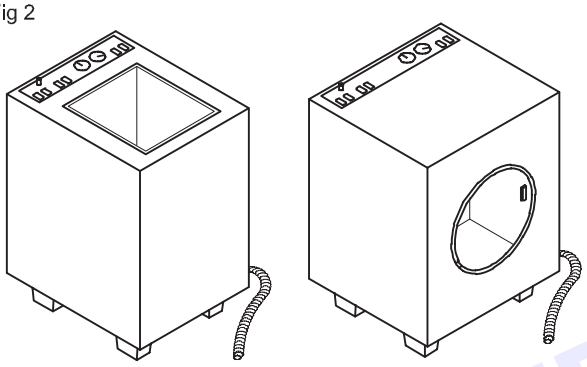
The pulsator wash technique (Fig 1)**:** This is the most common type pulsator wash technique, it has disc in concave shape used to rotate the clothes in water. Dirt is removed from the cloth by rubbing against tub wall surfaces and the disc. (Fig 1 & 2)

Fig 1



PULSATOR WASH TECHNIQUE

Fig 2



a) TOP LOADING b) Front LOADING

Automatic electric iron

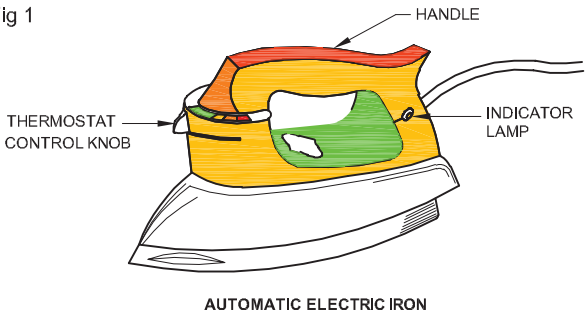
Objectives: At the end of this lesson you shall be able to
- **state the difference between non-automatic and automatic irons**
- **describe the construction of a bimetal thermostat**
- **illustrate the working of an adjustable thermostat**
- **list the possible faults, their causes and corrective action to be taken in an automatic iron.**

Automatic electric iron

The difference between an automatic iron and the ordinary (non-automatic) iron is that the automatic type has a thermostatic device to regulate the temperature. The other parts are more or less the same in both the types of irons. (Fig 1)

Automatic irons are fitted with a thermostatic switch to regulate the heat to a specific predetermined value. The thermostatic switch disconnects the supply when the predetermined value is reached and reconnects the supply when the iron cools down. A turning knob with a dial just below the handle, marked as rayon, cotton, silk, wool etc. can be operated to select the preset temperature.

Fig 1



AUTOMATIC ELECTRIC IRON

Electric kettle

Objectives: At the end of this lesson you shall be able to
- **explain electric kettle and its types**
- **list and state the parts of an electric kettle**
- **describe the method of fitting a new element**
- **state the general care and maintenance.**

Electric kettle

Electrical kettle is a heating device which is used to heat the liquid (like water, milk, etc) poured in it.

There are two types of electric kettles

– Saucepan type

– Immersion heating type.

Saucepan type: The construction of the sauce pan type kettle is given in Fig 1. The parts are as follows.

1 Bolt, nut and washer holding bottom cover

2 Heating element

3 Asbestos sheet

4 Sole-plate

5 Pressure plate

6 Bottom cover

7 Handle

8 Top lid

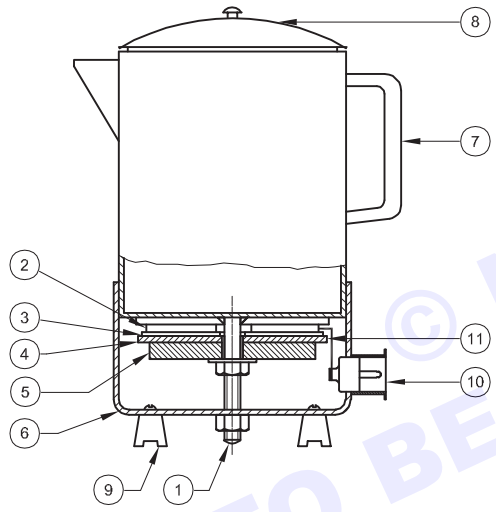
9 Ebonite leg

10 Outlet socket

11 Brass strips

Bottom cover: The bottom cover is fitted to the central bolt of the body by a nut and washer. (Fig 1).

Fig 1



CONSTRUCTION OF SAUCEPAN TYPE KETTLE

Heating element: In its general construction, the heating element is made of Nichrome ribbon. The Nichrome ribbon is wound over mica. This is placed between two circular mica pieces, so that the Nichrome wire may not come in contact with any metallic part of the kettle. The two ends of the elements are connected to the outlet socket terminals of the kettle through two brass strips.

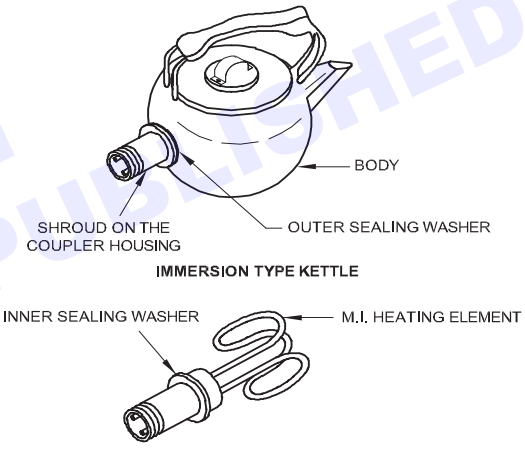
Asbestos sheet: This is placed below the element and mica insulation to serve as a heat insulator. It reduces the heat loss in the kettle in addition it gives increased insulation.

Sole-plate: The sole plate is a cast iron plate neatly ground to have a flat surface and its main function is to keep the element in close contact with the container and to avoid deformation of the element when heated.

Pressure plate: This is made of cast iron and fitted by a nut on the middle bolt. The pressure plate holds the sole plate in position.

This safety pin can be placed in position by soldering. The heating element is concealed inside a hollow tube and mineral insulated (Fig 2).

Fig 2

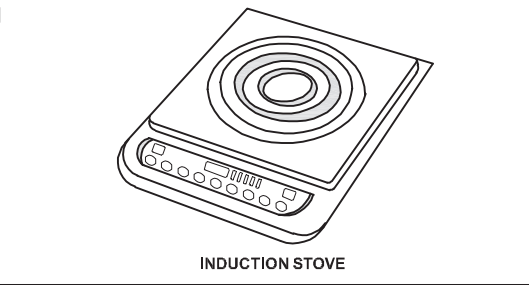


Induction heater

Objectives: At the end of this lesson you shall be able to
- **explain induction heater**
- **explain construction, advantages and disadvantages of induction heater.**

An induction heater uses an electromagnetic field to heat food. When the heater is turned on, an electric current passes through a coil of metal, creating a magnetic field. This magnetic field then penetrates the metal of a cooking pan, inducing a current in the pan. The current then dissipates energy in the form of heat, cooking the food in the pan. (Fig 1)

Fig 1



INDUCTION STOVE

Food mixer

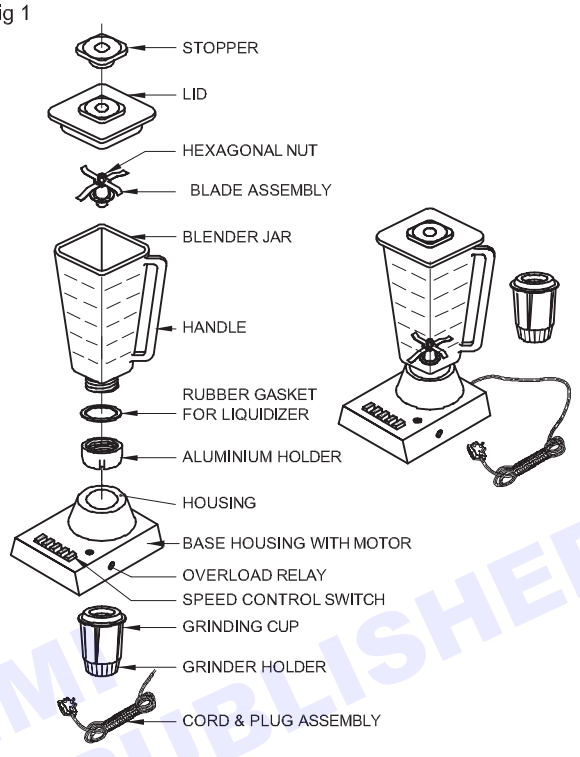
Objectives: At the end of this lesson you shall be able to
- **explain the food mixer and its features**
- **state the maintenance and service procedures of mixer**
- **list their common problems, causes and suggest remedial measures.**

Food mixer

It is an electric domestic appliance which is used to mix, juice, grind and blend the fruits and food grains.

A medium sized universal motor is used in it. Fig 1 shows an exploded view of a mixer.

Fig 1



EXPLODED VIEW OF A FOOD MIXER

Wet grinder

Objectives: At the end of this lesson you shall be able to
- **explain the wet grinder**
- **state the different types of wet grinders**
- **explain the parts of a wet grinder**
- **explain the possible faults in wet grinders and their remedies.**

Wet grinder

It is a domestic electrical appliance, which is used to grind the wet grains.

Types: There are three types of wet grinders

– Conventional (regular) wet grinder.

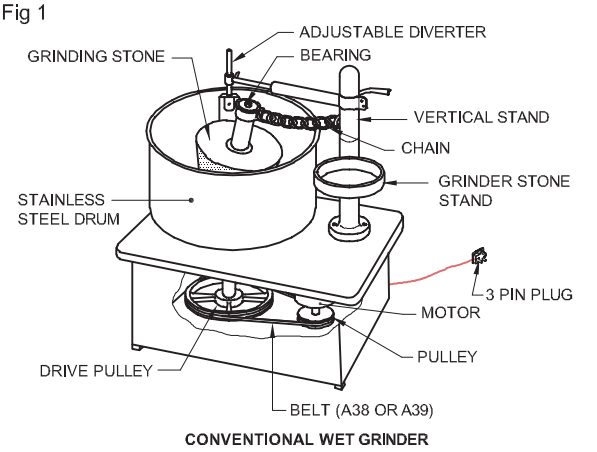
– Table top wet grinder.

– Tilting wet grinder.

Conventional (regular) wet grinder (Fig 1)

The most common wet grinder used in houses is the container rotating type wet grinder.

Fig 1



CONVENTIONAL WET GRINDER

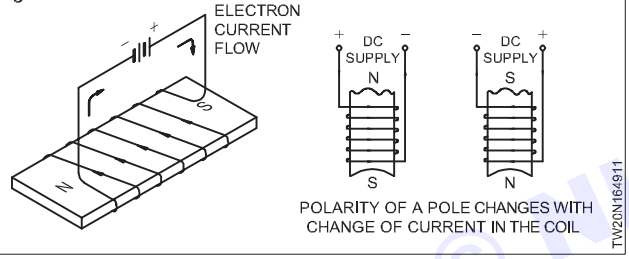
Magnetism and electro magnetism - Simple motors

Objectives: At the end of this lesson you shall be able to
- **explain what is meant by electromagnetism**
- **state right hand grip rule, corkscrew rule and right hand palm rule.**

Electromagnetism: On passing a current through a coil of wire, a magnetic field is set up around the coil. If a soft iron bar is placed in the coil of wire carrying the current, the iron bar becomes magnetized. This process is known as `electromagnetism'. The soft iron bar remains as a magnet as long as the current is flowing in the circuit. It loses its magnetism when the current is switched off from the coil.

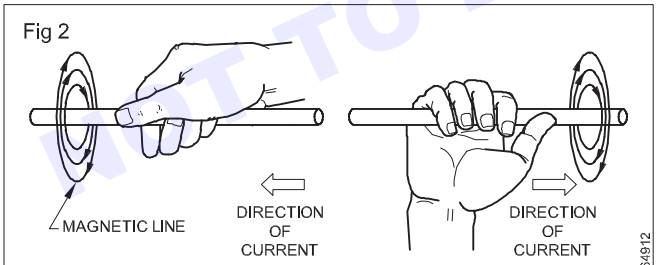
The polarity of this electromagnet depends upon the direction of the current flowing through it. If the direction of the current is altered, the polarity of the magnetic field will also be changed as shown in Fig 1.

Fig 1



The right hand grip rule can be used to determine the direction of the magnetic field. If you wrap your fingers around the wire with your thumb pointing in the direction of current flow, your fingers will point in the direction of the magnetic field as shown in Fig 2.

Fig 2



Assume a right handed corkscrew to be along the wire so as to advance in the direction of the current. The motion of the handle gives the direction of magnetic lines of force around the conductor (Fig 3)

The direction of the magnetic field can be found from right hand palm rule (Fig 4)

The right hand palm rule : Hold the right hand palm over the solenoid in such a way the fingers point in the direction of current in the solenoid conductors then the thumb indicates the direction of magnetic field (North Pole) of the solenoid.

Fig 3

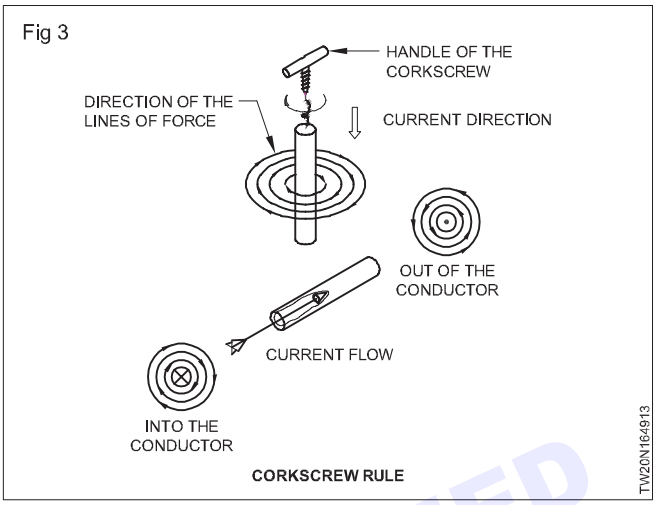
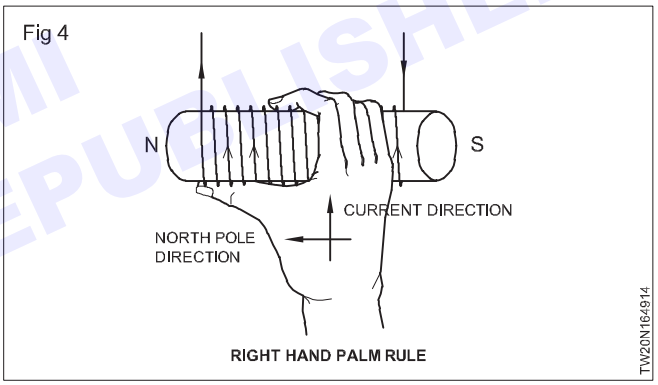


Fig 4



Magnetic materials for temporary magnets: Electromagnets are generally known as temporary magnets. The magnetic strength of such magnets can be varied by varying the current passing through them. Soft iron is used in electromagnets as a magnetic core. Silicon steel is very much used in bigger magnets (steel with 2.4% silicon). Nowadays other metals like permalloy, mumetal are also used for some applications.

Permalloy is an alloy of iron and nickel which can be magnetized by a very weak magnetic field and is useful for telephones.

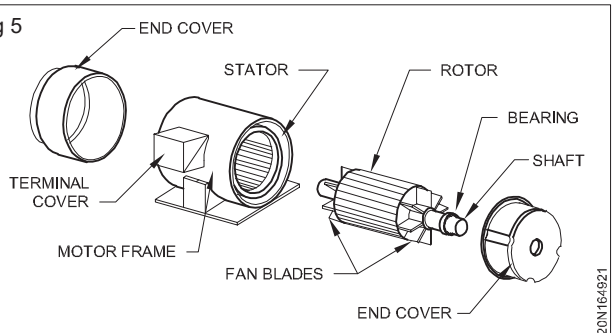
Mumetal is an alloy of nickel, copper, chromium and iron. It has very high permeability and resistivity. Eddy current loss is very low. It is used in instrument transformers and for screening magnetic fields.

Motors

Single phase induction start motor / split phase motor

1 Identify the parts of single phase induction start induction run motor from the real objects or from the exploded view chart. (Fig 5).

Fig 5



PARTS OF 3 PHASE SQUIRREL CAGE INDUCTION MOTOR

2 Label the each identified parts with number tags.

3 Write the name of the parts of each labelled numbers tag.

Capacitor start induction run motor

1 Read and interpret the name details of the capacitor start, induction run motor.

2 Identify the parts of the capacitor start, induction run motor from the real objects (or) from the exploded view Fig 6 & 7.

Fig 6

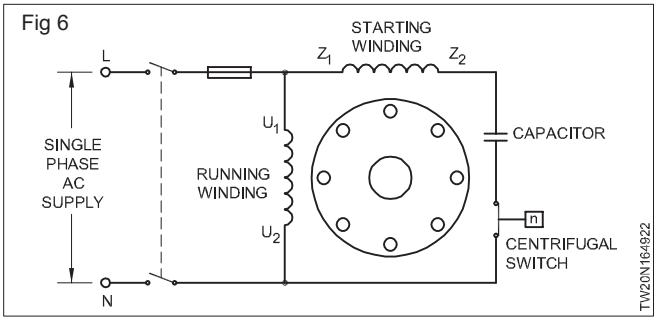
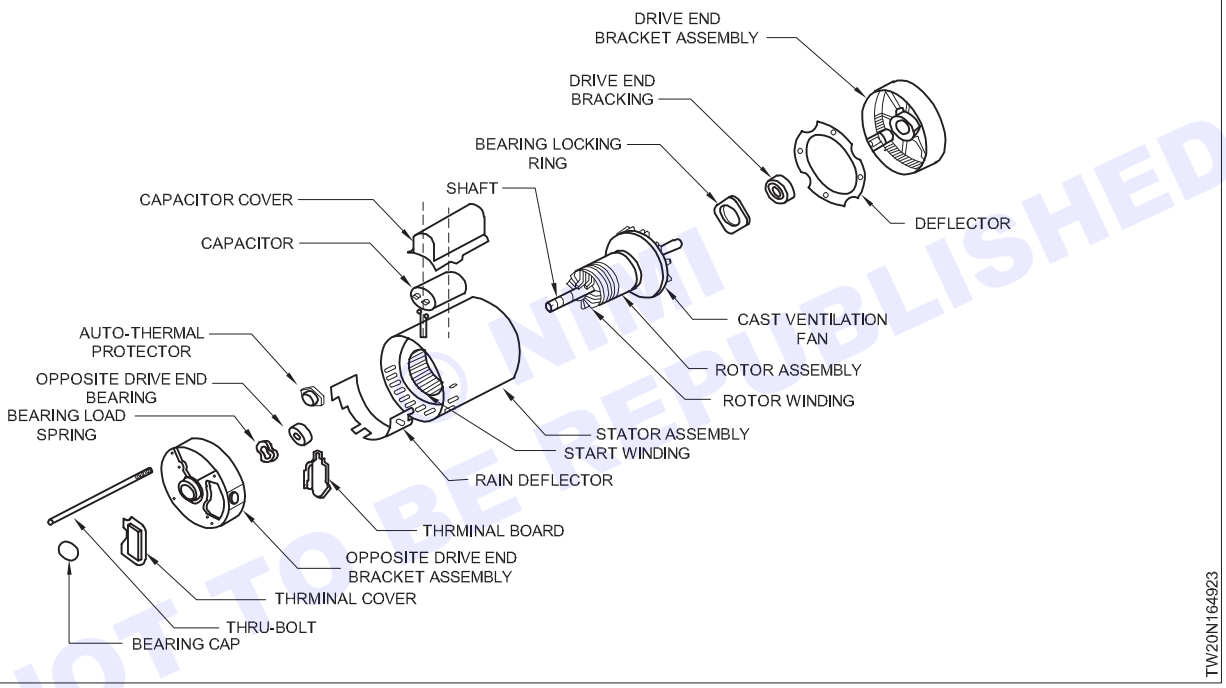


Fig 7



Generators, principles and rules applied

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

- **state the general concepts of rotating electrical machine**
- **state the principle of the DC generator**
- **explain the faraday's of laws of electro magnetic induction**
- **explain the production of dynamically induced e.m.f., its magnitude and direction**
- **describe the parts of a DC generator and their function.**

General concept of rotating electrical machine: In rotating machines, there are two parts, the stator and rotor. Rotating electrical machines are also of two types - DC and AC machines. Electrical machines are widely used. In DC machines the stator is used as a field and the rotor is used as an armature, while reverse is the case for AC machines. That is synchronous generators and synchronous motors. The induction motor is another kind of AC machine, which is singly excited; that is AC supply voltage is only given to the stator and no supply is given to the rotor. In DC machines and synchronous machines, the field is always excited.

Generator: An electrical generator is a machine which converts mechanical energy into electrical energy.

Principle of the generator: To facilitate this energy conversion, the generator works on the principle of Faraday's Laws of Electromagnetic Induction.

Faraday's laws of electromagnetic induction: There are two laws.

The first law states

First law: Whenever the flux linking to a conductor an emf will be induced in the same conductor.

The second law states: The magnitude of such induced emf depends upon the rate of change of the flux linkage.

$$\text{emf} \propto \frac{\text{Change of flux}}{\text{Time taken for change}} \cdot e = N\frac{d\phi}{dt}$$

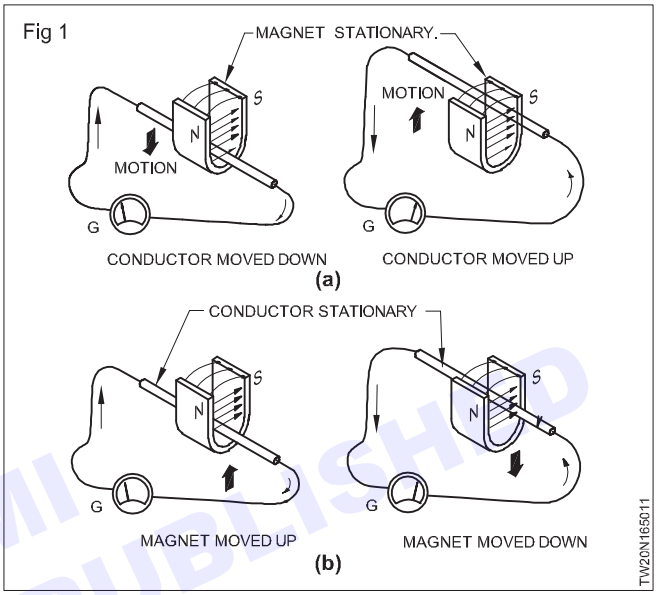
Types of emf: According to Faraday's Laws, an emf can be induced, either by the relative movement of the conductor and the magnetic field or by the change of flux linking on a stationary conductor.

Dynamically induced emf: In case, the induced emf is due to the movement of the conductor in a stationary magnetic field as shown in Fig 1a or by the movement of the magnetic field on a stationary conductor as shown in Fig 1b, the induced emf is called dynamically induced emf.

As shown in Fig 1a & 1b, the conductor cuts the lines of force in both cases to induce an emf, and the presence of the emf could be found by the deflection of the needle of the galvanometer `G'. This principle is used in DC and AC generators to produce electricity.

Production of dynamically induced emf: Whenever a conductor cuts the magnetic flux, a dynamically induced emf is produced in it. This emf causes a current to flow if the circuit of the conductor is closed.

Fig 1



For producing dynamically induced emf, the requirements are

- magnetic field
- conductor
- relative motion between the conductor and the magnetic field.

If the conductor moves with a relative velocity 'v' with respect to the field, then the induced emf `E' will be

$E = BLV \sin\theta$ Volts

where

B = magnetic flux density, measured in tesla

L = effective length of the conductor in the field in metres

V = relative velocity between field and conductor in metre/second

θ = the angle at which the conductor cuts the magnetic field.

Let us consider Fig 2a in which conductors A to I are placed on the periphery of the armature under magnetic poles. Assume for this particular generator shown in Fig 2a, the value of BLV = 100V.

Accordingly the conductor A induces an emf

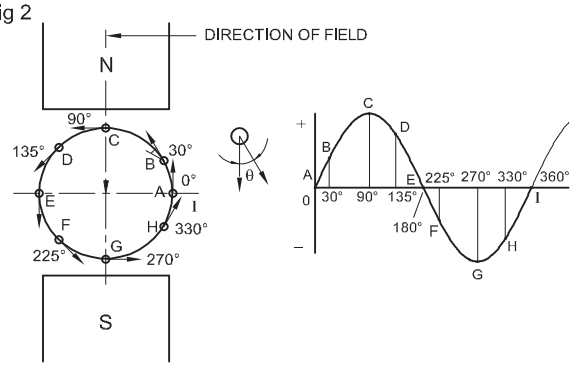
= BLV Sin θ where θ = zero and Sin zero is equal to zero

= 100 x 0 = zero.

Likewise for every position of the remaining conductors in the periphery, the emf induced could be calculated. If these values are plotted on a graph, it will represent the sine wave pattern of induced emf in a conductor when it rotates under N and S poles of uniform magnetic field.

As in Fig 2b the emf induced by this process is basically alternating in nature, and this alternating current is converted into direct current in a DC generator by the commutator.

Fig 2

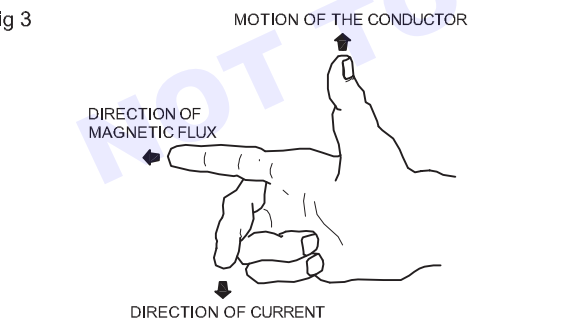


PRODUCTION OF THE SINEWAVE

TW20N165012

Fleming's right hand rule: The direction of dynamically induced emf can be identified by this rule. Hold the thumb, forefinger and middle finger of the right hand at right angles to each other as shown in Fig 3 such that the forefinger is in the direction of flux and the thumb is in the direction of the motion of the conductor, then the middle finger indicates the direction of emf induced, i.e. towards the observer or away from the observer.

Fig 3



FLEMINGS RIGHT HAND RULE

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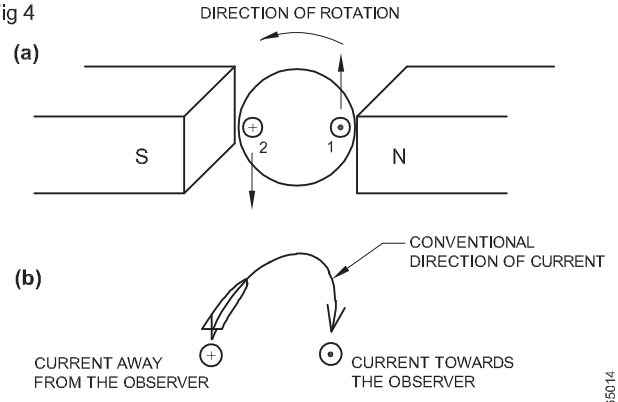
Imagine a conductor moving in between north and south poles in an anticlockwise direction as shown in Fig 4a.

Applying Fleming's right hand rule, we find that the conductor 1 which is moving upwards under the north pole will induce an emf in the direction towards the observer indicated by the dot sign and the conductor 2 which is moving down under the south pole will induce an emf in the direction away from the observer indicated by the plus sign.

Fig 4b indicates the current direction in the form of an arrow. The dot sign indicates the pointed head of the arrow showing the current direction towards the observer and the plus sign indicates the cross-feather of the arrow showing the current direction away from the observer.

Fig 4



DIRECTION OF THE INDUCED CURRENT

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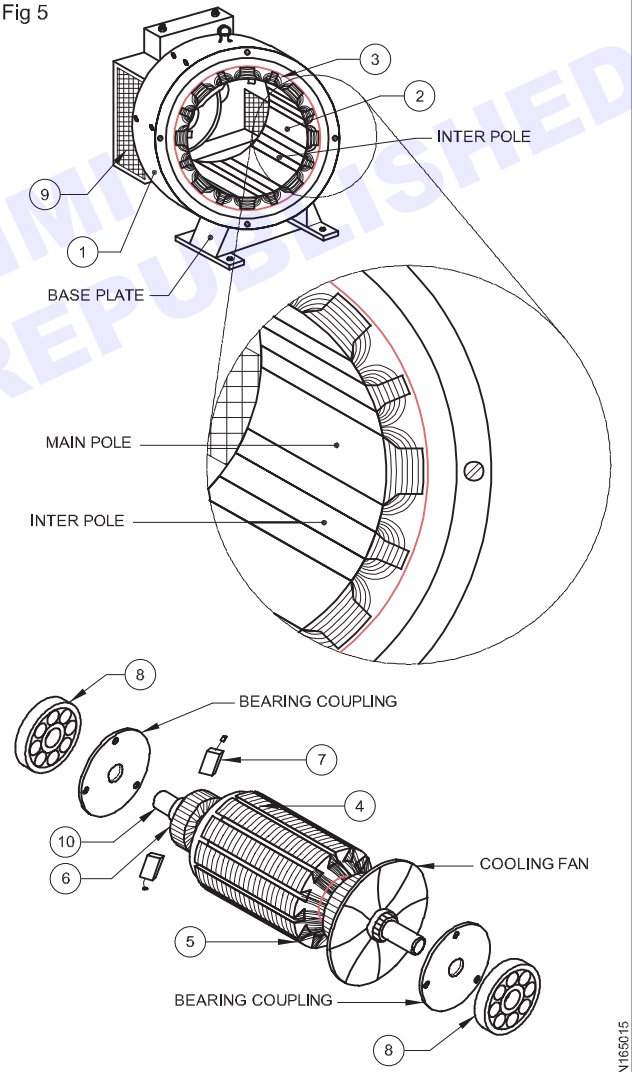
Parts of DC generator: A DC generator consists of the following essential parts as shown in Fig 5.

Fig 5



PARTS OF A DC MACHINE

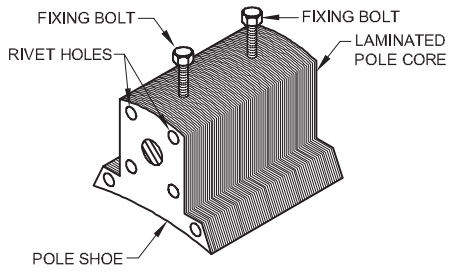
TW20N165015

1 Frame or yoke

2 Field poles and pole-shoes (Figs 6,7 & 8)

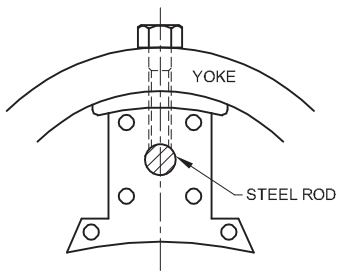
3 Field coils or field winding (Fig 8)

Fig 6



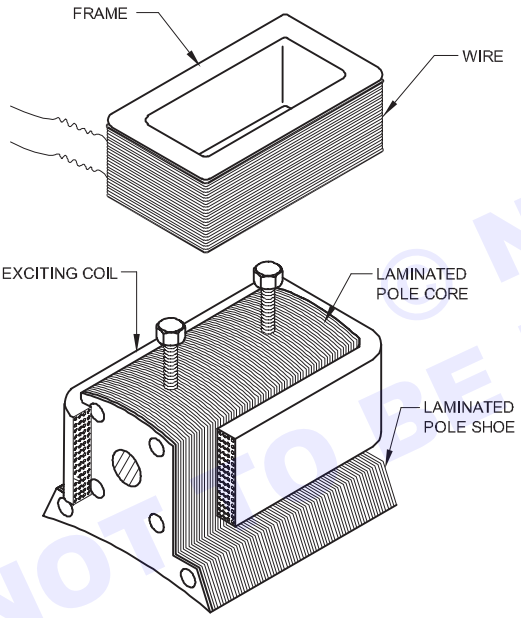
LAMINATED POLE CORE

Fig 7



HOLDING SCREW BOLTED IN TO STEEL BAR POLE CORE ASSEMBLY

Fig 8



POLE ASSEMBLY

4 Armature core

5 Armature windings or armature conductors

6 Commutator

7 Brushes

8 Bearings and end plates

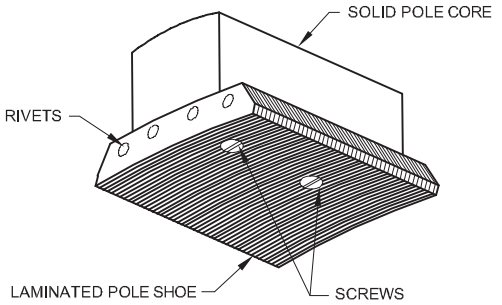
9 Air filter for fan

10 Shaft

Yoke: The outer frame or yoke serves a dual purpose. Firstly, it provides mechanical support for the poles and acts as a protecting cover for the whole machine. Secondly, it allows the magnetic circuit to complete through it. In small generators where cheapness rather than weight is the main consideration, yokes are made of cast iron. But for large machines usually cast steel or rolled steel is used.

Pole cores and pole shoes (Fig 9): The field magnets consist of pole cores and pole shoes. The pole shoes serve two purposes; (i) they spread out the flux in the air gap uniformly and also, being of a larger cross-section, reduce the reluctance of the magnetic path, and (ii) they also support the field coils.

Fig 9



SEPERATE POLE SHOE BOLTED TO POLE CORE

Pole coils (Field coils): The field coils or pole coils, which consist of copper wire or strip are former-wound for the correct dimension. Then the former is removed and the wound coils are put into place over the core as shown in Fig 8.

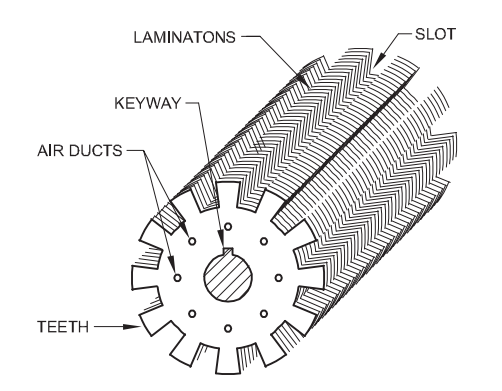
When a current is passed through the coils, they magnetise the poles which produce the necessary flux that is cut by revolving armature conductors.

Both thick gauge wire winding (series) and thin gauge winding (shunt) are wound, one over the other with separate insulations, and the terminals are brought out separately.

Armature core: The armature core houses the armature conductors and rotate in the magnetic field so as to make the conductors to cut the magnetic flux. In addition to this, its most important function is to provide a path of very low reluctance to the field flux, thereby allowing the magnetic circuit to complete through the yoke and the poles.

The armature core is cylindrical or drum-shaped as shown in Fig 10, and build up of circular sheet steel discs or laminations approximately 0.5mm thick as shown in Fig 11.

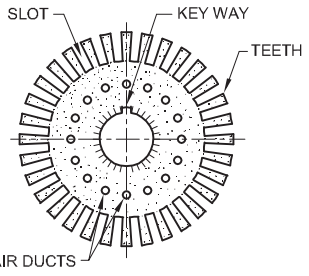
Fig 10



ARMATURE CORE MADE OF LAMINATION

Armature windings: The armature windings are usually former-wound. These are first wound in the form of flat rectangular coils and are then pulled into their proper shape with a coil puller.

Fig 11



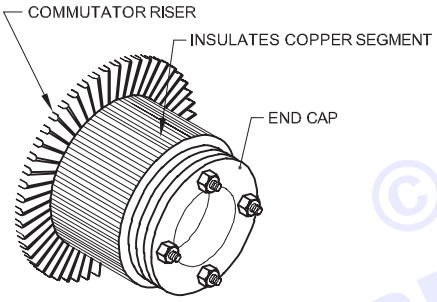
ARMATURE CORE LAMINATIONS

TW20N16501B

Commutator: The function of the commutator is to facilitate collection of current from the armature conductors. It rectifies i.e. converts the alternating current induced in the armature conductors into uni-directional current for the external load circuit. It is of cylindrical structure and is built up of wedge-shaped segments of high conductivity, hard-drawn or drop-forged copper. These segments are insulated from each other by thin layers of mica. The number of segments is equal to the number of armature coils.

Each commutator segment is connected to the armature conductor by means of a copper lug or riser, whose general appearance when assembled is shown in Fig 12.

Fig 12



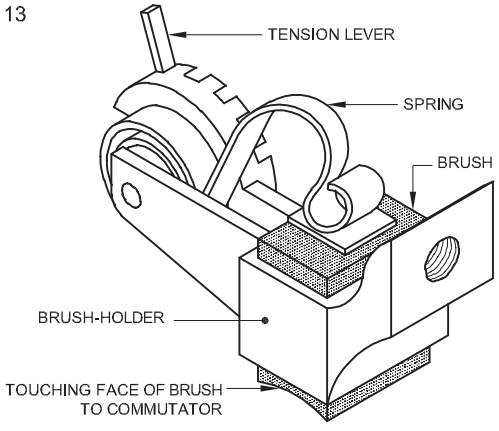
COMPLETE ASSEMBLY OF COMMUTATOR

TW20N16501C

Brushes: The brushes whose function is to collect current from the commutator are usually made of carbon and graphite and are in the shape of a rectangular block.

These brushes are housed in brush-holders, shown in Fig 13, which have a box-holder for the brush, a spring to maintain the brush tension and a hole to fix the holder to the rocker arm.

Fig 13

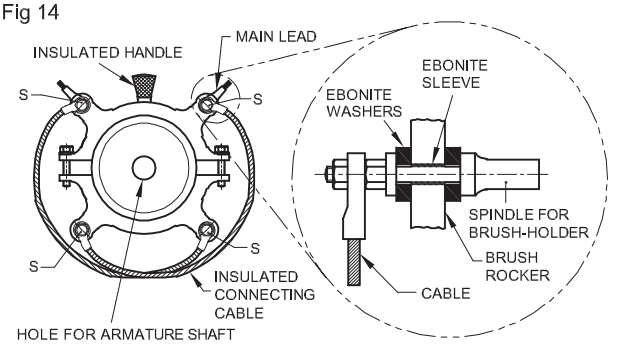


TW20N16501D

Brush-rocker: The spindle is used to have a number of brushes connected in a large machine. There may be only two brushes for a small machine. All the spindles are insulated and attached to the brush rocker.

The brush-rocker may either be supported by a bearing cover in a small machine or by brackets attached to the yoke as shown in Fig 14. The brush position to the neutral axis can be set by changing the position of the brush- rocker.

Fig 14

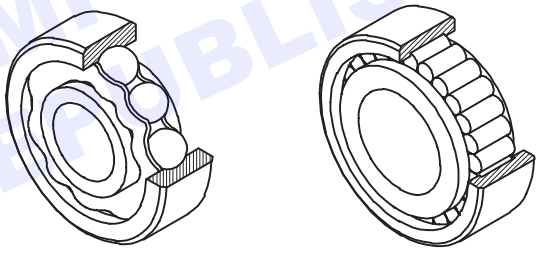


BRUSH-HOLDER S-SPINDLE FOR BRUSH-HOLDER

TW20N16501E

Bearings (Fig 15): Because of their reliability ball bearings are frequently employed, though for heavy duties roller bearings are preferable.

Fig 15

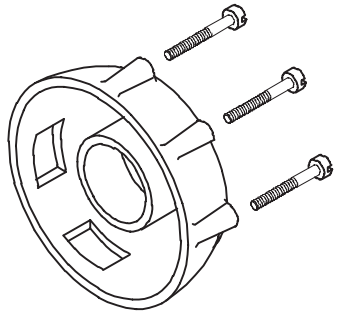


BALL BEARING ROLLER BEARING

TW20N16501F

End plates (Fig 16): The bearings are housed in these end plates, and they are fixed to the yoke. They help the armature for frictionless rotation and to position the armature in the air gap of the field poles.

Fig 16



END PLATE 2-OFF

TW20N16501G

Cooling fan

DC Machines are often selected based upon a particular work or load requirement. In most cases, heat dissipation is achieved through a cooling fan fitted on the DC Machine shaft. Another method to remove heat from DC machine is by providing forced air cooling.

Explanation of electrical measuring instruments - ammeter - voltmeter wattmeter - energy meter

Objectives: At the end of this lesson you shall be able to
- **state the features and advantages of digital ammeter, digital voltmeter and wattmeter**
- **state the features and advantages tong tester digital energy meter, multimeter and digital multimeter.**

Digital ammeter: Digital Ammeters are instruments that measure the current in ampere and display it in digital. These instruments provide information about current drawn and current continuity to help users troubleshoot electric loads.

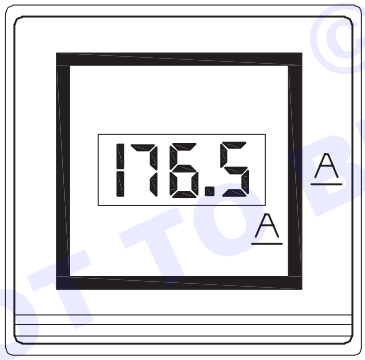
They have both positive and negative leads and low internal resistance. Digital ammeters are connected in series with a circuit so that current flow passes through the meter.

It can be used to measure the A.C and D.C. Many digital ammeters include a current sensor built in the meter.

Features: Different types of digital ammeters can measure different ranges of A.C current and D.C current and also A.C frequency.

Batteries are provided in it to operate without plug-in-power and suitable for cut door use Fig 1 shows a typical digital ammeter.

Fig 1



TYPICAL DIGITAL AMMETER

Standards: Digital ammeters must have a certain standards and specifications to ensure proper design and functionality refer IEC 600 51 - 2.

Digital Volt Meter (DVM): The Digital Volt Meter(DVM) is an electrical measuring instrument which is used to measure line potential difference (P.D) between two points. The voltage to be measured may be AC or DC.

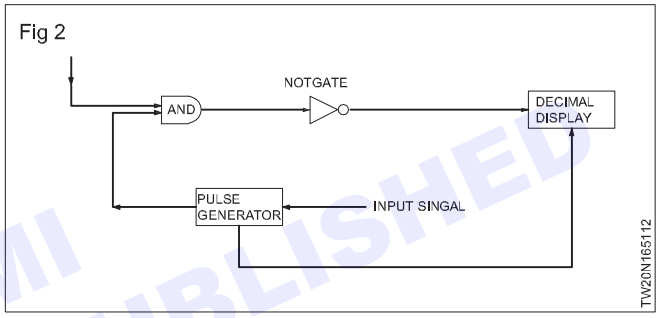
Digital voltmeters display the value of AC or DC voltage being measured directly as discrete numerical instead of a pointer deflection on a continuous scale as in analog instruments.

Advantages of digital voltmeters

- Read out of DVMs is easy as it eliminates observational errors in measurement
- Parallax error is eliminated
- Reading can be taken very fast
- Output can be fed to memory devices for storage and future computations
- More versatile and accurate
- Compact portable and cheap
- Requires low power

Working principle of digital voltmeter: The block diagram of a simple digital voltmeter is shown in the Fig 2 It consists the following blocks

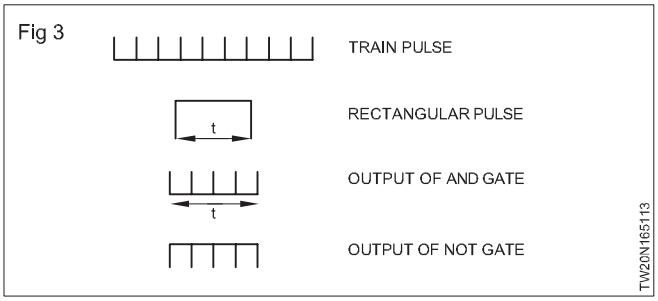
Fig 2



1 Input signal
2 Pulse generator
3 AND gate
4 Decimal display

Working (Fig 3)

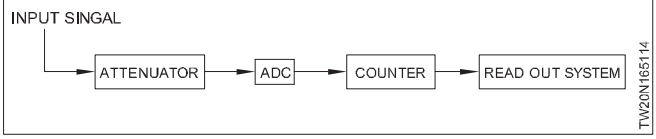
Fig 3



- Unknown voltage signal is fed to the pulse generator which generates a pulse whose width is proportional to the input signal.
- Output of pulse generator is fed to one leg of the AND gate.
- The input signal to the other leg of the AND gate is a train of pulses.
- Output of AND gate is positive triggered train of duration same as the width of the pulse generated by the pulse generator.
- This positive triggered train is fed to the inverter which converts it into a negative triggered train.
- Output of the inverter is fed to a counter which counts the number of triggers in the duration which

is proportional to the input signal i.e. voltage under measurement this counter can be calibrated to indicate voltage in volts converts an analog signal into a train of pulses, the number is proportional to the input signal. So a digital voltmeter can be made by using any one of the A/D conversion methods (Fig 4)

Fig 4



Now-a-days digital voltmeters are also replaced by digital multi meters due to its multitasking feature.

Wattmeters

Advantages of measuring power supply: Power in a single phase AC circuit can be calculated by using an ammeter, a voltmeter and a power factor meter with the help of the formula

Power in a single phase circuit = = EI Cos ∅ watts.

To get an on the spot true power reading, a wattmeter is used. The power dissipated in the circuit can be read directly from the scale of the meter. The wattmeter takes the power factor of the circuit into account and always indicates the true power.

Types of wattmeters

There are three types of wattmeters in use as stated below.

- Dynamometer wattmeter
- Induction wattmeter
- Electrostatic wattmeter

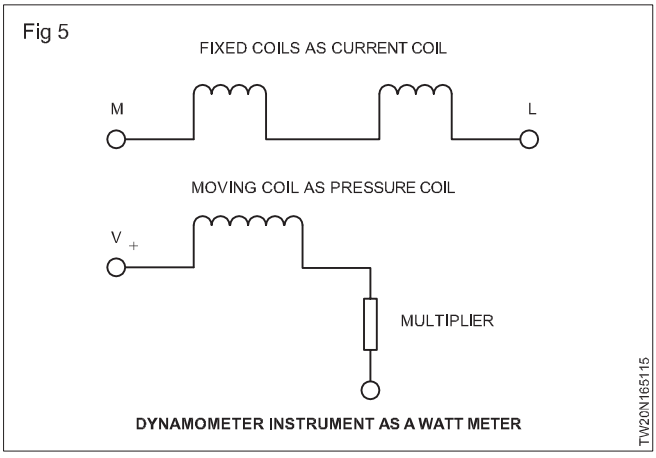
Among the three, the electrostatic type is very rarely used. Information given here is for the other two types only.

Dynamometer type, single phase wattmeter: This type is commonly used as a wattmeter.

Dynamometer used as a wattmeter: The dynamometer is commonly used as a wattmeter to measure power in both AC and DC circuits and will have uniform scale.

When this instrument is used as a wattmeter, the fixed coils are treated as current coil, and the moving coil is made as pressure coil with necessary multiplier resistance (Fig 5).

Fig 5



DYNAMOMETER INSTRUMENT AS A WATT METER

Advantages

- This instrument can be used both in AC and DC.
- As this is an air cored instrument, the hysteresis and eddy current losses are eliminated.
- This instrument has better accuracy.
- When used as wattmeter, the scale is uniform.

Disadvantages

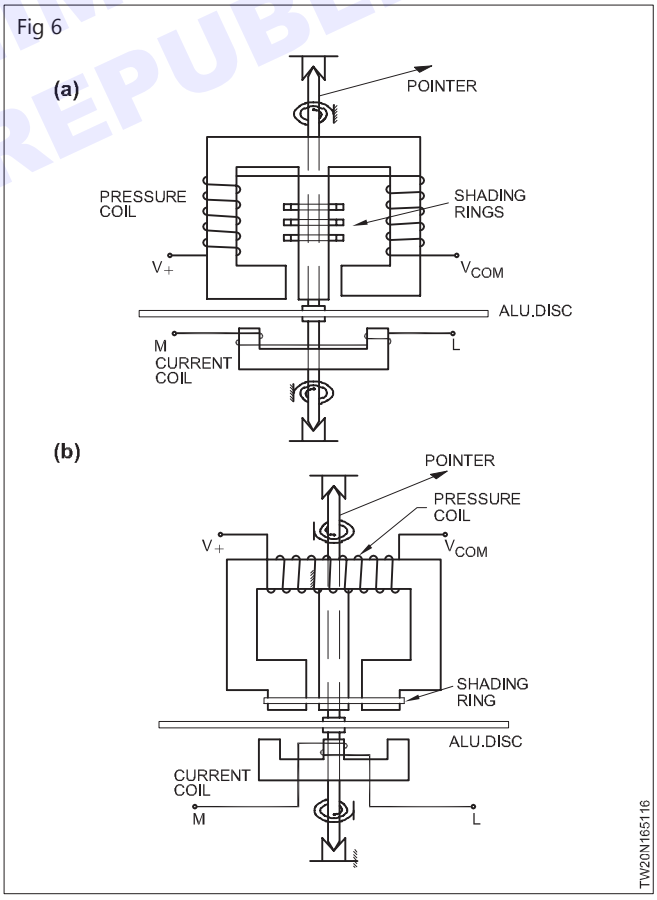
- It is more expensive than PMMC and moving iron instruments.
- When used as voltmeter or ammeter the scale will not be uniform.
- It has a low torque/weight ratio-as such has low sensitivity.
- Sensitive for over loads and mechanical impact. Hence careful handling is necessary.
- It consumes more power than PMMC meters.

Induction type single phase wattmeter: This type of wattmeters could be used only in AC circuits whereas a dynamometer type wattmeter could be used in both AC and DC circuits.

Induction type wattmeters are useful only when the supply voltage and frequency are almost constant.

Construction: Induction wattmeters having two different types of magnetic cores (Fig 6a & 6b).

Fig 6



Both the types have one pressure coil magnet and one current coil magnet. The pressure coil carries a current proportional to the voltage whereas the current coil carries the load current.

A thin aluminium disc is mounted on a spindle in between the space of the magnets and its movement is controlled by springs. The spindle carries a weightless pointer at one end.

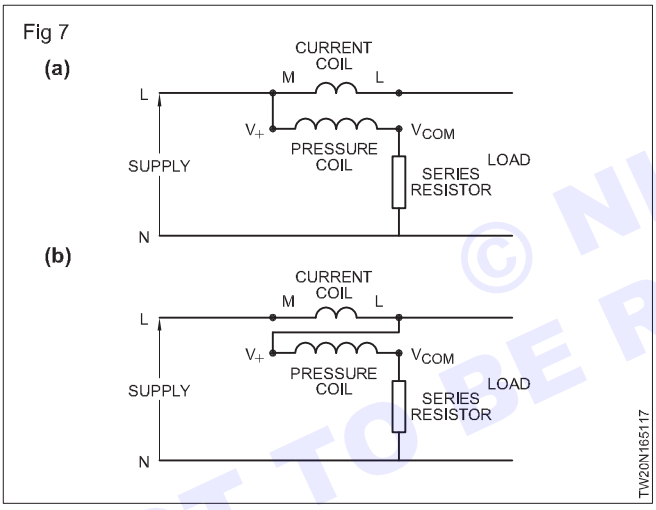
Working: The alternating magnetic fluxes produced by the pressure and current coils cut the aluminium disc and produce eddy currents in the disc. Due to the interaction between the fluxes and the eddy currents a deflecting torque is produced in the disc and the disc tries to move. Control springs attached to the two ends of the spindle control the deflection and the pointer shows the power in watts on a graduated scale.

Shaded rings provided in the pressure coil (shunt) magnet could be adjusted in order to cause the resultant flux in the magnet to lag in phase by exactly 90° behind the applied voltage.

Method of connecting wattmeter in single phase circuits - pressure coil connection to reduce erroneous measurement: There are two ways of connecting the pressure coil of the wattmeter.

Both the methods shown in Figs 7a & b need correction in power measurement due to the reasons stated below.

Fig 7



In the method of connection shown in Fig 7a, the pressure coil is connected on the 'supply' side of the current coil, and hence, the error in power measurement is due to the fact that the voltage applied to the voltage coil is higher than that of the load on account of the voltage drop in the current coil. As such the wattmeter measures the load power in addition to the power lost in the current coil.

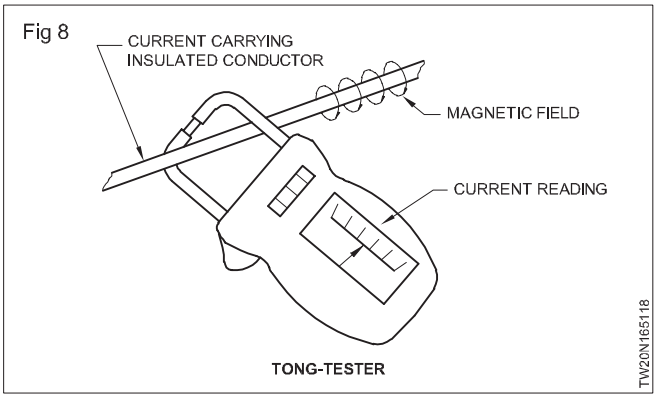
On the other hand, in the method of connection shown in Fig 7b, the current coil carries the small current taken by the voltage coil, in addition to the load current, thereby introducing errors in power measurement. As such the wattmeter measures the load power in addition to the power lost in the pressure coil.

If the load current is small, the voltage drops in the current coill will be small, so that the method of connection, shown in Fig 7a, introduces a very small error and, hence, preferable.

On the other hand, if the load current is large the power lost in the pressure coil will be negligible when compared to the load power in the method of connection shown in Fig 7b, and, hence, a very small error is introduced resulting in the preference of this connection.

Tong - tester (clamp - on ammeter) (Fig 8)

Fig 8



A tong-tester is an instrument devised for the measurement of A.C current, without interrupting the circuit. It is also called clip-on ammeter, or sometimes a clamp-on ammeter.

Working principle: The instrument can function only when current passes through its deflecting system. It works under the mutual induction principle.

Construction: A tong-tester (the clamp-on ammeter) circuit. The split-core meter consists of a secondary coil with the split-core and a rectifier type instrument connected to the secondary. The current to be measured in the conductor serves as the primary of one turn coil. It induces a current in the secondary winding and this current causes the meter to deflect.

The core is so designed that there is only one break in the magnetic path. The hinge and the opening both fit tightly when the instrument closes around the conductor. The tight fit of the instrument ensures minimum variation in the response of the magnetic circuit.

To measure current with a clamp-on meter, open the jaws of the instrument and place them around the conductor in which you want to measure the current. Once the jaws are in place, allow them to close securely. Then, read the indicator position on the scale.

When the core is clamped around a current-carrying conductor, the alternating magnetic field induced in the core, produces a current in the secondary winding.

This current causes a deflection on the scale of the meter movement. The current range can be changed by means of a `range switch', which changes the taps on the transformer secondary (Fig 9 & 10).

Fig 9

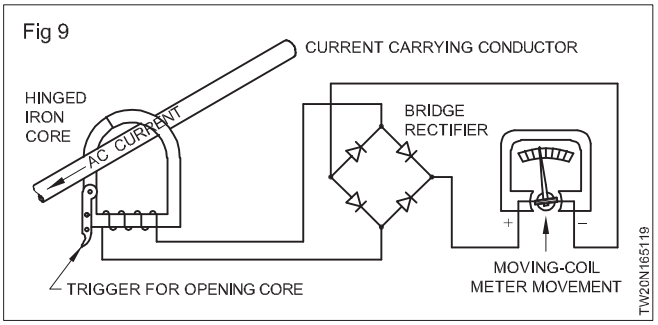
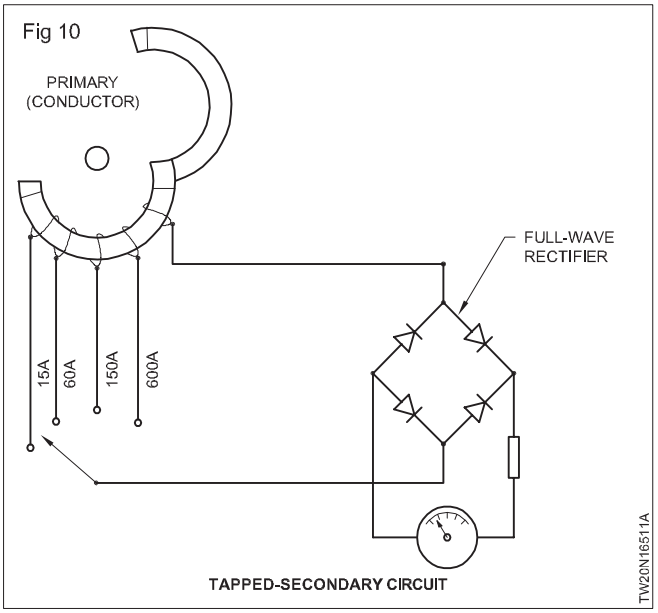


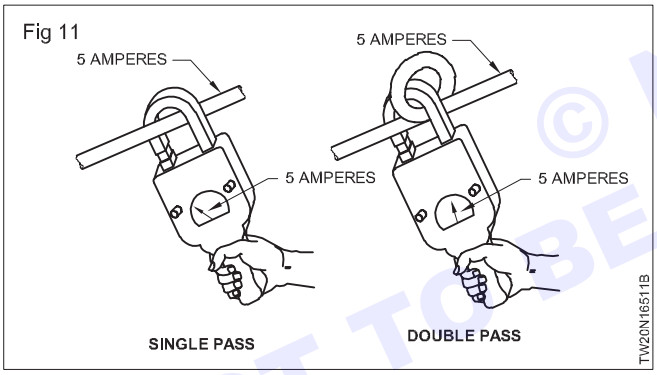
Fig 10



Safety: The secondary winding of the current transformer should always be either shunted or connected to the ammeter; otherwise, dangerous potential differences may occur across the open secondary.

Before taking any measurement, make sure the indication is at zero on the scale. If it is not, reset by the zero-adjustment screw. It is usually located near the bottom of the meter. (Fig 11)

Fig 11



Looping the conductor more than once through the core is another means of changing the range. If the current is far below the meter's maximum range, we can loop the conductor through the core two or more times.

Application

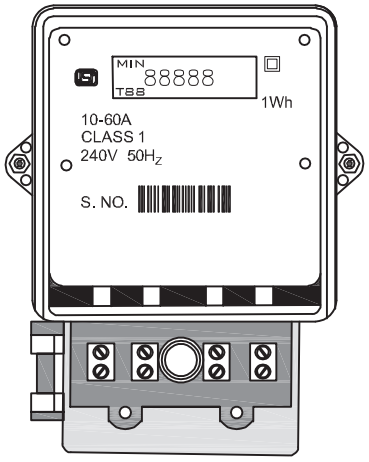
1 For measuring the incoming current in the main panel board.
2 Primary current of AC welding generators.
3 Secondary current of AC welding generators.
4 Newly rewinded AC motor phase current and line current.
5 Starting current of all AC machines.
6 Load current of all AC machines and cables.
7 For measuring the unbalanced or balanced loads.
8 For finding the faults in AC, 3-phase induction motors.

Precaution

1 Set the ampere range from higher to low if the measuring value is not known.
2 The ampere-range switch should not be changed when the clamp is closed.
3 Before taking any measurement make sure the indication is at zero on the scale.
4 Do not clamp on a bare conductor for current measurement.
5 Seating of the core should be perfect.

Digital energy meter (Fig 12)

Fig 12



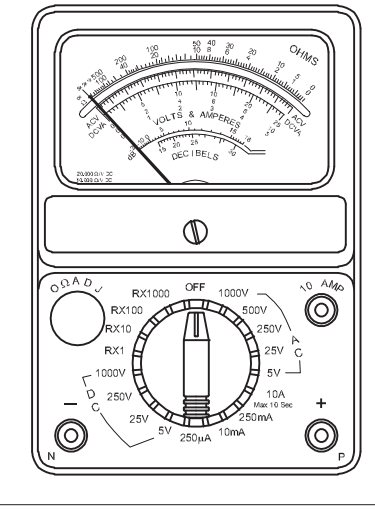
DIGITAL electronic meters are much more accurate than electromechanical meters. There are no moving parts and, hence, mechanical defects like friction are absent.

Multimeter: A single instrument used for measuring current voltage and resistance is known as a multimeter. It is a portable, multi range instrument.

It has a full scale deflection accuracy of ±1.5 %. The lowest sensitivity of multimeters for AC voltage range is 5 K ohms/volts and for the DC voltage range it is 20 K ohms/volts. The lowest range of DC is more sensitive than the other ranges.

Fig 13 show typical multimeters.

Fig 13



Construction of a multimeter: A multimeter uses a single meter movement with a scale calibrated in volts, ohms and milliamperes. The necessary multiplier resistors and shunt resistors are all contained within the case. Front

panel selector switches are provided to select a particular meter function and a particular range for that function.

On some multimeters, two switches are used, one to select a function, and the other the range. Some multimeters do not have switches for this purpose; instead, they have separate jacks for each function and range.

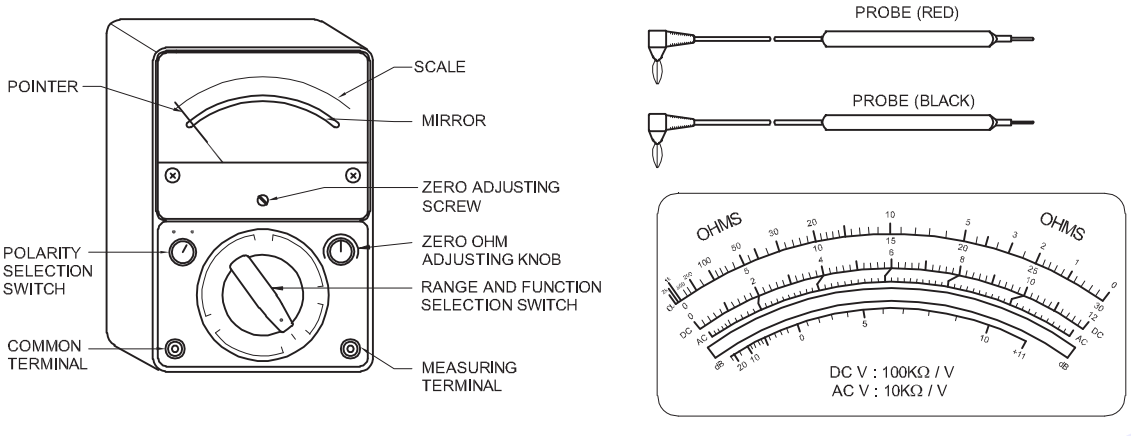
Batteries/cells fixed inside the meter case provide the power supply for the resistance measurement.

The meter movement is that of the moving coil system as used in DC ammeters and voltmeters.

Rectifiers are provided inside the meter to convert AC to DC in the AC measurement circuit.

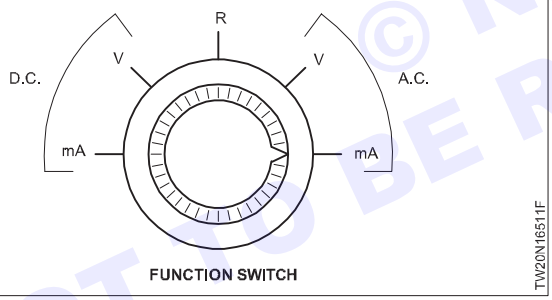
Parts of a multimeter: A standard multimeter consists of the main parts and controls (Fig 14).

Fig 14



Controls: The meter is set to measure the current, voltage (AC and DC) or resistance by means of the FUNCTION switch. In the example given in Fig 15 the switch is set to mA, AC.

Fig 15



Digital multimeter

In a digital multimeter the meter movement is replaced by a digital read out (Fig 16 & 17).

Fig 16

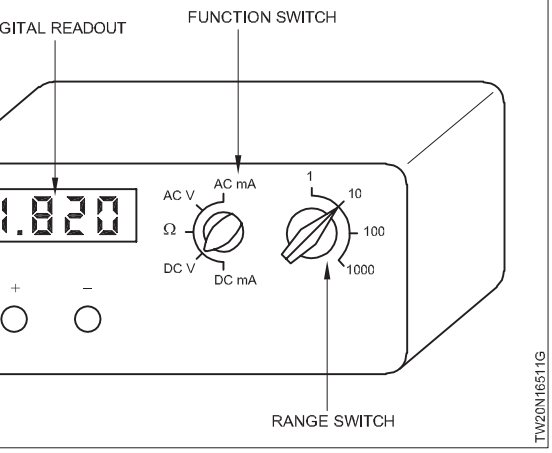
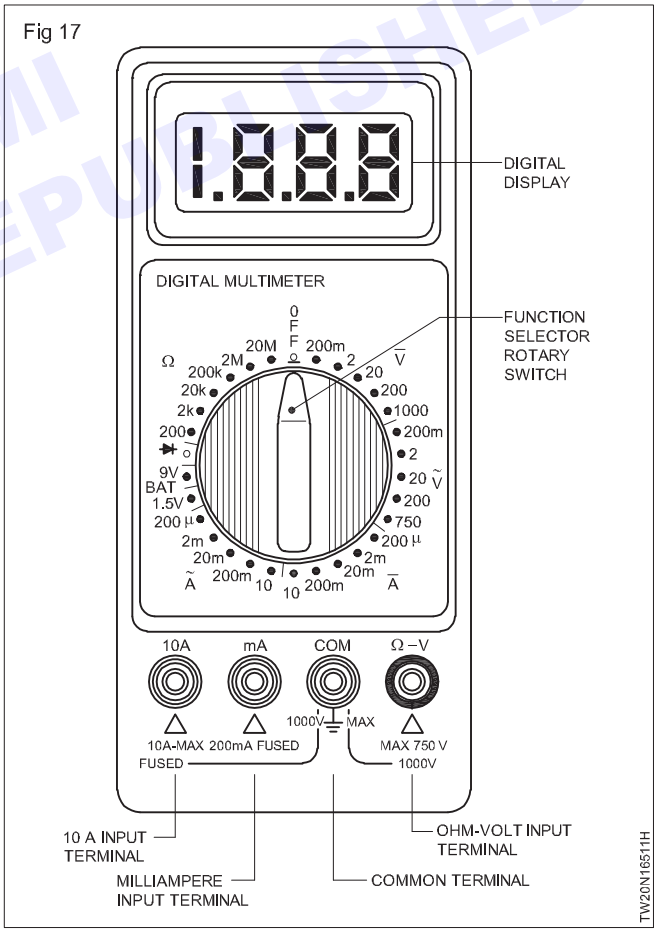


Fig 17



This readout is similar to that used in electronic calculators. The internal circuitry of the digital multimeter is made up of digital, integrated circuits. Like the analog-type multimeter, the digital multimeter has a front panel switching arrangement.

Electronic active - passive components - resistors, capacitors - inductors - coils simple rectifiers, power supply, amplifier - logic gates, principle of operations

Objectives: At the end of this lesson you shall be able to
- **state the passive components**
- **explain the active components.**

Passive components: Components like resistors, capacitors and inductors used in electronic circuit are called as passive components. These components by themselves are not capable of amplifying or processing an electrical signal. However these components are equally important in electronic circuit as of active components, Without the aid of passive components, a transistor (active components) cannot be made to amplify electrical signal.

Circuits formed with passive components obey the electrical circuit laws such as Ohm's law, Kirchhoff's Laws etc.,

Active components : In electronic circuits, components other than resistors, capacitors and inductors are also used. Namely transistors, diodes, vacuum tubes, SCRs, diacs, zener-diode etc. The application of electrical circuit laws (Ohm's law etc.) in the circuit containing the above components will not give correct results. i.e. these components do not obey Ohm's law, Kirchhoff's law etc. These components are called active components.

The different active components and the method of representing them by symbols are given in Fig 1 & 2.

Fig 1

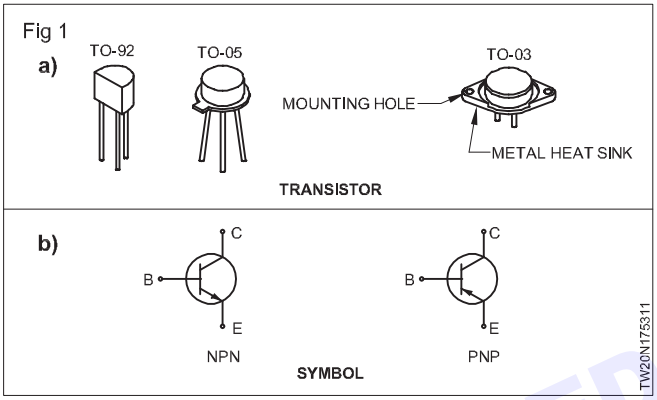
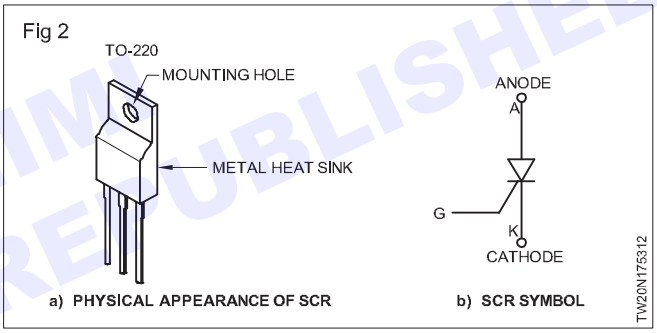


Fig 2



Passive components - Resistors

Objectives: At the end of this lesson you shall be able to
- **state the function of a resistor in a circuit**
- **explain the classifications of resistors**
- **explain the classifications of fixed value resistors**
- **state the power rating of resistors**
- **state the tolerance in a resistor**
- **find the value of a resistor using colour code**
- **state the constructional details of fixed and variable resistors.**

Resistors: Resistors are electronic components, used to reduce, or limit, or resist the flow of current in any electrical or electronic circuit. Chart 1 at the end of this lesson shows different types of resistors.

Fig 1 shows a circuit in which the bulb glows brightly. Fig 2 shows the same circuit with a resistor, and the bulb glows dim. This is because, the current in the circuit is reduced by the 1000 ohms resistor. If the value of this resistor is increased, current in the circuit will be further reduced and the light will glow even dimmer.

Resistors are made of materials whose conductivity fall in- between that of conductors and insulators. This means, the materials used for making resistors have free electrons, but not as many as in conductors. Carbon is one such material used most commonly for making resistors.

When a large number of electrons are made to flow through a resistor, there is opposition to the free flow of electrons. This opposition results in generation of heat.

Unit of resistance: The property of the resistor to limit the flow of current is known as resistance. The value, or quantity of resistance is measured in units called ohms denoted by the symbol Ω.

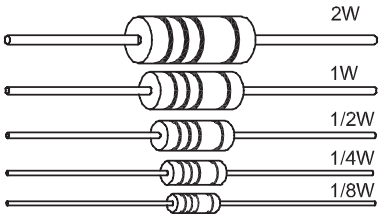
Resistors are called passive devices because, their resistance value does not change even when the level of applied voltage or current to it is changed. Also, the resistance value remains same when the applied voltage is AC or DC.

Resistors can be made to have very small or very large resistance. Very large values of resistances can be represented as given below.

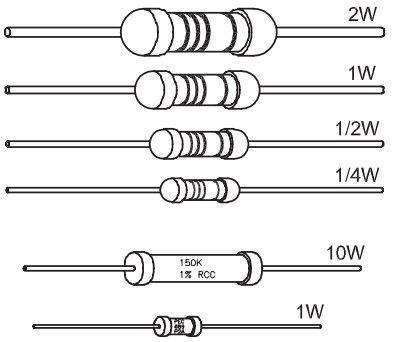
FIXED VALUE RESISTORS

CARBON TYPES

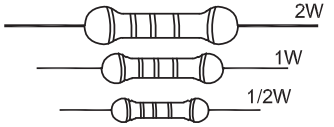
CARBON COMPOSITION



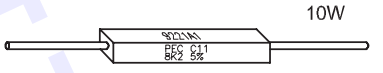
METAL FILM

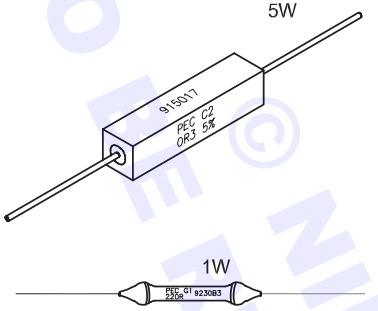


METAL OXIDE

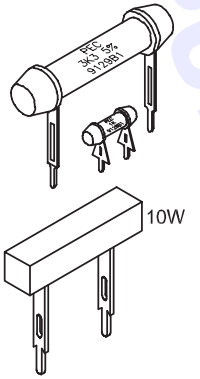


CERAMIC TYPES

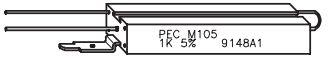




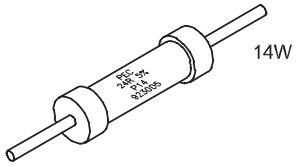
RADIAL LEADS



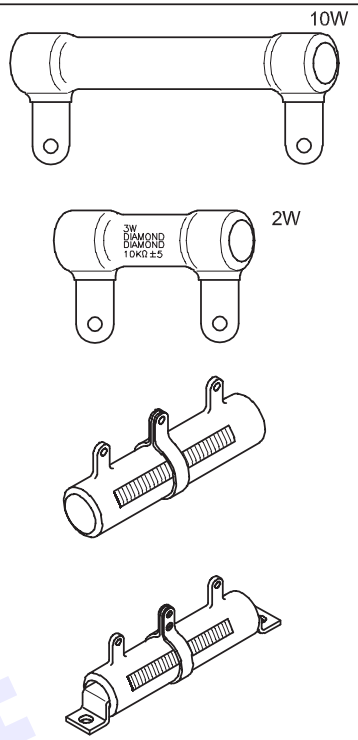
VERTICAL MOUNT

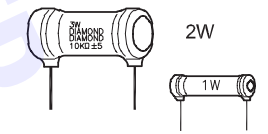


WIRE WOUND TYPES

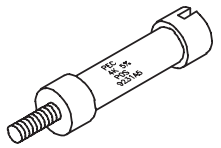


RADIAL LEADS





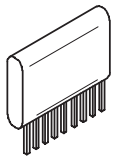
SPECIAL TYPES



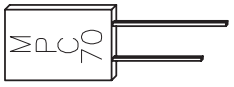
PRECISON RESISTOR

METAL FILM RESISTOR

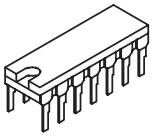
NETWORK RESISTOR



LOW OHM METAL FILM RESISTOR



INTEGRATED RESISTOR (DIL)



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Classification of resistors

Resistors are classified into two main categories.

1 Fixed

2 Variable

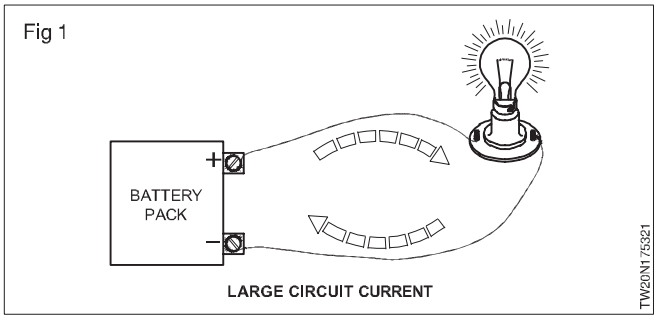
1000 Ω = 1 x 1000 Ω = 1 x kiloΩ = 1 K Ω

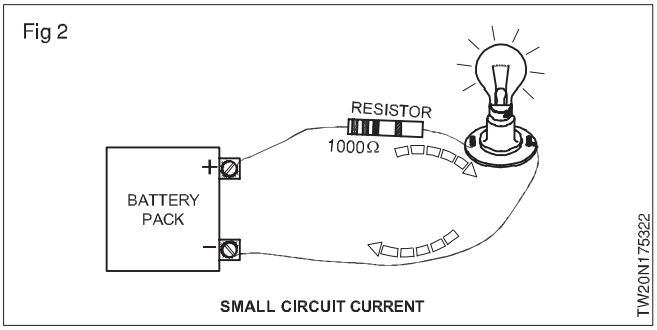
10,000 Ω = 10 x 1000 Ω = 10 x kiloΩ = 10 K Ω

100,000 Ω = 100 x 1000 Ω = 100 x kilo Ω = 100 K Ω

1000,000 Ω = 1000 x 1000Ω = 1000 x kiloΩ = 1000 KΩ

= 1Mega Ω = 1MΩ





Passive components - Inductors

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

- **state inductor and inductance**
- **state self - induction**
- **state the factors determining the value of an inductor**
- **explain mutual inductance**
- **explain the value of inductors in series and parallel**
- **explain Q factor.**

Inductive reactance/DC resistance of inductance: Inductors are components consisting of coil of wire. The basic function of an inductor is to store electric energy in the form of magnetic field, when current flows through the inductor.

Inductance is the electrical property of inductors. Letter 'L' is used as a symbol to represent Inductance. Inductance, is the ability of a device to oppose any change in the current flowing through it. This opposition to change in current, is achieved by the energy stored by it, in the form of magnetic field.

Inductance, and thus an inductor, chokes off or restricts sudden changes in current through it. The change may be either increasing or decreasing. Hence inductors are also sometimes called as Chokes.

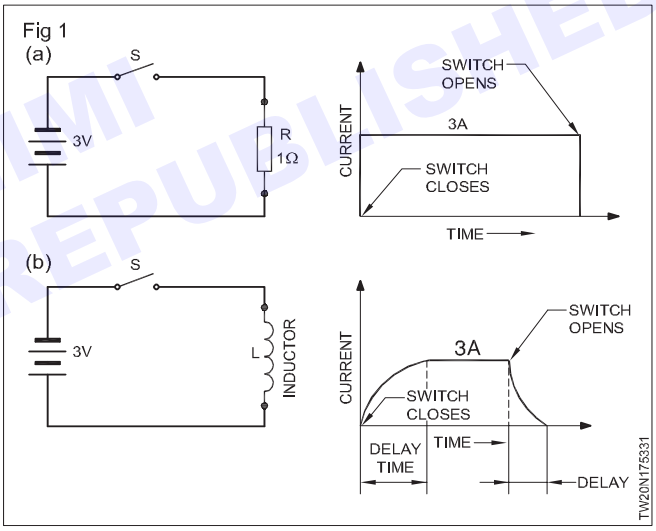
Principle of operation: Recall that, when current begins to flow through a conductor, magnetic flux rings start to expand around the conductor. This expanding flux induces a small voltage in the conductor called back-emf or counter emf. This induced voltage has a polarity that opposes the source voltage which creates the induced voltage.

Thus, the inductance in a coil of wire, carrying current, opposes any rise or fall of current through it and tries to keep the current through it constant.

It should be noted that, the inductance cannot completely stop the increase in current because, the induced voltage is caused by the increasing flux, and the increasing flux depends on the increasing current. Therefore, an inductor can restrict only, the rate at which the current can increase or decrease through it.

Example: A Resistor of 1 Ω is connected to a DC source of 3 volts, as shown in Fig 1a. The moment switch S is ON, current will increase from 0 to its steady state value of 3Amps instantaneously, as shown in graph. When the switch is opened, the current drops back to zero just as fast as it raised.

Whereas, when the same DC voltage is applied to an Inductor having a coil resistance of 1Ω as shown in Fig 1b, the current will not increase instantaneously from 0 to its steady value because the inductor in the circuit does not allow it to happen. The current will reach the steady state value after a time delay as shown in graph. The amount of delay depends on the value of inductance and the ohmic resistance of the inductor.

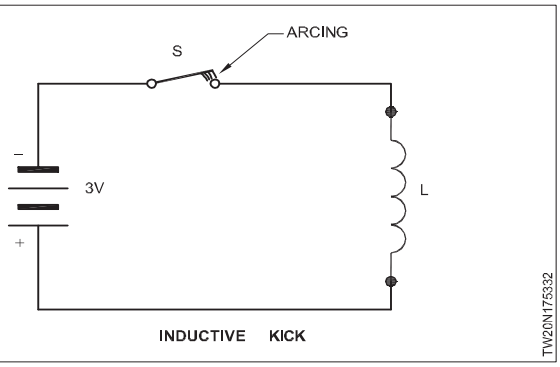


Once the current through the circuit in Fig 1b reaches its steady state value of 3 Amps, which is decided by the ohmic value of the inductance, the magnitude of current remains constant and hence the inductive effect stops. At this point, the only opposition the inductor offers is its ohmic/DC resistance.

When the switch S of Fig 1b is opened, the back-emf (bemf) or counter emf (cemf) of the inductor becomes very high, much greater than the source voltage. This high voltage (cemf), prevents the current from instantaneously dropping to zero. It does this by ionizing the air between the switch contacts as the switch opens. This causes the switch contacts to arc and burn as shown in Fig 2. This is known as inductive kick. As the energy stored in the inductors magnetic field gets used up, the switch contacts deionize and current stops.

This property of a coil to induce an emf within the coil due to a changing current through it is termed as self inductance.

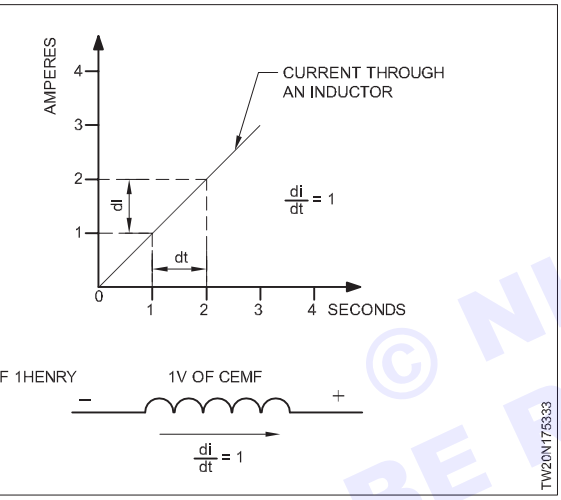
Fig 2



Unit of inductance - The henry: The basic unit of measure of Inductance is Henry abbreviated as H. The unit henry is defined in terms of, the amount of cemf produced when the amplitude of current through the inductor is changing. Based on this, One henry is that amount of Inductance which develops 1 V of cemf in the coil when the current changes at the rate of 1 Amp/sec.

From the above definition, referring Fig 3.

Fig 3



Inductance, $L = \frac{V_L}{di / dt}$

Where, V_L = Induced voltage

and $\frac{di}{dt}$ = rate of change of current. Refer Fig 3.

Polarity of Induced emf: The induced emf (voltage) in an inductor (cemf) has polarity that always opposes the source voltage (Lenz's law).

Fig 4 shows an inductor across an AC voltage source. When the applied voltage is increasing from 0 to +ve peak as shown in Fig 4a, the counter emf at end P of inductor will have +ve polarity opposing the increasing source voltage.

In Fig 4b, when the source voltage is decreasing from +ve peak to zero, the cemf at end P of the inductor will have -ve polarity opposing the decreasing source voltage.

Factors determining value of Inductance: The inductance of an inductor is primarily determined by the following four factors

1 The number of turns of wire

2 The material on which the coil is wound or the core material

3 The spacing between turns of wire and

4 The diameter of the coil

Fig 5 illustrates the effect of these factors on the inductance value.

Fig 4

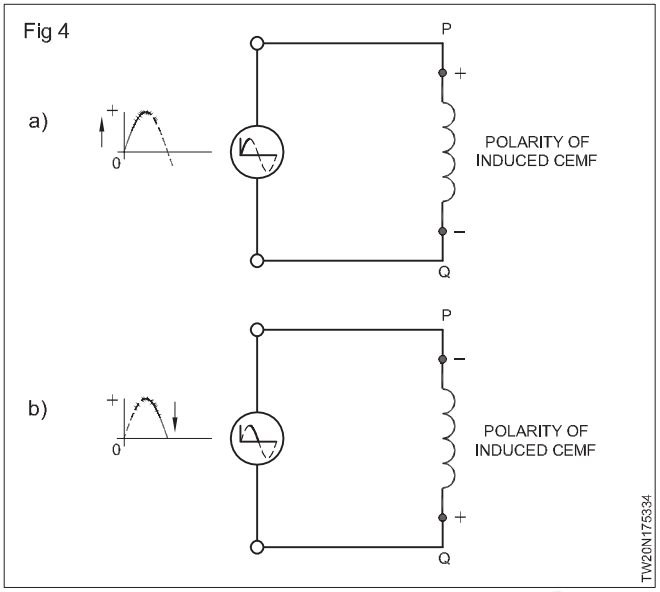
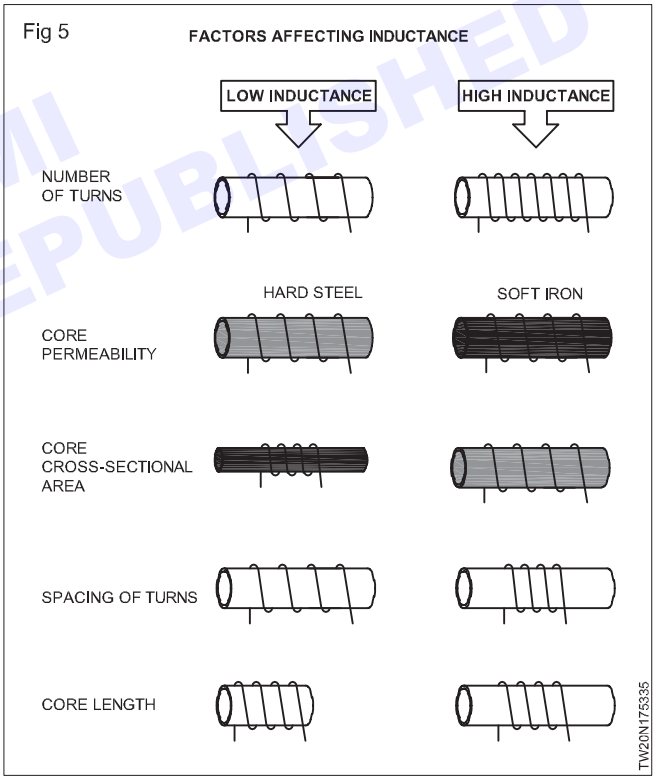


Fig 5



Given the parameters listed above, the inductance of a coil can be calculated using the formula,

$$L = \mu \frac{N^2 A}{l} \text{ Henries}$$

where,

μ = Permeability of the magnetic core around which the coil is wound, in Wb/At-m ($\mu = \mu_o \mu_r$)

N = Number of turns of the coil

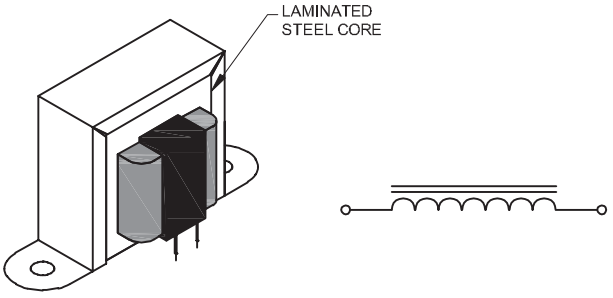
A = Area of cross-section of the core in square metres, m^2

l = length of the coil in meters.

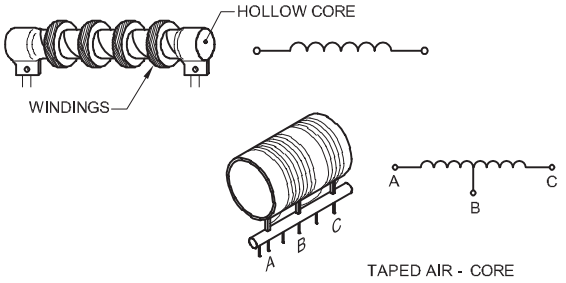
CHART - 1

PHYSICAL APPEARANCE OF DIFFERENT TYPES OF INDUCTORS

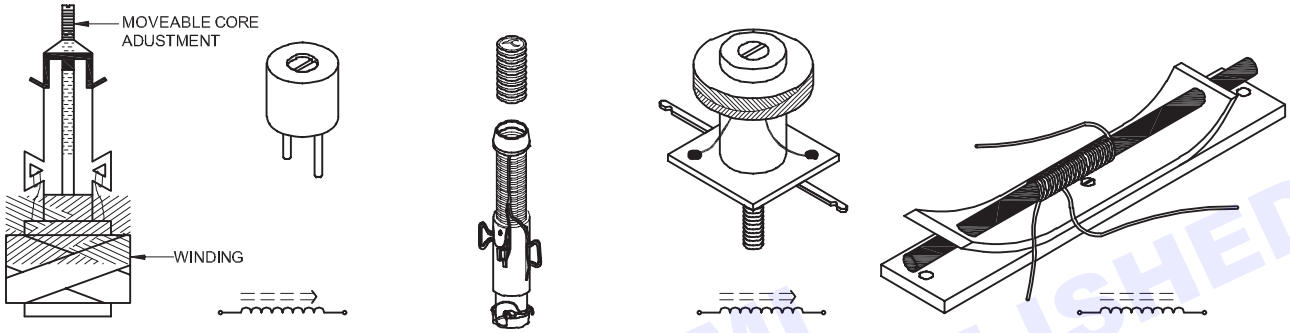
IRON-CORE INDUCTOR OR CHOKE



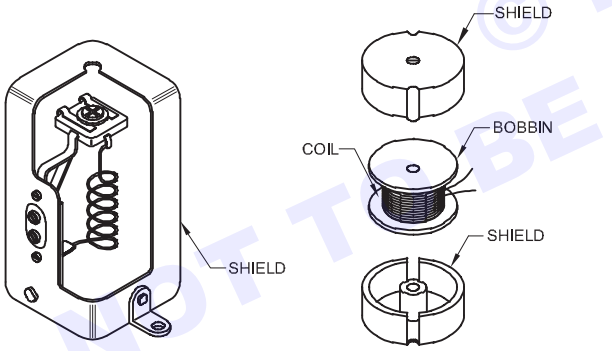
AIR-CORE INDUCTORs



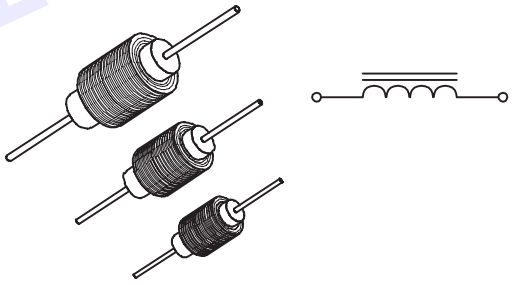
FERRITE-CORE INDUCTORS



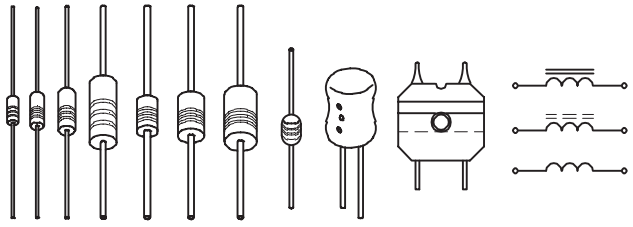
SHIELDED INDUCTORS



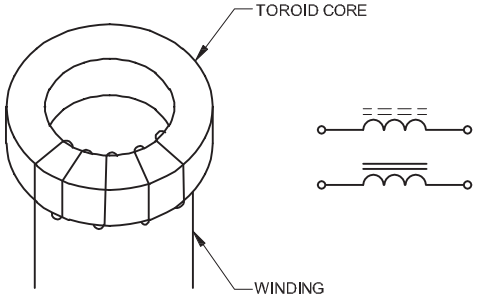
HIGH FREQUENCY INDUCTORS



MOULDED INDUCTORS



TOROID FERRITE CORE INDUCTOR



TW20N1753T2

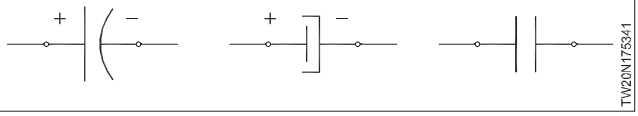
Passive components - Capacitors

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

- **state the function of capacitor.**
- **describe energy storing in capacitor**
- **state the factors that determine capacitance value**
- **state the functions of dielectric in a capacitor**
- **explain the types of fixed value capacitors**
- **explain the constructional details of capacitors**
- **connect the capacitors in series, parallel and series and parallel.**

Capacitors and capacitance: Capacitors are electronic components which can store electric energy in the form of electric charge. The charge storage ability of a capacitor is called the capacitance of a capacitor. Symbols used to represent capacitors are shown in Fig 1. Alphabet 'C' is used to represent the capacitance of a capacitor.

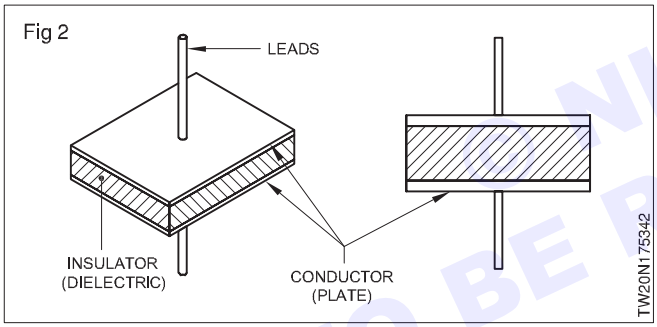
Fig 1



A simple capacitor consists of two pieces of conductors separated by an insulator as shown in Fig 2.

In capacitors the conductors shown in Fig 2 are called plates and the insulator is called dielectric.

Fig 2



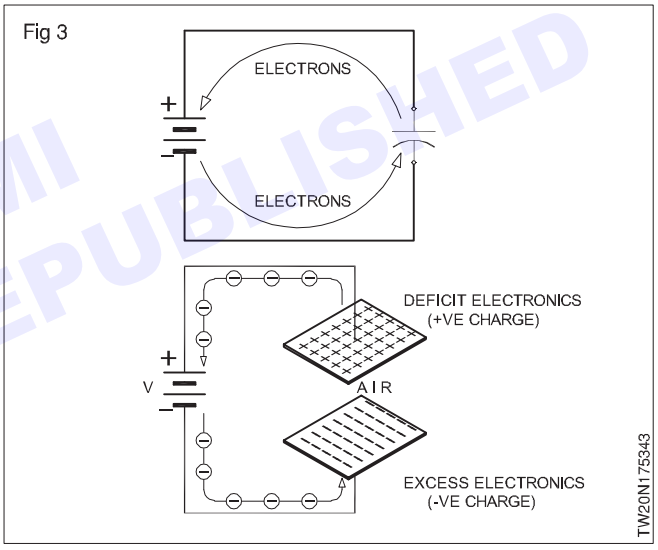
The plates of a capacitor can be of any size and shape and the dielectric may be any one of several insulator materials. Depending on the type of insulator/dielectric used capacitors are called as paper, mica, ceramic, glass, polyester, air electrolyte capacitors etc.,

Capacitor action of storing charge

When electric charge is forced on to the plates of a capacitor by some energy source, such as a battery, the capacitor stores these charges.

When a capacitor is connected to a battery as shown in Fig 3, electrons from the negative terminal of battery move through the connecting leads and pile up on one of the plates of the capacitor. At the same time free electrons from the other plate of the capacitor (remember that plates of a capacitor are conductors having free electrons) move through the connecting lead to the positive terminal of the battery. This process is known as 'charging of capacitor'. As the process of charging continues, the net result is that, one plate of the capacitor ends up with excess of electrons (Negative charge) and the other plate with deficiency of electrons (Positive charge). These charges on the plates of the capacitor represent a voltage source similar to that of the charges on the terminals of a battery/cell. The process of charging stops once the energy stored on the capacitor develops a voltage equal to that of the battery.

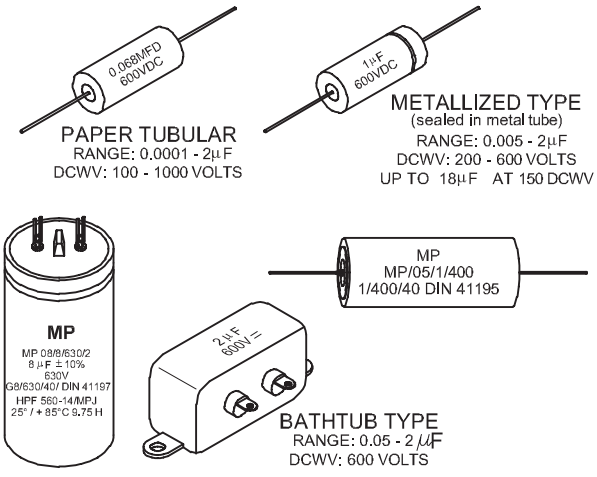
Fig 3



It is important to note that during the process of charging, although electrons were moving from and to the capacitor plates causing current flow in the circuit (you can connect an ammeter to measure it), no electrons moved nor did current flow from one plate through the dielectric to the other plate of the capacitor. The charging current through the circuit stops when the voltage across the capacitor becomes equal to, and in opposition to, the battery voltage. This charged capacitor can be disconnected from the circuit and used as a new energy source.

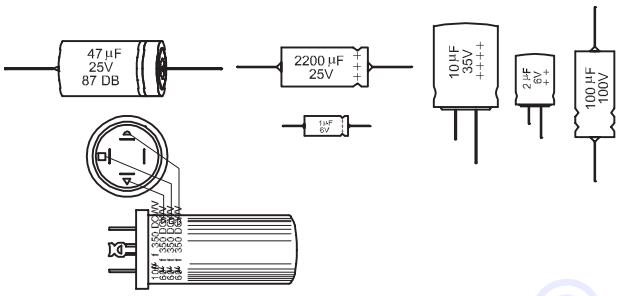
CHART- 1 : Physical appearance of types of fixed value capacitors

PAPER CAPACITORS

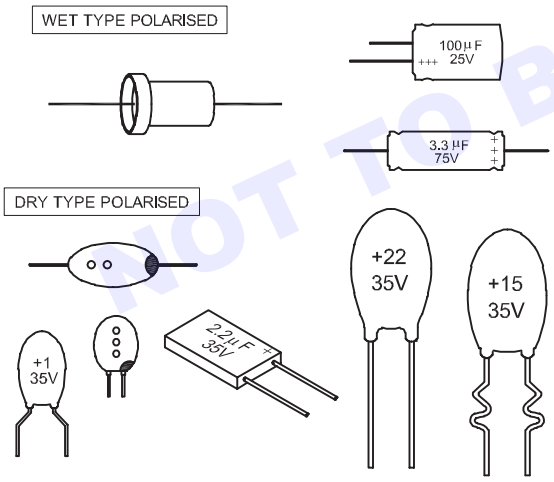


ELECTROLYTIC CAPACITORS

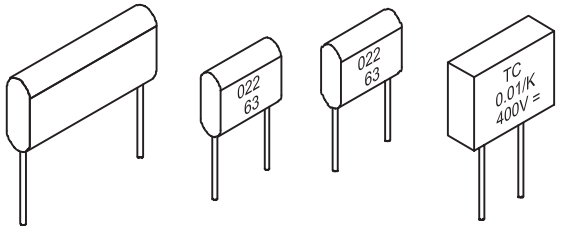
ALUMINIUM TYPE



TANTALUM TYPE

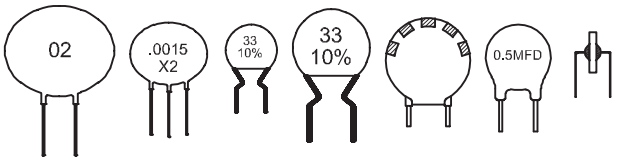


PLASTIC FILM CAPACITORS

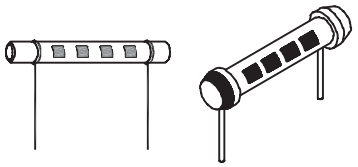


CERAMIC CAPACITORS

DISC

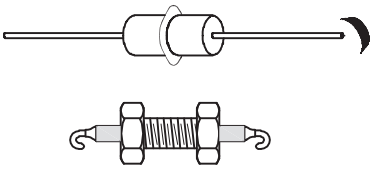


TUBULAR

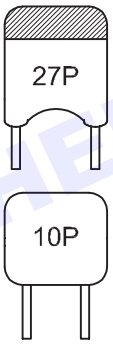


PIN - UP

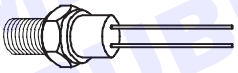
FEED - THROUGH



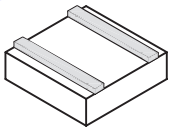
FLAT



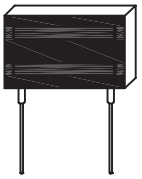
STAND - OFF



MONOLYTHIC CHIP

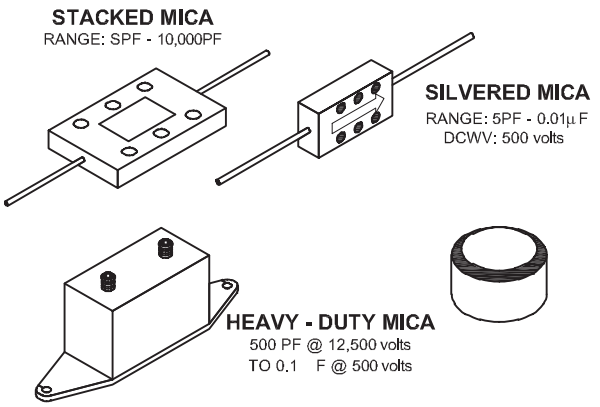


BUNDELED TUBE



BUTTON

MICA CAPACITORS



TW20N1753T3

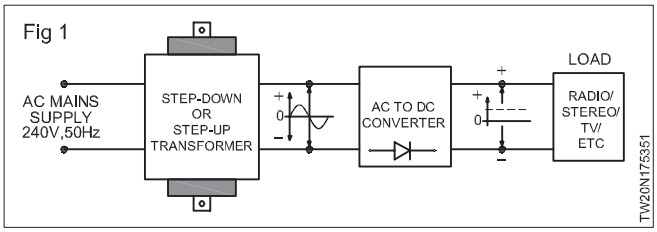
Rectifiers

Objectives: At the end of this lesson you shall be able to
- **describe working of half wave, full wave & bridge rectifier**
- **describe ripple frequency, R.C filter, inductor fitter and L.C fitters.**

Rectifier: Almost all electronic circuits need DC voltage for their working. This DC voltage can be obtained by dry cells and batteries. Use of a dry cell is practicable only in portable electronic circuits such as transistor radio, tape recorders etc. But in circuits requiring large voltages and currents, like high power audio amplifiers, television sets etc. batteries will not only be very expensive but also be voluminous.

An alternative method of obtaining DC voltage is by converting the AC mains supply of 240V, 50Hz into DC voltage. This technique is not only convenient but also takes very small space compared to battery packs. This process of converting AC to DC is known as rectification. Fig 1 shows the principle of converting AC to DC of required voltage level.

Fig 1



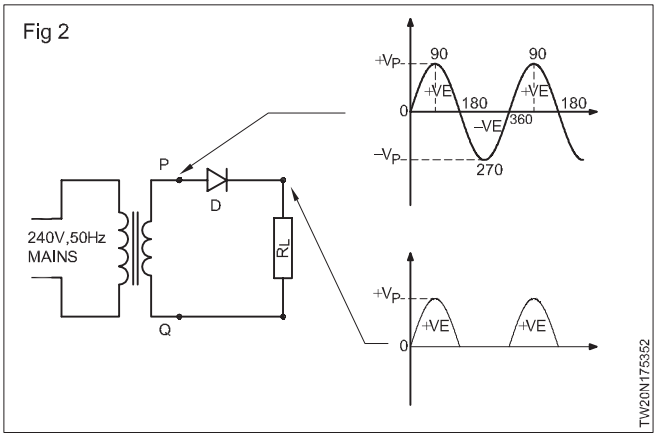
The transformer will step-down or step-up the mains AC to the required level. The stepped-up or stepped-down AC from the output of the transformer is then converted to DC using diodes making use of their unique unidirectional property.

Half wave rectifier

The simplest form of AC to DC converter is obtained by using one diode. such an AC to DC converter is known as half-wave rectifier as shown in Fig 2.

At the secondary of the transformer, across terminals P & Q, when seen on a CRO, the electric signal is a sinusoidal wave with its peak value of V_P and a frequency determined by the rate at which the alternations (+ve to –ve) are taking place. The frequency is 50Hz as this voltage is taken from 50Hz AC mains supply.

Fig 2



If the voltage across P and Q is measured using an AC voltmeter, the voltmeter shows the rms (root mean square) value, V_{rms} of the sinusoidal wave which will be less than the peak value. The relationship between V_{Peak} and V_{rms} is given by,

$V_{rms} = 0.707\ V_{peak}$ .....[1]

conversely,

$$V_{peak} = \frac{V_{rms}}{0.707} = \sqrt{2}\ V_{rms}$$

When this sinusoidal signal is applied across the diode D as shown in Fig 2, the diode conducts (behaves as a closed switch) only during the +ve half cycle of the input sinusoidal voltage and does not conduct (behaves as a open switch) during the -ve half of the input sinusoidal voltage. This process repeats again and again thus producing a pulsating +ve wave form at the output across the load, R_L as shown in Fig 2.

Regulated power supply

Objectives: At the end of this lesson you shall be able to
- **explain the regulated and unregulated power supply.**

DC regulated power supply: The main purpose of a DC regulated power supply is to get a constant DC supply for electrical and electronic circuits for conducting experiments in laboratories and also to provide testing voltage for equipments like radio, TV, tape recorders, computers etc.

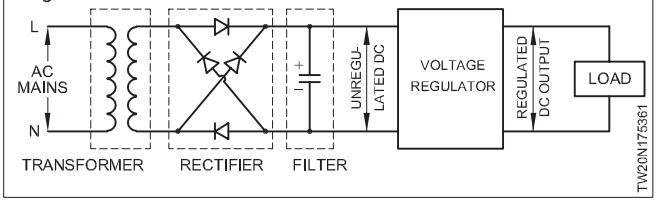
DC unregulated power supply: The most common method of obtaining DC from AC supply is to use a transformer for stepping down/up of the AC voltage and to use a rectifier circuit for converting AC supply into DC. Often capacitors/inductors are used to filter the DC output. In this type of circuits the DC output voltage changes with a change in load and is generally used in a circuit where load current is constant eg. battery charging, electroplating, communication system etc.

Types of regulated power supply: There are two basic ways of deriving a stable DC supply from an AC supply. They are the conventional way and a system using switch mode technique.

Most of the electronic equipment uses the conventional type of power supply. In this type, voltage and current regulation are used combinedly.

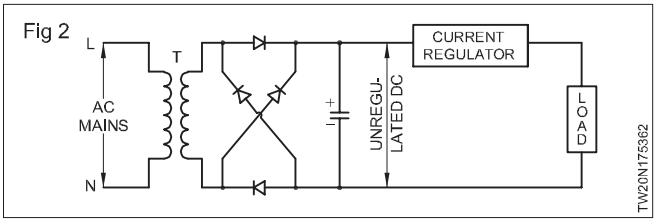
Voltage regulated power supply: The voltage regulated power supply consists of a step down transformer, rectifier and a storage capacitor to generate an unregulated DC supply that is electrically isolated from the AC mains supply. Then this DC output voltage which is not regulated is passed through voltage regulator circuitry to get the regulated DC voltage. (Fig 1).

Fig 1



Current-regulated power supply: A current regulated power supply consist of an unregulated power supply similar to voltage-regulated power supply and a current limiting circuit. (Fig 2)

Fig 2



By suitably designing the current regulator circuit it is possible to get current regulation for a single range or a multi-range of currents.

Voltage and current regulation combined: Commercially available DC regulated power suppliers provide both voltage and current regulation combined in the supply unit. (Figs 3 & 4)

Fig 3

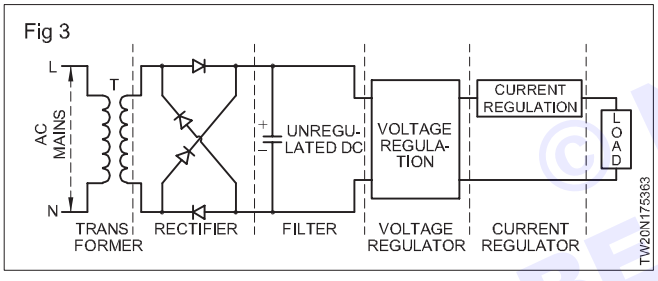
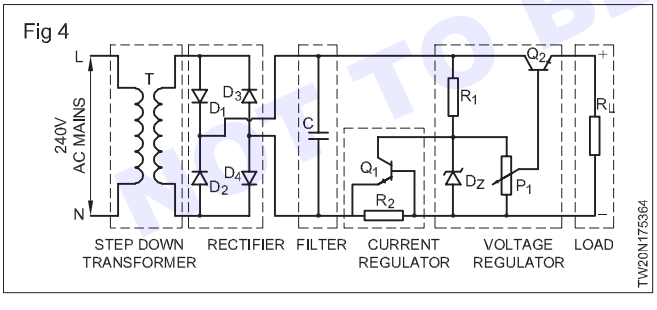


Fig 4



Circuit description: Fig 4 shows a circuit diagram of a simple voltage and current regulated power supply. The functions of circuit elements are as follows. Transformer 'T' is used for stepping down AC voltage to the required AC voltage. Full wave bridge rectifier 'D_1 to D_4' is used to rectify AC to DC voltage. A capacitor 'C' is used for filtering. The voltage across zener diode 'D_z' is used as a reference voltage source which is constant. The potentiometer 'P_1' is used for controlling the DC output voltage. Transistor Q_2 works as a voltage regulator. For a set voltage by potentiometer 'P_1' that is when there is no load, transistor Q_2 conducts less and voltage drop across collector and emitter is maximum. When the load current increases transistor 'Q_2' conducts more and the voltage drop across collector and the emitter decreases almost compensating the drop in unregulated DC output, thereby keeping the regulated output voltage constant. Transistor 'Q_2' also works as a current regulator. The conduction of transistor 'Q_1' depends upon the voltage drop across resistor 'R_2'. In turn the voltage drop across 'R_2' depends upon the resistance value of R_2 and load current ($I_L \times R_2$). When the load current increases the voltage drop across 'R_2' also increases and for a set current transistor 'Q_1' conducts resulting the base of transistor 'Q_2' to almost at negative potential reducing the output voltage. The ultimate result is the current will not increase above the set value of current but the voltage goes on decreasing for any reduction of load resistance "R_L".

Terms used in specifying regulated power supplies: The regulation requirement of a regulated power supply is often associated with its application. Hence the following terms are considered while selecting a regulated power supply.

Line regulation (Source regulation) : The line regulation is also called a source regulation specifying the change in DC output voltage due to the variation in the line voltage.

$$\% \text{ Source regulation} = \frac{\% \text{ of variation of DC output voltage for a given constant load}}{\% \text{ of variation of AC input line voltage}} \times 100$$

Load regulation: The load regulation is also called load effect which is defined as the change in the regulated output voltage when the load current changes from minimum to maximum.

Load regulation = No load voltage E_{NL} – Full load voltage E_{FL}

Load regulation = $E_{NL} - E_{FL}$

Load regulation is often expressed as a percentage by dividing the change in the load voltage by the no load voltage.

$$\% \text{ Load regulation} = \frac{E_{NL} - E_{FL}}{E_{NL}} \times 100$$

Ripple: The term ripple implies that the residue of AC delivered to the load as a result of imperfect rectification and filtering.

The ripple may be mentioned as AC voltage available for a given or nominal DC output voltage. In general the 'Ripple factor' is defined as the percentage ratio of the AC voltage available in the DC output.

$$\% \text{ Ripple factor} = \frac{\text{AC voltage available in DC output}}{\text{Normal DC voltage at the output}} \times 100$$

The size of the power supply unit depends upon the maximum DC output power required ie. DC voltage and DC amperes. The circuit of the regulated power supply becomes more and more sophisticated depending upon the high precision in regulation and a number of protection circuits incorporated in the equipment. The circuit may use a number of ICs transistors, controls and other components depending on the accuracy required.

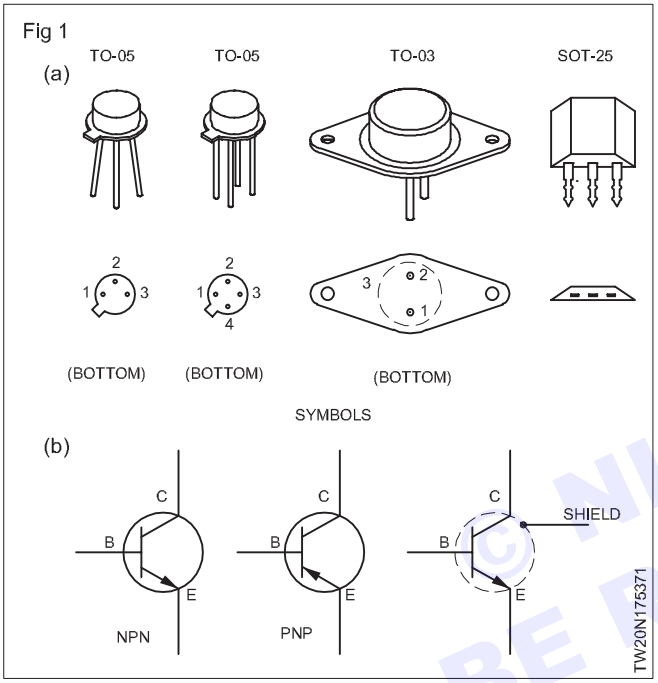
Transistors and classification

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

- **introduction of transistors**
- **list the advantages of transistors over vacuum tubes**
- **list the important classifications of transistors**
- **state the name and functions of terminals of a transistor**
- **name of the types of transistor packages**
- **describe the two tests to be conducted on a transistor before using it**
- **working principle of transistor.**

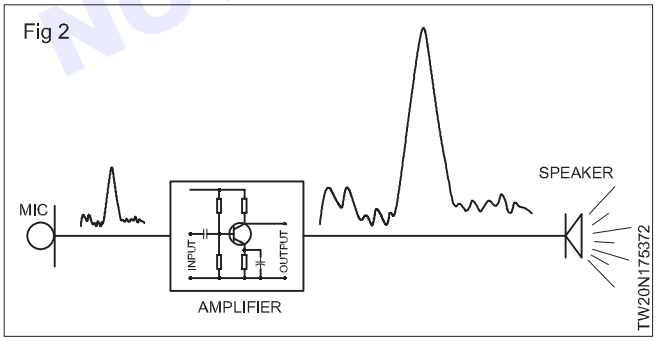
Introduction : Transistors are the semiconductor devices having three or four leads/terminals. Fig 1a shows some typical transistors. Fig 1b shows the symbols used for different types of transistors.

Fig 1



Transistors are mainly used for enlarging or amplifying small electric/electronic signals as shown in Fig 2. The circuit which uses transistors for amplifying is known as a transistor amplifier.

Fig 2



One other important application of transistors is its use as a solid state switch. A solid state switch is nothing but a switch which does not involve any physical ON/OFF contacts for switching.

Transistors can be thought of as two PN junction diodes connected back to back as shown in Fig 3.

– Very small in size (see Fig 4b)

Fig 3

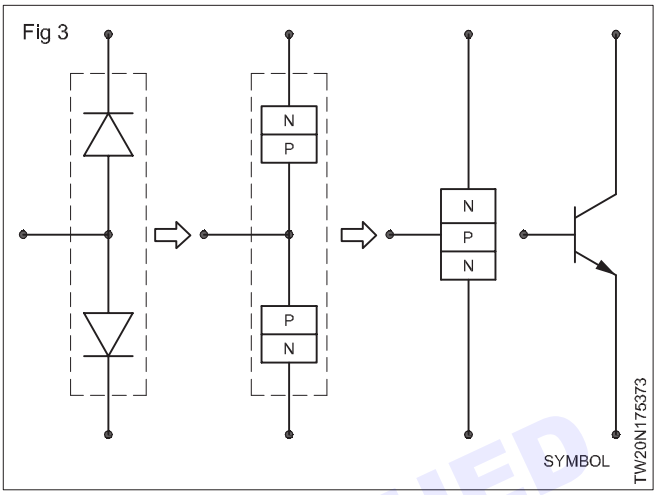
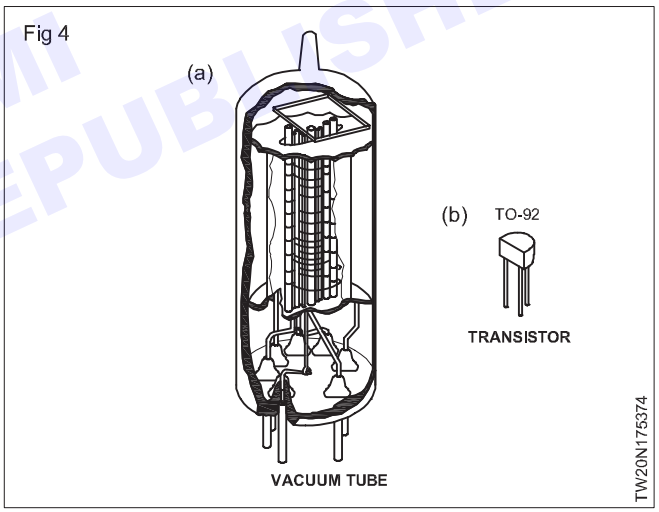


Fig 4



- Light in weight
- Minimum or no power loss in the form of heat
- Low operating voltage
- Rugged in construction.

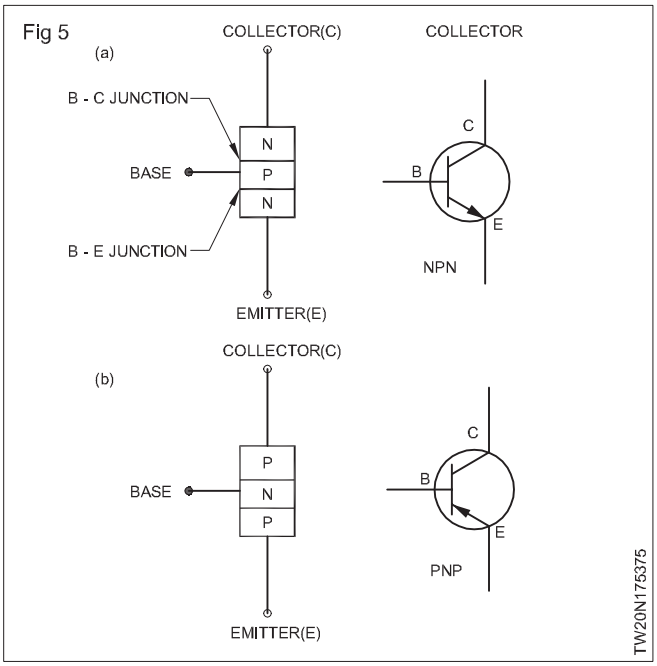
Classification of transistors

1 Based on the semiconductor used

- Germanium transistors
- Silicon transistors

Like in diodes, transistors can be made, using any one of the above two important semiconductors. However, most of the transistors are made using silicon. This is because, silicon transistors work better over a wide temperature range (higher thermal stability) compared to germanium transistors.

2 Based on the way the P and N junctions are organized as shown in Fig 5.

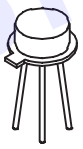
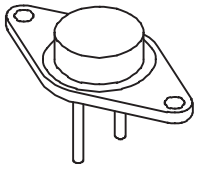


– NPN transistors

– PNP transistors

Both NPN and PNP transistors are equally useful in electronic circuits. However, NPN transistors are preferred for the reason that NPN has higher *switching speed* compared to PNP.

3 Based on the power handling capacity of transistors as shown in table below (Fig 6).

Low power transistors (less than 2 watts)	**Medium power transistors** (2 to 10 watts)	**High power transistors** (more than 10 watts)
TO-92 	TO-05 	TO-03 

Low power transistors, also known as small signal amplifiers, are generally used at the first stage of amplification in which the strength of the signal to be amplified is low. For example, to amplify signals from a microphone, tape head, transducers etc.,

Medium power and high power transistors, also known as large signal amplifiers are used for achieving medium to high power amplification. For example, signals to be given to loudspeakers etc. High power transistors are usually mounted on metal chassis or on a physically large piece of metal known as heat sink. The function of heat sink is to, take away the heat from the transistor and pass it to air.

4 Based on the frequency of application

– Low freq. transistors (Audio frequency or A/F transistors)

– High freq. transistor (Radio frequency or R/F transistors)

Amplification required for signals of low or audio range of frequencies in Tape recorders, PA systems etc., make use of A/F transistors. Amplifications required for signals of high and very high frequencies as, in radio receivers, television receivers etc., use R/F transistors.

5 Based on the type of final packaging

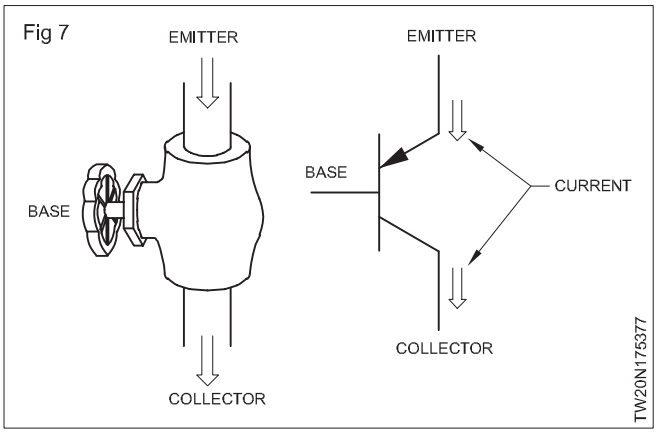
- Metal
- Plastic
- Ceramic

Metal packaged transistors are generally used in medium and high power amplifications. Plastic packaging is generally used for low power amplification. Some plastic packages come with a metal heat sink. Such transistors are used for medium power amplification. Ceramic packaging is used for special purpose very high frequency applications, for higher temperature stability etc.,

Some examples of packaging type codes used with transistors are, TO-3, TO-92, SOT-25 and so on.

Inside a transistor: Inside a transistor there are two PN junctions connected to each other as shown in Fig 3 and Fig 5. Outside a transistor, one can see only three leads. As shown in Fig 5, the three leads/pins/pin called base, emitter and collector are taken from each of doped semiconductor material.

In simple terms, as shown in Fig 7, the function of the base, emitter and collector regions of a transistor are,



Emitter - emits current carriers (electrons/holes)

Collector - collects current carriers

Base - controls flow of current carriers from emitter to collector.

Transistor type packages: The popular transistors with different ratings used for general purpose to special applications are manufactured in a variety of package styles. Some of the commonly used transistors with their package numbers and lead identifications are shown in Fig 8.

Fig 8

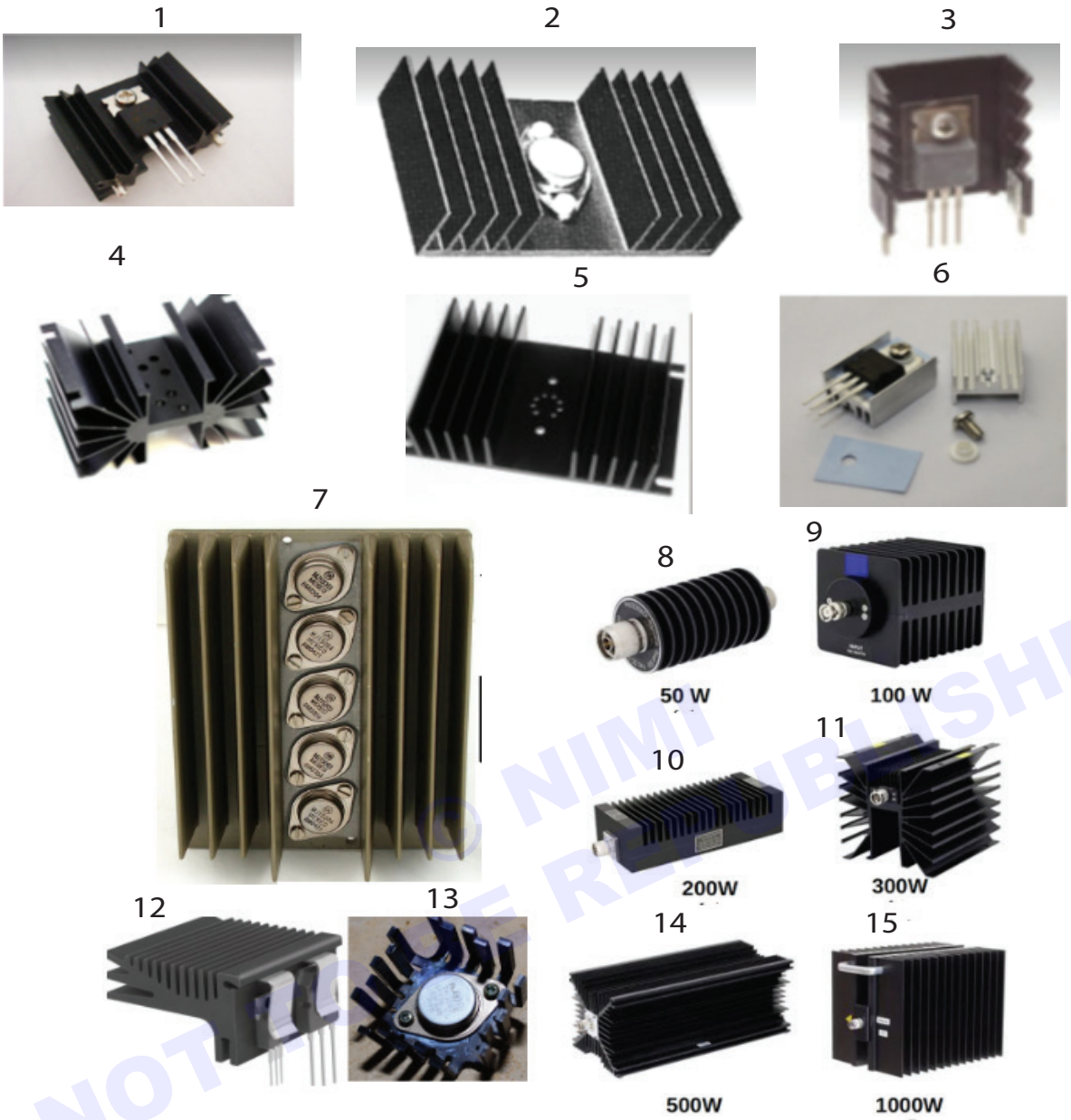
Heat sink: In any electrical/electronic circuits the high power rectifiers, SCRs, transistors, MOSFETS, even LEDs used in high bright lights consumes power generates considerable amount of heat while the circuit is functioning. Typically power handling semiconductor devices/components are inadequate to dissipate heat as their dissipation capability is significantly low.

Due to this reason, heating up of components leads to malfunctioning problems and may cause failure of the entire circuit or performance of the system. Therefore, to solve these problems, heatsinks are the solution that must be provided to these semiconductor devices for cooling purpose.

Heatsink is a device made of aluminium metal attached to the electronic device, that dissipates heat into surrounding air medium and cools them for improving their performance reliability and also avoids the damage to the components. Heat sink transfers the heat or thermal energy from a high temperature component to a low temperature medium like air.

Heatsinks are classified into different categories as extruded heatsinks as they can be made as extrusions based on the heat dissipating rating shape and size etc as shown in Fig 9.

Fig 9



Gain and impedance of common emitter amplifier

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

- **state the meaning and method of finding voltage gain**
- **state the meaning and method of finding input impedance**
- **state the meaning and method of finding output impedance**
- **state the meaning and method of finding power gain**
- **state the phase relationship between input and output in a CE amplifier.**

After a transistor is biased with the Q point near the middle of the DC load line, the transistor can be made to amplify AC and DC signals as shown in Fig 1a. When we use a transistor to amplify a small AC signal, the small AC signal to be amplified is coupled to the base of the transistor using a capacitor. A capacitor is used for AC coupling because as discussed in earlier lessons capacitors behave as short for AC signal and open for DC signal. The varying amplitude and frequency of the coupled AC signal produces greater value variations in the collector current of the same shape and frequency as shown in Fig 1b.

As shown in Fig 1a, if the input is a 1 kHz sine wave, the output will be an enlarged 1 kHz sine wave. The small

sine wave given at the base of the transistor produces variations in the base current. Hence, the collector current is an amplified sine wave of the same frequency. The sinusoidal collector current flows through the collector resistor and produces an amplified sine wave output. Such amplifiers which retain the shape of the input signal at the output are called linear amplifiers.

Fig 1

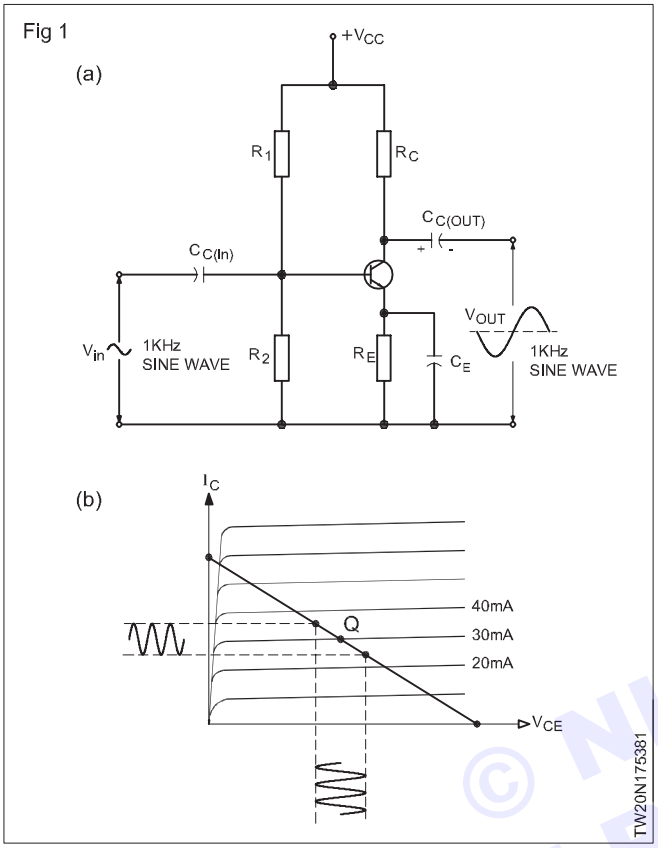


Fig 1b, shows the DC load line, the Q point and AC input and output signals. This is generally referred to as the *AC* load line. As can be seen from Fig 1b, the AC input voltage produces variations in the base current. This results in sinusoidal variations about the Q point. Variations in Q point are nothing but the variations in the collector current resulting amplified form of the input signal.

For small input signal levels, generally referred to as small signal operation, the peak to peak swing in the collector current should be less than the ±10% of the collector current at Q point to keep the distortion in the amplified output with in acceptable limits.

For large input signal levels, generally referred to as large-signal operation, the peak to peak swing in the collector current will be larger(more than 10%). If the swing is very large, the transistor may go into saturation and cut off. This swing into saturation and cut off will clip the positive and negative peaks of the output signal. This clipping is nothing but distortion, meaning, the output will not be an exact replicate of the input signal.

AC Current gain A_i, of a CE amplifier: The AC current gain of a CE amplifier shown in Fig 1 is the ratio of the AC component of the collector current i_c, to the AC base current i_b.

$$A_i = \frac{\Delta i_c}{\Delta i_b}$$

Small letter i is used to represent AC current whose value keeps changing with time.

It is to be noted that in most linear CE amplifier circuits the current gain A_i is almost equal to b_{dc} of the transistor. Therefore the following approximation can be used for A_i.

$$A_i \approx \beta$$

In the amplifier at Fig 1, if b_{dc} of the transistor is 100, then the current gain A_i of the amplifier can be taken as 100.

Voltage gain, A or A_V of CE amplifier

The voltage gain of an amplifier is the ratio of AC output voltage to the AC input voltage. This is represented as,

$$\text{Voltage gain, } A_v = \frac{V_{out}}{V_{in}}$$

Small letter v is used for voltage because it is AC voltage whose amplitude keeps changing with time.

For example, in Fig 1, if the input voltage v_{in} is 80 m $V_{(p-p)}$ and the corresponding output voltage v_{out} is 7.2 $V_{(p-p)}$, then the voltage gain A_v is given by,

$$\text{Voltage gain, } A_v = \frac{7.2\ (p-p)}{80\text{m}\ V_{(p-p)}} = 90$$

A voltage gain of 90 means that, in this amplifier, a base voltage of 1 mV produces an output voltage of 9 mV.

The input and output voltage may be rms, peak, peak-to-peak, as long as the input and output are measured the same way consistently.

Input impedance, Z_{in} of CE amplifier: Recall that the maximum transfer of power takes place when the impedances of the supplying and receiving circuits are matched.

If impedances are to be matched for best circuit operation, both impedances must be known. If a single device such as a microphone, speaker, relay, etc. is to be used, its impedance will be given by the manufacturer. The amplifier to be designed for such a circuit must have an input or output impedance to match the input-output devices.

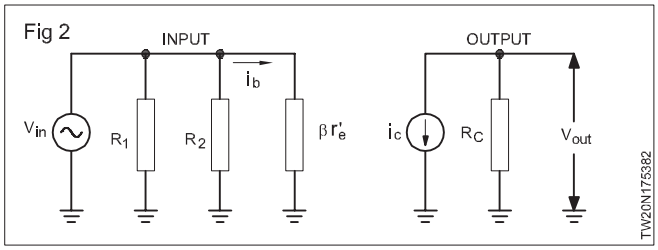
The AC source driving the amplifier has to supply AC current to the amplifier. The less the current the amplifier draws from the source, the better because the supplying source does not get loaded. The input impedance of the amplifier determines how much of current the amplifier takes from the ac source or the preceding stage of the amplifier.

In the normal frequency range of an amplifier, the coupling and by pass capacitors behave as a short for ac. The AC input impedance Z_{in} sometimes referred to as input resistance R_{in} is defined as the ratio of input signal voltage to input signal current.

$$Z_{in} = \frac{V_{in}}{i_{in}}$$

where, V_{in} and i_{in} are rms or peak or peak-to-peak values.

Fig 2 shows the AC equivalent circuit of the CE amplifier shown in Fig 1.



From the AC equivalent circuit the input impedance Z_{in} is given by,

$$Z_{in} \approx R_1 \| R_2 \| \beta r'_e \quad \text{.....[1]}$$

where,

R_1 and R_2 are the voltage divider resistors,

b is the DC current gain and r'_e is the ac emitter resistance (V_{BE}/I_E). r'_e is approximately equal to 25W when the Q point is chosen at the mid of the load line.

In the CE amplifier at Fig 1, if R_1 = 18KW, R_2 = 8.2KW and the transistor b is 100, the input impedance Z_{in} will be,

b'r = 100 (25W) = 2.5 KΩ

$Z_{in} = R_1 \| R_2 \| b\, r'_e$

= 18 KW $\|$ 8.2 KW $\|$ 2.5 KΩ

= 1.73 KΩ

Logic gates and logic probes, logic gates - Principles of operations

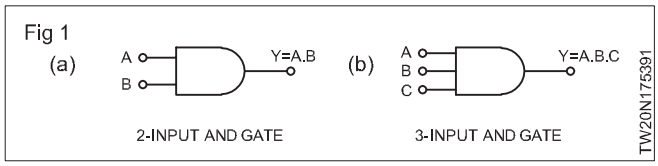
Objectives: At the end of this lesson you shall be able to

- **explain the function of logic gates**
- **explain the AND gate using diode and its truth table**
- **explain the OR gate using diode and its truth table**
- **explain a NOT gate using transistor and its truth table**
- **explain the NAND,NOR gate and their truth table**
- **explain the EX-OR and EX - NOR gates and their truth table.**

Introduction: Logic gates are electronic circuits used in digital circuits for the purpose of decisions. Logic circuits are basically of two types namely decision making circuits and memory circuits. Their functioning depends on the binary inputs they receive and produce binary output which are a function of the input as well as the characteristics of the logic circuit they implemented. All logic gates have a single output and they may have two or more inputs. For specific decision making function there are several types of logic gates are used. Basic Logic gates are a group of the logic gates specifically called as AND,OR and NOT gates. All these gates have their own identical, logical function. By the combination of these gates we can obtain any Boolean or logical functions or any logical function.

AND gates: The AND gate has two or more inputs but only one output. All input signals must be held high to get a high output. Even if one of the inputs is low, the output becomes low.

The schematic symbols for 2 input and 3 input AND gates are shown in Fig 1a & 1b.

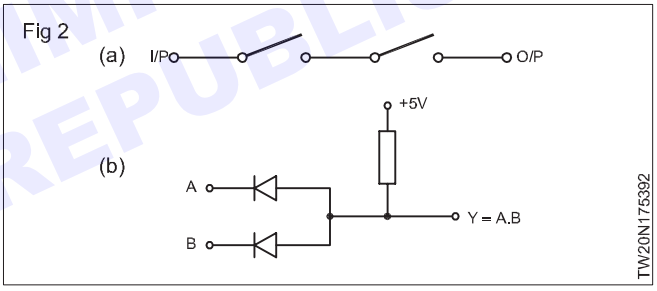


Truth table

Two input AND gate

A	B	Y=A.B
0	0	0
0	1	0
1	0	0
1	1	1

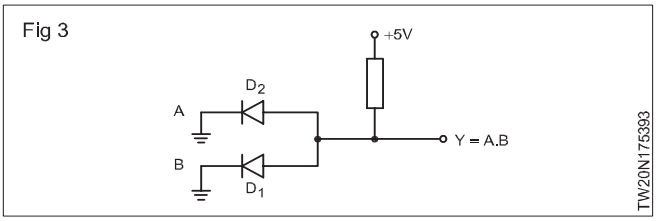
Electrical equivalent circuit of an AND gate: The electrical equivalent of AND gate and AND gate using diodes are shown in Fig 2a & 2b.



Two input AND gate using diode

Condition-1

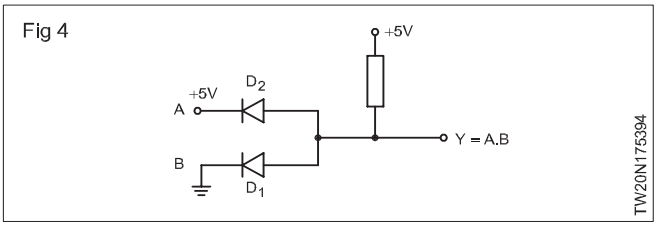
A=0, B=0, Y=0 as shown in Fig 3.



During the above condition inputs A and B are connected to ground to make logic low inputs. During this condition, both the diodes conduct, and pulls the output Y to logic0.

Condition-2

A=0, B=1, Y=0 as shown in Fig 4.

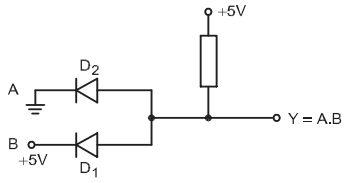


In the condition shown in Fig 4, diode D_1 is connected to logic-0 input and diode D_2 is connected to +5V [Logic high]. Diode D_1 is in forward bias and conducts. Diode D_2 is having equal potential (+5V) at anode and cathode. So potential difference between anode and cathode is 0. Hence diode D2 does not conduct. The output Y is pulled down to logic zero, since D_1 is conducting.

Condition- 3

A=1, B=0, Y=0 as shown in Fig 5.

Fig 5

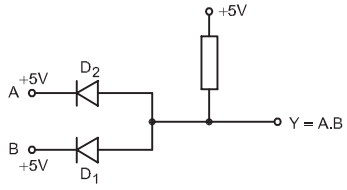


The condition-3 is similar to the condition-2. D_2 is forward biased. D_1 is reverse biased. Hence, output Y is pulled to logic-0.

Condition- 4

A=1, B=1, Y=1 as shown in Fig 6.

Fig 6



In this condition both the diodes are reverse biased. So both the diodes act as open circuit. Therefore, output Y is+5V i.e y is in logic1 condition.

For pin diagram refer to the data sheet of the IC.

A. For example, if 1000 pulses pass through the gate in the 1 second interval of the enabled pulse, there are 1000 pulses/sec. That is, frequency is 1000Hz.

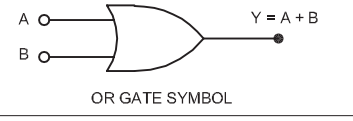
AND gates are available in the form of IC.IC7408 is a TTL type AND gate IC having 4 numbers of AND gates inside it.

OR gate

The OR gate has two or more inputs, but only one output.

The output of an OR gate will be in 1 state if one or more of the inputs is in 1 state. Only when all the inputs are in 0-state, the output will go to 0-state. Fig 7 shows the schematic Symbol of an OR Gate

Fig 7



The boolean expression for OR gate is Y=A+B.

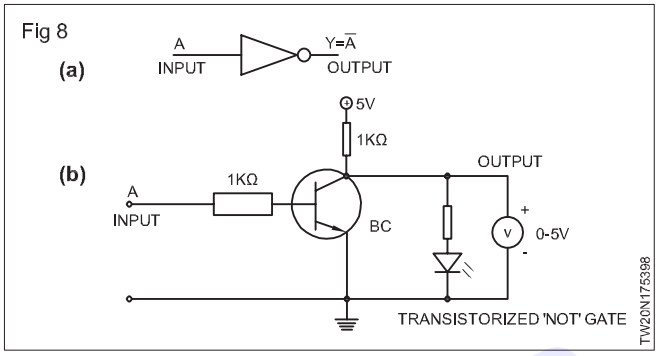
The equation is to be read as Y equals A (or) as B. Two-input truth table given below is equivalent to the definition of the OR operation.

Truth table for OR gate

A	B	Y=A + B
0	0	0
0	1	1
1	0	1
1	1	1

NOT gate: The NOT gate has only one input and one output as per the schematic symbol shown in Fig 8a and the circuit to construct the NOT gate using discrete components in Fig 8b.

Fig 8



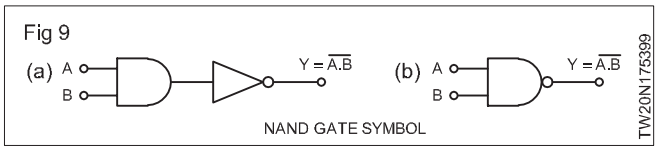
The NOT gate inverts the logic stage of a binary signal input. The small circle (bubble) at the output of the symbol is formally called a negation indicator and designates the logical complement.

NAND gate: The NAND gate is the complement of the AND operation. Its name is an abbreviation of NOT AND.

The schematic symbol for the NAND gate consists of an AND symbol with a bubble on the output, denoting that that a complement operation is performed on the output of the AND gate.

The schematic symbol and truth table of NAND gate is shown in Fig 9a & b.

Fig 9



Truth table

A	B	Y=A.B
0	0	1
0	1	1
1	0	1
1	1	0

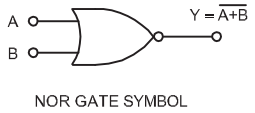
The truth table cleary shows that the NAND gate operation is the complement of the AND gate.

NOR gate: The NOR gate is the complement of the OR operation. ITS name is an abbreviation of NOT OR.

The schematic symbol for the NOR gate consists of an OR symbol with a bubble on the output, denoting that a complement operation is performed on the output of the OR gate.

The schematic symbol and the truth table of NOR gate is shown in the Fig 10.

Fig 10



NOR GATE SYMBOL

TW20N17539A

Input		Output
A	B	Y=A+B
0	0	1
0	1	0
1	0	0
1	1	0

The output of NOR gate is '0' even if one of the input is in logic1. Only when both the inputs are in logic '0',the output is in logic '1'.

The IC 7402 is a TTL type NOR gate IC. It contains 4 NOR gates. For pin details of the IC refer to the data sheet of the IC.

EX-OR gate

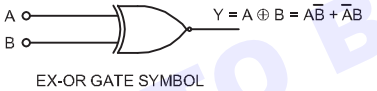
Exclusive-OR gate

Exclusive OR gate is actually formed by a combination of other gates already discussed. However, because of their fundamental importance in many applications, these gates are treated as basic logic elements with their own unique symbols.

The EX-OR gate has only two inputs unlike the other gates, it never has more than two inputs.

The schematic symbols of Exclusive-OR (XOR for short) is gate shown in Fig 11.

Fig 11



EX-OR GATE SYMBOL

TW20N17539B

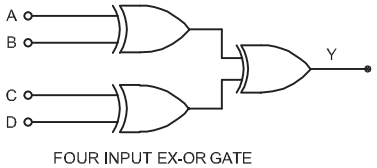
The truth table of EX-OR gate is given below.

Truth table

A	B	Q=A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

Using 2-input EX-OR gates as building blocks, an EX-OR gate with more than two inputs can be built as shown in Fig 12.

Fig 12



FOUR INPUT EX-OR GATE

TW20N17539C

Four input EX-OR gate

Y = A+B+C+D

Truth table

A	B	C	D	Y	Remarks for input
0	0	0	0	0	Even
0	0	0	1	1	Odd
0	0	1	0	1	Odd
0	0	1	1	0	Even
0	1	0	0	1	Odd
0	1	0	1	0	Even
0	1	1	0	0	Even
0	1	1	1	1	Odd
1	0	0	0	1	Odd
1	0	0	1	0	Even
1	0	1	0	0	Even
1	0	1	1	1	Odd
1	1	0	0	0	Even
1	1	0	1	1	Odd
1	1	1	0	1	Odd
1	1	1	1	0	Even

To summarizes the action by referring truth table of 4-input XOR gate, each input word with an odd number of 1's produces a logic high (1) output and for words with an even number of 1's it produces logic-Low(0) output. Because of this reason the EX-OR gate is used for parity check, IC 7486 is an quad 2 input EX-OR gate which is available both in TTL and CMOS family.

Application of EX- OR gate as a parity checker

Parity is the term used to mention the number of 1's in a binary word. Even parity means an n-bit input has even number of 1s. For instance, 110011 has even parity because it contain four 1s. Odd parity means an n-bit input has an odd no. of 1s. For example, 110001 has odd parity because it contains three 1s.

Parity checker

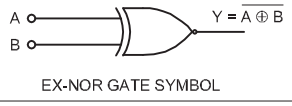
Exclusive-OR gates are ideal for checking the parity of a binary number because they produce an output 1 when the input has an odd no. of 1s. Therefore an even parity input to an Exclusive-OR gate produces a low output, while an odd parity input produce a high output.

Exclusive-NOR gate

Input		Output
A	B	Q= A + B
0	0	1
0	1	0
1	0	0
1	1	1

The schematic symbols for the EX-NOR (XNOR) gate is shown in Fig 13. Like the XOR gate, XNOR has only two inputs. The bubble on the output of the XNOR symbol indicates that its output is opposite that of the XOR gate.

Fig 13



EX-NOR GATE SYMBOL

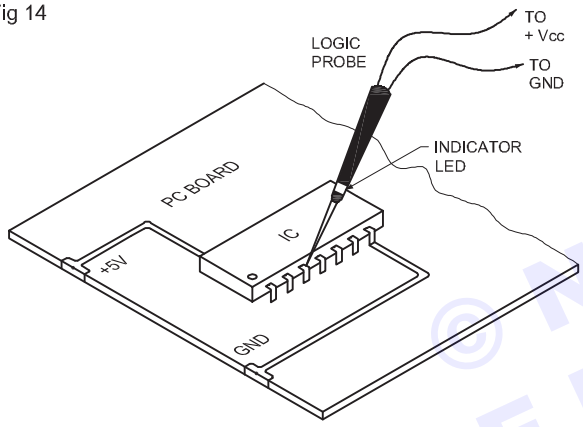
TW20N17539D

In an exclusive-NOR gate operation, "Output Q is LOW' if input A is LOW and input B is HIGH or if A is HIGH and B is LOW, Q is HIGH if A and B are both HIGH or both LOW.

Application: EX-OR gate can be used as a controlled inverter. One of its inputs can be used to control whether the signal at the other input will be inverted or not. This property will be useful in certain application.

Logic probe: A logic probe is used to monitor the logic level activity at an IC pin or any other accessible point in a logic circuit. Logic probe normally has one or more indicator LEDs that indicate the various conditions of the logic signal. The indication may be related to logic HIGH, LOW, Intermediate & Pulsing states that are present at that point in the circuit which the probe tip is touching. Fig 14 shows how a logic probe is connected to an IC pin.

Fig 14



TW20N17539E

A logic probe is used as a troubleshooting tool of digital systems. The most common internal failures of digital ICs are as follows

1 Malfunction in the internal circuitry.

2 Inputs or Outputs open circuited.

3 Inputs or Outputs shorted to ground or Vcc.

4 Short between two pins (other than ground or Vcc).

NAND gate as a universal gate: To prove that any Boolean function can be implemented using only NAND gates, we will show that the AND, OR, and NOT operations can be performed using only these gates.

NAND gate implemented as NOT gate: In the following circuit NAND gate is used as an inverter (NOT gate).

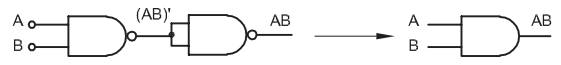
All input pins of NAND gates are connected to the input signal A gives an output A as shown in Fig 15.

Fig 15

TW20N17539F

NAND gate implemented as AND gate. An AND gate can be implemented by NAND gate as shown in Fig16. (The AND is replaced by a NAND gate with its output complemented by a NAND gate inverter).

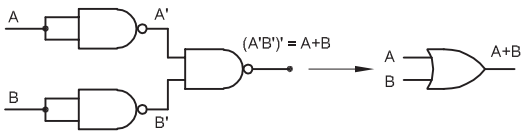
Fig 16



TW20N17539G

NAND gates implemented as OR gate. An OR gate can be implemented by NAND gates as shown in Fig 17. (The OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverters).

Fig 17



TW20N17539H

Thus it is proved that the NAND gate is a universal gate since it can implement the AND, OR and NOT logic functions.

NOR gate as a universal gate. In the following paragraphs the NOR gate is used to prove that any Boolean function can be implemented only with NOR gates.NOR to replace the AND,OR and NOT operations .

NOR gate implemented as NOT gate.In the following circuit a NOR gate is used as an inverter (NOT gate).

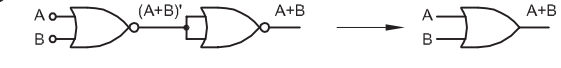
All input pins of NOR gate is connected to the input signal A gives an output $\overline{A}$ as shown in Fig 18.

Fig 18

TW20N17539I

NOR gate implemented as OR gate: An OR gate can be implemented by NOR gates as shown in Fig 19.(The OR is replaced by a NOR gate with its output complemented by a NOR gate inverter)

Fig 19

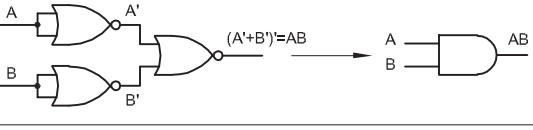


TW20N17539J

NOR gate implemented as AND gate: An AND gate can be implemented by NOR gates as shown in the Fig 20. (The AND gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverters)

Thus it is proved that the NOR gate is a universal gate since it can implement the AND, OR and NOT logic functions.

Fig 20



TW20N17539K

Overview of textile industry, strength and weakness of textile industry and familiarization of textile machines

Objectives: At the end of this lesson you shall be able to
- **state about the overview of textile industry**
- **state about the history of textile**
- **state about Indian textile industry - SWOT analysis**
- **state about textile machines.**

Indian textile industry contributes about 11 percent to industrial production, 14 percent to the manufacturing sector, 4 percent to the GDP and 12 percent to the country's total export earnings. It provides direct employment to over 35 million people, the second largest provider of employment after agriculture. Besides, another 54.85 million people are engaged in its allied activities.

The fundamental strength of this industry flows from its strong production base of wide range of fibres / yarns from natural fibres like cotton, jute, silk and wool to synthetic / man-made fibres like polyester, viscose, nylon and acrylic. We can just track the strong multi-fibre strong base by highlighting the following important positions reckon by this industry across globe are:

Cotton: Second largest cotton and cellulosic fibres producing country in the world.

Silk: India is the second largest producer of silk and contributes about 18% to the total world raw silk production.

Wool: India has 3rd largest sheep population in the world, having 6.15 crores sheep, producing 45 million kg of raw wool, and accounting for 3.1% of total world wool production. India ranks 6th amongst clean wool producer countries and 9th amongst greasy wool producers.

Man - Made fibres: the fourth largest in synthetic fibres/ yarns globally.

Jute: India is the largest producer and second largest exporter of the jute goods.

History of textile: The archaeological surveys and studies have found that the people of Harrapan Civilization knew weaving and the spinning of cotton four thousand years ago. Reference to weaving and spinning materials is found in the Vedic Literature also.

There was textile trade in India during the early centuries. A block printed and resist-dyed fabrics, whose origin is from Gujarat is found in tombs of festat, egypt. This proves that Indian export of cotton textiles to the egypt or the Nile Civilization in medieval times were to a large extent. Large quantities of north Indian silk were traded through the silk route in China to the western countries.

The Indian silk was often exchanged with the western countries for their spices in the barter system. During the late 17th and 18th century there were large export of the Indian cotton to the western countries to meet the need of the european industries during industrial revolution. Consequently there was development of nationalist movement like the famous Swadeshi movement which was headed by the Aurobindo Ghosh.

Indian textile industry - swot analysis

Strength

- India has rich resources of raw materials of textile industry. It is one of the largest producers of cotton in the world and is also rich in resources of fibres like polyester, silk, viscose etc.
- India is rich in highly trained manpower. The country has a huge advantage due to lower wage rates. Because of low labor rates the manufacturing cost in textile automatically comes down to very reasonable rates.
- India is highly competitive in spinning sector and has presence in almost all processes of the value chain.
- Indian garment industry is very diverse in size, manufacturing facility, type of apparel produced, quantity and quality of output, cost, and requirement for fabric etc. It comprises suppliers of ready-made garments for both, domestic or exports markets.

Weakness

- Knitted garments manufacturing has remained as an extremely fragmented industry. Global players would prefer to source their entire requirement from two or three vendors and the Indian garment units find it difficult to meet the capacity requirements.
- Industry still plagued with some historical regulations such as knitted garments still remaining as a SSI domain.
- Labour force giving low productivity as compared to other competing countries.
- Technology obsolescence despite measures such as TUFS.
- Low bargaining power in a customer-ruled market.
- India seriously lacks in trade pact memberships, which leads to restricted access to the other major markets.
- Indian labour laws are relatively unfavourable to the trades and there is an urgent need for labour reforms in India.

Opportunity

- Low per-capita domestic consumption of textile indicating significant potential growth.
- Domestic market extremely sensitive to fashion fads and this has resulted in the development of a responsive garment industry.
- India's global share is just 3% while China controls about 15%. In post-2005, China is expected to capture 43% of global textile trade.
- Companies need to concentrate on new product developments.
- Increased use of CAD to develop designing capabilities and for developing greater options.

Threats

- Competition in post-2005 is not just in exports, but is also likely within the country due to cheaper imports of goods of higher quality at lower costs.
- Standards such as SA-8000 or WARP have resulted in increased pressure on companies for improvement of their working practices.
- Alternative competitive advantages would continue to be a barrier.

Prospect : Considering the continual capital investments in the textile industry, the Govt. of India may extend the Technology Upgradation Fund Scheme (TUFS) by the end of the 11th Five Year Plan (till 2011-2012), in order to support the industry. Indian textile industry is massively investing to meet the targeted output of $ 85 bn by the end of 2010, aiming exports of $ 50 bn. There is huge development foreseen in Indian textile exports from the $ 17 bn attained in 2005-06 to $ 50 bn by 2009-10. The estimation for the exports in the current financial year is about $ 19 bn. There is substantial potential in Indian exports of technical textiles and home-textiles, as most European companies want to set up facilities near-by the emerging markets, such as China and India.

The global demand for apparel and woven textiles is likely to grow by 25 percent by year 2010 to over 35 mn tons, and Asia will be responsible for 85 percent output of this growth. The woven products output will also rise in Central and Southern American countries, however, at a reasonable speed. On the other hand, in major developed countries, the output of woven products will remain stable. Weaving process is conducted to make fabrics for a broad range of clothing assortment, including shirts, jeans, sportswear, skirts, dresses, protective clothing etc., and also used in non-apparel uses like technical, automotive, medical etc

It is been forecasted that the woven Textile & Handloom markets will sustain their growth from current till 2010. The imports of apparel and textiles will rise from developed economies like the USA and the western countries of Europe and Japan, along with some newly emerged economies, such as South Korea and Taiwan. Certainly, import growth has been witnessed vertical rise in the previous year.

Definition and classification of textile fibre

Objectives: At the end of this lesson you shall be able to
- **state about textile fibre**
- **state the classification of textile fibres**
- **state the about natural, protein and synthetic fibres.**

Textile fiber: Fiber or fibre is classes of materials that are continuous filaments or are in discrete elongated pieces, similar to lengths of thread. They are very important in the biology of both plants and animals, for holding tissues together. Human uses for fibers are diverse. They can be spun into filaments, string or rope, used as a component of composite materials or matted into sheets to make products such as paper or felt. Fibers are often used in the manufacture of other materials. Synthetic fibers can be produced very cheaply and in large amounts compared to natural fibers, but natural fibers enjoy some benefits, such as comfort, over their man-made counterparts.

Classification of textile fibres

Natural fibres: All fibers which come from natural sources (animals, plants, etc.) and do not require fiber formation or reformation are classed as natural fibers. The natural fibers are vegetable, animal, or mineral in origin. Some of the natural fibers like vegetable fibers are obtained from the various parts of the plants. They are provided by nature in ready-made form. Natural fibres should have a uniform length. The plant is a shrub native to tropical and subtropical regions around the world, including the Americas, Africa, and India.

List few natural fibres

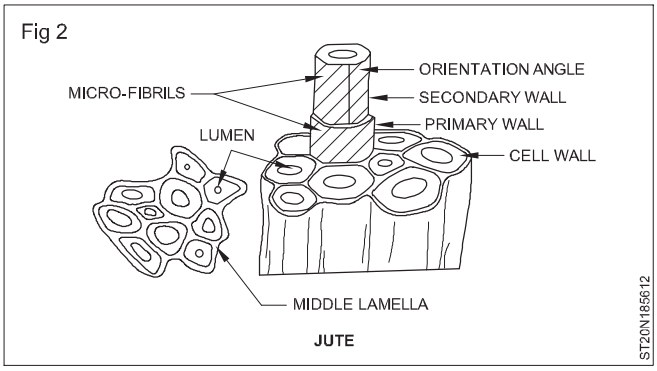
a Cotton (Fig 1)

Fig 1

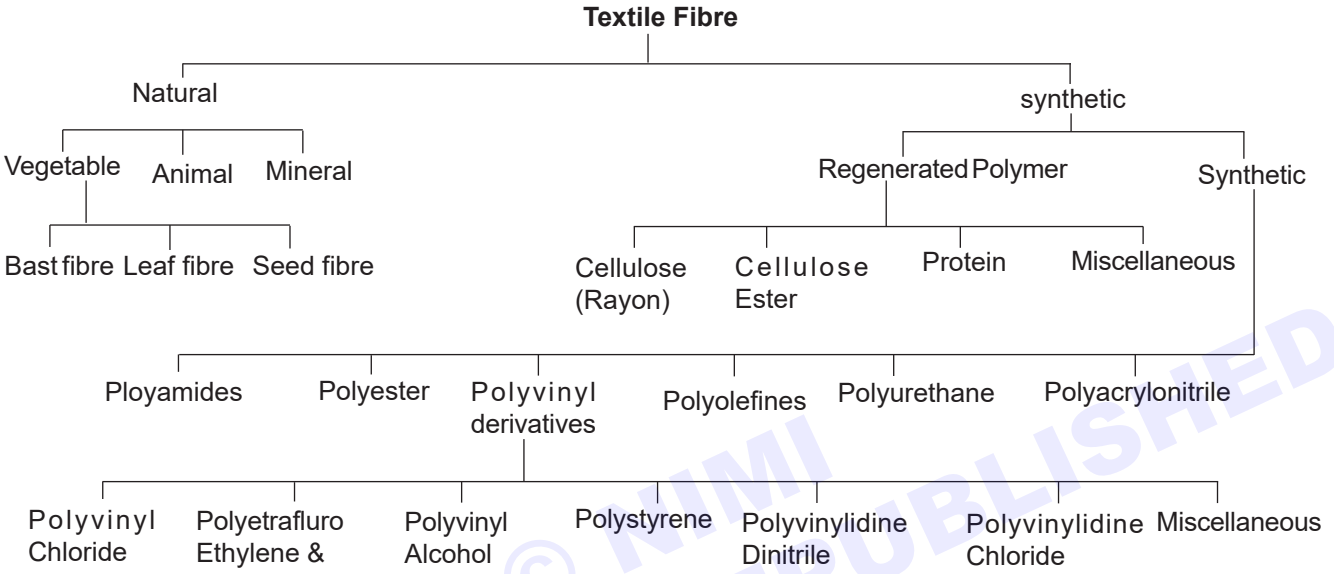
Cotton

Among the seed and fruit fibres, cotton has grown in stature as the most important textile fibre in the world. In fact, cotton is the backbone and basic foundation of the world's textile trade and industry. Cotton is a natural vegetable fibre produced in the cotton plant in many countries of the world even in Bangladesh also.

b Jute (Fig 2)



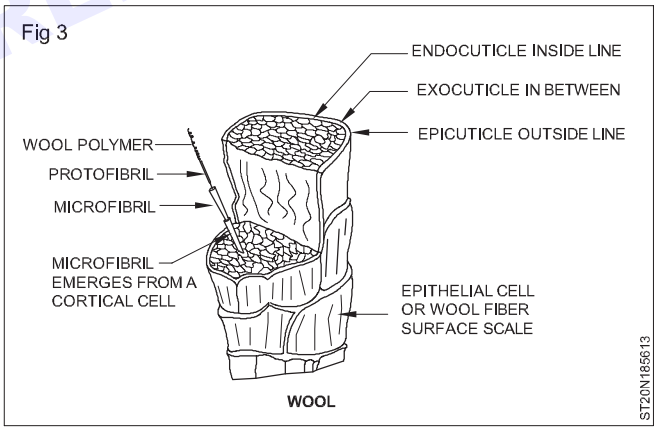
Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced from plants in the genus Corchorus, which has been classified in the family Tiliaceae, or more recently in Malvaceae. However, it has been reclassified within the family Sparrmanniaceae. Jute is one of the most affordable natural fibres and is second only to cotton in amount produced and variety of uses of vegetable fibres. Jute fibres are composed primarily of the plant materials cellulose (major component of plant fibre) and lignin (major components of wood fibre).



Protein fibre: Animal fibers are natural fibers that consist largely of particular proteins. Instances are silk, hair/fur (including wool) and feathers. The animal fibers used most commonly both in the manufacturing world as well as by the hand spinners are wool from domestic sheep and silk. Also very popular are alpaca fiber and mohair from Angora goats. Unusual fibers such as Angora wool from rabbits and Chiengora from dogs also exist, but are rarely used for mass production. Not all animal fibers have the same properties, and even within a species the fiber is not consistent. Merino is very soft, fine wool, while Costwold is coarser, and yet both merino and Cotswold are types of sheep. This comparison can be continued on the microscopic level, comparing the diameter and structure of the fiber. With animal fibers, and natural fibers in general, the individual fibers look different, whereas all synthetic fibers look the same. This provides an easy way to differentiate between natural and synthetic fibers under a microscope.

List few protein fibres

a Wool (Fig 3): Wool is the textile fiber obtained from sheep and certain other animals, including cashmere from goats mohair from goats, qiviut from muskoxen, vicuña, alpaca, camel from animals in the camel family, and angora from rabbits. Wool has several qualities that distinguish it from hair or fur: it is crimped, it is elastic, and it grows in staples (clusters).

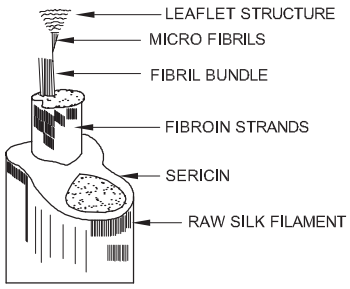


Properties of wool fiber

- The characteristics of Wool fiber or protein fibers are as follows
- They are composed of amino acids.
- They have excellent absorbency.
- Moisture regain is high.
- They tend to be warmer than others.
- They have poor resistance to alkalis but good resistance to acids.
- They have good elasticity and resiliency.

b Silk (Fig 4)

Fig 4



SILK

ST20N185614

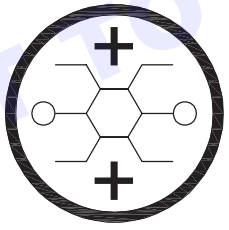
Silk is a natural protein fibre, some forms of which can be woven into textiles. The protein fibre of silk is composed mainly of fibroin and produced by certain insect larvae to form cocoons. The best-known type of silk is obtained from the cocoons of the larvae of the mulberry silkworm Bombyx mori reared in captivity (sericulture). The shimmering appearance of silk is due to the triangular prism-like structure of the silk fibre, which allows silk cloth to refract incoming light at different angles, thus producing different colors.

Synthetic fibres: Synthesis means to make and synthetic means man-made, so man made fibres are called synthetic fibres. A synthetic fibre is also a chain of small units joined together. Each small unit is actually a chemical substance. Many such small units combine to form a large single unit called a polymer. The word 'polymer' comes from two Greek words; poly meaning many and mer meaning part/unit. So, a polymer is made of many repeating units. Synthetic staple fibres have uniform length.

List few synthetic fibres

a Polyester (Fig 5)

Fig 5



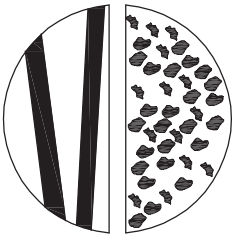
POLYESTER

ST20N185615

Polyester is much more fade resistant and shrink resistant than cotton and is very wrinkle resistant. Polyester fibres are particularly resistant to light and weather and can withstand climatic effects. They can be used where lightness and fineness are primary requirements. Polyester fibres are very well suited to blends with natural fibres. Fabrics in 100% polyester, or blends with an appropriately high proportion, are very crease-resistant and retain shape even when affected by moisture. Polyester fibres have good moisture transport and dry quickly.

b Viscose rayon (Fig 6): Rayon is a regenerated cellulose fiber because it is produced from naturally occurring polymers, it is neither a truly synthetic fiber nor a natural fiber; it is a semi-synthetic or artificial fiber.

Fig 6



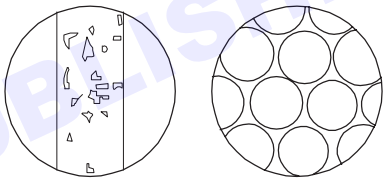
VISCOSE RAYON

ST20N185616

Rayon fibers are naturally very bright, but the addition of delustering pigments cuts down on this natural brightness. Rayon is a versatile fiber and has the same comfort properties as natural fibers. It can imitate the feel and texture of silk, wool, cotton and linen. The fibers are easily dyed in a wide range of colors. Rayon fabrics are soft, smooth, cool, comfortable, and highly absorbent, but they do not insulate body heat, making them ideal for use in hot and humid climates. The durability and appearance retention of regular viscose rayon are low, especially when wet; also, rayon has the lowest elastic recovery of any fiber.

c Nylon (Fig 7)

Fig 7



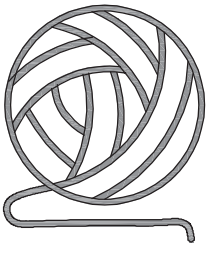
NYLON

ST20N185617

Nylon is a generic designation for a family of synthetic polymers known generically as polyamides. Nylon is a thermoplastic, silky material, first used commercially in a nylon-bristled toothbrush. Nylon's outstanding characteristic in the textile industry is its versatility. It can be made strong enough to stand up under the punishment tire cords must endure, fine enough for sheer, high fashion hosiery, and light enough for parachute cloth and backpacker's tents. Nylon is used both alone and in blends with other fibers, where its chief contributions are strength and abrasion resistance. Nylon washes easily, dries quickly, needs little pressing, and holds its shape well since it neither shrinks nor stretches.

d Acrylic (Fig 8)

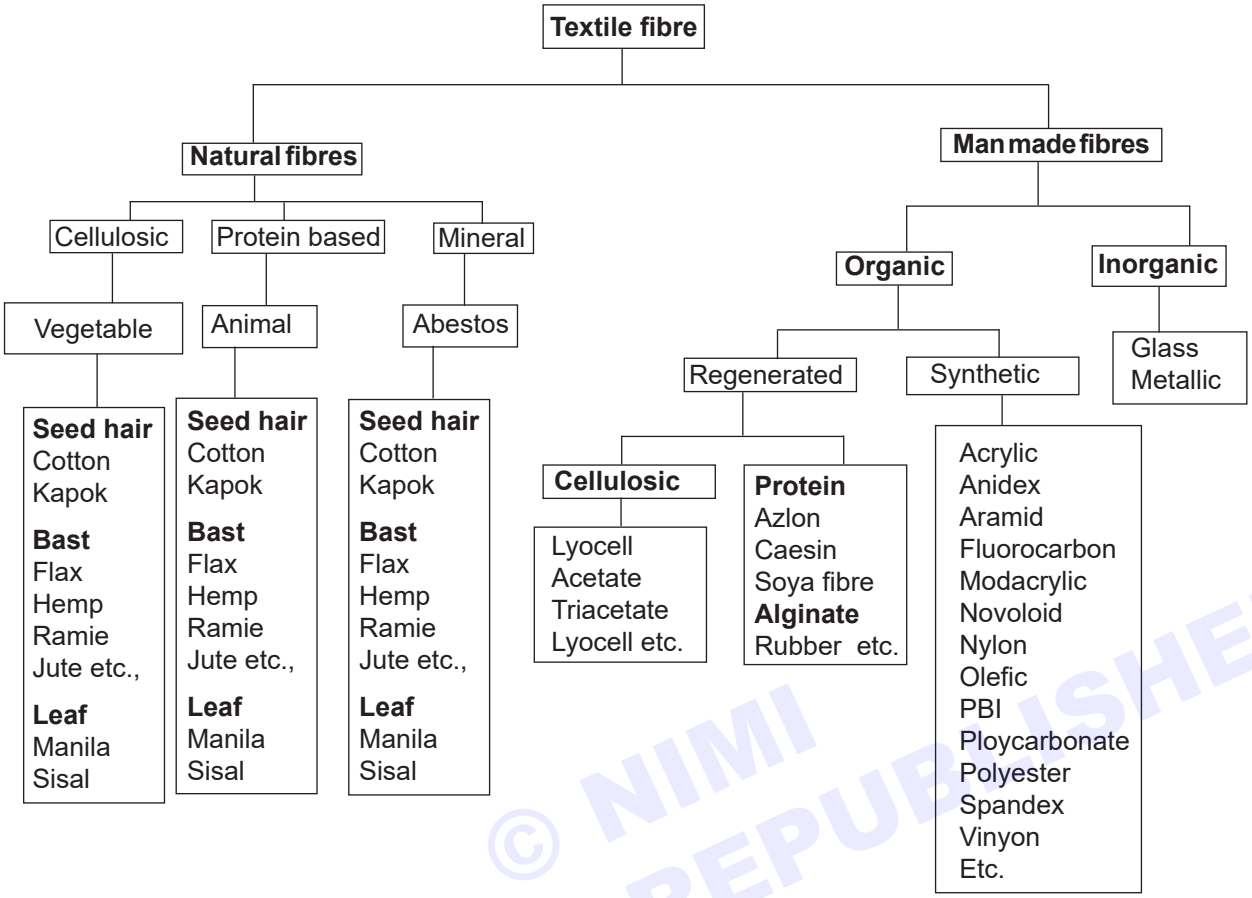
Fig 8



ACRYLIC

ST20N185618

Acrylic fibers are synthetic fibers made from a polymer (polyacrylonitrile) with an average molecular weight of ~100,000, about 1900 monomer units. To be called acrylic in the U.S, the polymer must contain at least 85% acrylonitrile monomer. Main properties of acrylic fibres are it feels like wool, with high bulk. It has very good heat retention and fastness to light. It has very good shape retention, durability, easy care and quick dry qualities.



What is a fluid?

A fluid is a substance that can flow. It can be liquid (like water) or gas (like air).

Important properties of fluids

1 Density - How heavy the fluid is for its size.

2 Pressure - Force applied by the fluid on a surface.

3 Viscosity - How thick or sticky a fluid is.

4 Temperature - Affects how fast or slow the fluid moves.

Types of flow

1 Laminar flow - Smooth and straight (like water from a small tap).

2 Turbulent flow - Rough and fast (like water from a fire hose).

Viscosity - Simple explanation

- Viscosity means how easily a fluid can flow.
- High Viscosity = Thick fluid (like oil or honey)
- Low Viscosity = Thin fluid (like water or petrol)

Units of viscosity

- Poise or Pascal second (Pascal second)
- In industries, it's also measured in seconds using viscometers.

How to measure viscosity

1 Capillary viscometer (Ostwald)

- A thin glass tube is used.
- Time is measured for liquid to flow between two marks.
- **Used for:** Thin liquids like alcohol or milk.

2 Falling ball viscometer

- A small ball is dropped in the fluid.
- Time is measured as it falls.
- **Used for:** Sticky fluids like oil.

3 Rotating viscometer

- A disc or spindle rotates in the fluid.
- The force needed to rotate tells us the viscosity.
- **Used for:** Paint, grease, shampoo.

4 Saybolt viscometer

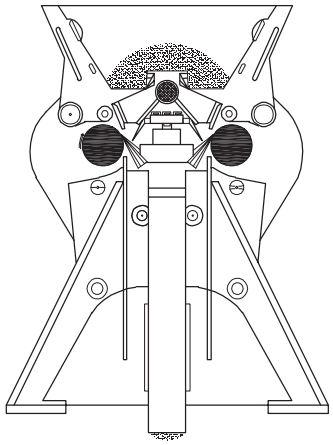
- Measures how long it takes for a set amount of fluid to flow out through a hole.
- **Used for**: Lubricating oils.

Overview of textile machinery

Objectives: At the end of this lesson you shall be able to
- **introduction of textile machineries.**

Ginning machine (Fig 1)

Fig 1



GINNING MACHINE

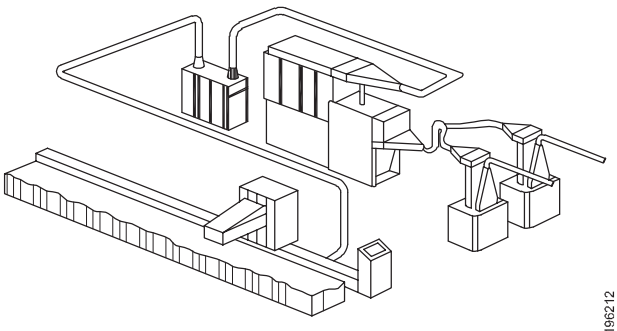
ST20N196211

Ginning is the process of separating the cotton fibers from the cotton seeds, removes any foreign material such as leaves and stems from the lint. Perfect ginning operation would be performed if the separation of fibers from seed was effected without the slightest injury to either seeds or to the fiber. A cotton gin is a machine that quickly and easily separates the cotton fibers from the seeds, a job previously done by manually. These seeds are either used again to grow more cotton or, if badly damaged, are disposed of.

There are mainly two types of gins (i) roller gins and (ii) saw gins. Both type of gins are noted for certain advantages and disadvantages. The roller gin is used on high quality, fine fibred, extra-long staple cottons because of its tendencies to maintain fibre length and low nep levels as opposed to the adverse effects on these characteristics by the saw gins.

Blow room machine (Fig 2)

Fig 2



BLOW ROOM MACHINE

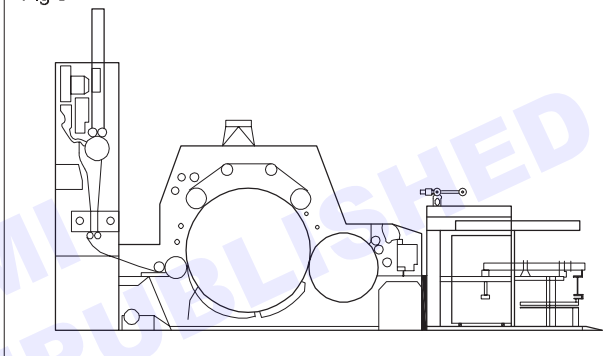
ST20N196212

Blow room consists of a number of machines used in succession to open and clean the cotton fibre to the required degree, 40 to 70% trash is removed in this section.

A section in which the supplied compressed bales are opened, cleaned and blending or mixing to form uniform lap of specific length is called blow room section. The cleaning efficiency of blow room is 60 to 65%. This is the first section of spinning line.

Carding machine (Fig 3)

Fig 3



CARDING MACHINE

ST20N196213

Carding is a mechanical process that disentangles, cleans and intermixes fibers to produce a continuous web or sliver suitable for subsequent processing. This is achieved by passing the fibers between differentially moving surfaces covered with card clothing. It breaks up locks and unorganised clumps of fibre and then aligns the individual fibres to be parallel with each other. In preparing wool fiber for spinning, carding is the step that comes after teasing.

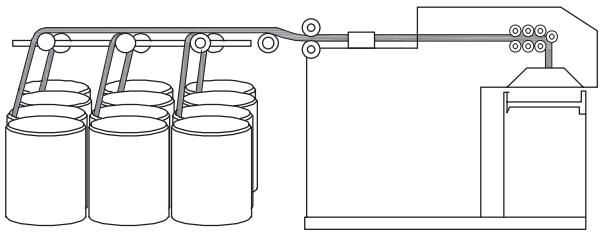
The word is derived from the Latin carduus meaning teasel, as dried vegetable teasels were first used to comb the raw wool. These ordered fibres can then be passed on to other processes that are specific to the desired end use of the fibre: Cotton, batting, felt, woollen or worsted yarn, etc. Carding can also be used to create blends of different fibres or different colors. When blending, the carding process combines the different fibres into a homogeneous mix. Commercial cards also have rollers and systems designed to remove some vegetable matter contaminants from the wool.

Common to all carders is card clothing. Card clothing is made from a sturdy flexible backing in which closely spaced wire pins are embedded. The shape, length, diameter, and spacing of these wire pins is dictated by the card designer and the particular requirements of the application where the card cloth will be used. A later version of the card clothing product developed during

the latter half of the 19th century and found only on commercial carding machines, whereby a single piece of serrated wire was wrapped around a roller, became known as metallic card clothing

Draw frame (Fig 4)

Fig 4



DRAW FRAME

ST20N196214

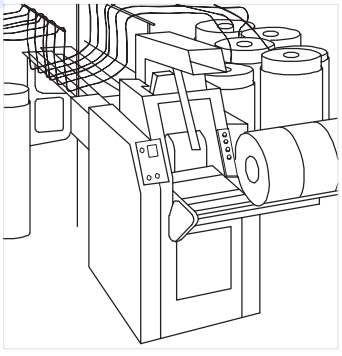
The draw frame contributes less than 5% to production costs of the yarn. However, its influence on quality, especially evenness, is all the greater for this. Further, if the draw frame is not properly adjusted, there will also be effects on yarn strength and elongation. Secondly, a defect arising at the draw frame itself can exert an effect of significant proportions on the overall process.

The draw frame in a textile mill is unavoidable in yarn spinning as fibers need to be kept side by side termed as parallelization of fibers in textile technology. This is done as we see that most of the fibers at carding stage are drawn so fast that there is little or no fiber parallelization. In draw frame this is achieved in two stages. This is termed as First Passage and second Passage drawing. Six slivers or eight slivers are fed to four or five pairs of rollers in drawing them evenly in stages from the first pair of rollers to second and from second to third and from third to front pairs of rollers. The drafted slivers are deposited in to plastic cans.

Comber preparatory machine

Sliver lap and ribbon lap machine (Fig 5 & 6)

Fig 5

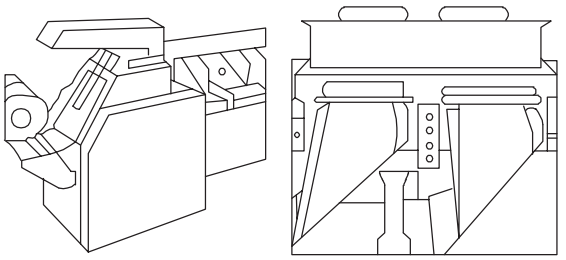


SLIVER LAB

ST20N196215

The idea of creating a comber feeding lap by a single web forming process directly in front of the comber - with a draw frame passage in front of this web former, of course - can be traced back to a development in 1948 by the former Whit in Company, called the super lap machine. Although all later machines are of different designs they all are based on this idea. That is why modern high-performance preparation systems will now be explained on the basis of the rieter machines, starting with the first designs.

Fig 6



RIBBON LAB MACHINE

ST20N196216

As already mentioned, the web former (e.g. UNI lap) always follows a normal draw frame. On the UNI lap machine the material flow starts with the creel, consisting of two feed rails. In normal operation 12 cans are laid out under each roller-assisted feed table. Altogether, this gives a total of 24 doublings. The pre-draw frame slivers run over a guide bridge above the service alley and also over several guide rollers to the drafting system at 2. The web created by the draft of 1.3 to 2.5 passes over two deflecting plates onto the web table on which the webs are superimposed. Calendar rollers draw these superimposed webs from the table to the lap winding assembly.

The strong compression created between the calendar rollers forms a new web, which is rolled into a lap in the lap forming assembly. Emptytubes are automatically exchanged for full laps. Transport of the laps to the combing machine is semi-automatic or fully automatic.

The first part of the machine is a creel on each side feeding two drafting arrangements from max. 28 cans from the draw frame. Here also the slivers are guided over a service alley (one on each side) to the drafting arrangement.

The UNI lap machine features a 3-over-3 roller, two-zone drafting arrangement. The pneumatically weighted top rollers can be continuously adjusted from minimum to maximum per top roller. Draft distances are individually variable, as are the draft levels in each of the break and main draft zones. Upper and lower clearer aprons in combination with a suction system keep the rollers clean. The easily accessible drive for the drafting arrangement is in an enclosed housing and is fitted with appropriate change gears and oil spray lubrication.

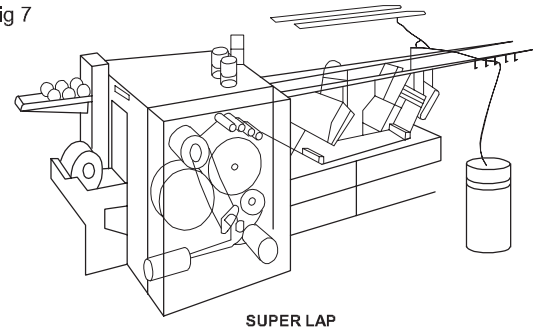
After passing the web table, the web runs through four calendar rollers. The pressure generated by two membrane cylinders can be adjusted up to 16000 N. The calendar rollers are followed by two winding rolls (2) and a lap tube holding device (3) with a lap weighting device; these have to cooperate to form the lap.

The required weighting pressure (up to 10,000 N), derived from a piston, is transferred via a pivoting lever to the weighting frame and thus to the lap tube. The UNIlap

has an automatic lap pressure control which adapts the pressure according to the lap diameter. An increase in diameter of the lap raises the weighting frame, in the course of which the pressure increases. The size of the increase can be set by adjustment using setting screws. The machine stops when a pre-set lap length is reached, whereupon an automatic device replaces the full lap by an empty tube.

Super lap machine (Fig 7)

Fig 7



SUPER LAP

ST20N1962217

The idea of creating a comber feeding lap by a single web forming process directly in front of the comber using a draw frame passage in front of this web former, is developed in 1948 by a Company, called the super lap machine.

Although all later machines are of different designs they all are based on this idea. That is why modern high-performance preparation systems will now be explained on the basis of the machinery manufacturers machines, starting with the first designs.

As already mentioned, the web former (e.g. Web Former) always follows a normal draw frame. On the Web Former machine the material flow starts with the creel 1, consisting of two feed rails. In normal operation 12 cans are laid out under each roller-assisted feed table.

Altogether, finally gives a total of 24 doublings. The pre-draw frame slivers run over a guide bridge above the service alley and also over several guide rollers to the drafting system at 2.

The web created by the draft of 1.3 to 2.5 passes over two deflecting plates onto the web table on which the webs are superimposed. Calendar rollers draw these superimposed webs from the table to the lap winding assembly.

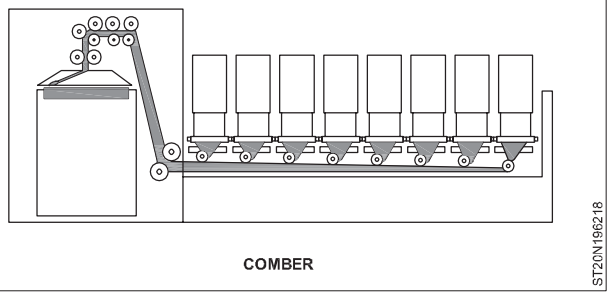
The strong compression created between the calendar rollers forms a new web, which is rolled into a lap in the lap forming assembly. Empty tubes are automatically exchanged for full laps. Transport of the laps to the combing machine is semi-automatic or fully automatic.

Comber (Fig 8): Combing is the process which is used to upgrade the raw material. It influences the following yarn quality.

- yarn evenness
- strength
- cleanness
- smoothness
- visual appearance

In addition to the above, combed cotton needs less twist than a carded yarn.

Fig 8



COMBER

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To produce an improvement in yarn quality, the comber must perform the following operation.

- Elimination of short fibres
- Elimination of remaining impurities
- Elimination of neps

The combing process is carried out in order to improve the quality of the sliver coming out of the card. The process eliminates short fibres, it achieves better parallelisation of fibres, it straightens curls, and it removes neps and residue impurities. The high degree of parallelization might reduce inter-fibre adhesion in the sliver to such an extent that the fibres slide apart while pulled out of the can. This may lead to sliver breaks or false draft.

Sequence of operation in a comber

a Feeding, lap is fed by feed roller

b Fed lap gripped by the nipper

c Gripped lap is combed by circular comb

d Detaching roller grips the combed lap and moves forward

e While the detaching roller delivers the material, top comb comes into action to further clean the lap

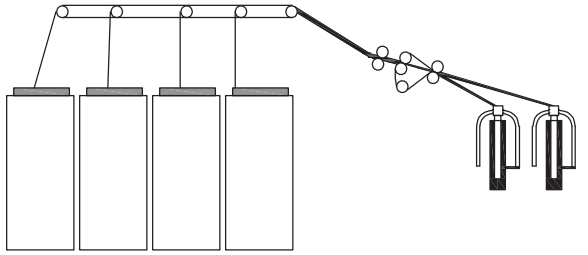
f While going back, nipper opens and receives a new bit of lap

g The raw material delivered by the carding machine cannot be fed directly to the comber. Lap preparation is a must

Speed frame (Fig 9): Slivers from the drawing stage are passed to the roving frame. The purpose is to further reduce the size of the sliver and to impart a little twist to enable it to withstand the tension in the ring spinning frame. The product from this operation is also called roving and is spun around big sized bobbins.

It is an intermediate process in which fibers are converted into low twist strand of fibres called roving. The sliver which is taken from draw frame is thicker so it is not suitable for manufacturing of yarn. Its purpose is to prepare input package for next process. This package is to prepare on a small compact package called bobbins.

Fig 9



SPEED FRAME

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Objectives of speed frame

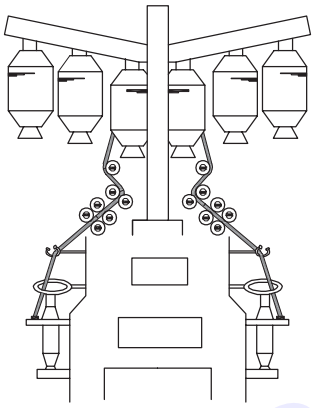
i Attenuation of draw frame sliver to a suitable size for spinning.

ii To insert a small amount of twist to strengthen the roving to prevent breakage during next processing.

iii To wind twisted strand on the bobbin.

Ring frame machine (Fig 10)

Fig 10



RING FRAME MACHINE

ST20N19621A

Ring spinning was perfected as a process by the end of the 19 th century. Its prominence reflects its versatility in terms of productivity, the range of yarn counts that can be spun on it and the fibre types that can be used. Ring spun yarns are also superior in terms of yarn strength and character in terms of fabric handle and comfort. The ring frame consists of a large number of spindles. One traveller and spindle co-operate with a bobbin, to twist and wind the yarn from a drafting system. The ring spinning frame transforms the roving from the roving frame into spun yarn using the operations of.

i Drafting

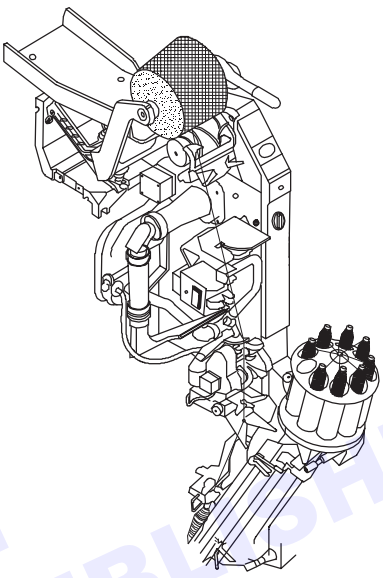
ii Twisting and

iii Winding

The ring frame is normally fed with roving from a large bobbin, and delivers yarn to a smaller one. Because of this, the roving bobbins in the creel have to be renewed less frequently than the yarn bobbins (ring tubes). When spinning a coarse count, the ring bobbins have to be doffed every few hours. This used to consume considerable amounts of labor. These days, the doffing is carried out automatically or semi automatically and this process is referred to as auto-doffing.

Automatic cone winding machine (Fig 11)

Fig 11



AUTOMATIC WINDING MACHINE

ST20N196213

Winding is the creation of large yarn packages that can be easily unwound. This makes using the yarn on subsequent machines both easier and more economical. In order to form packages of the right weight for subsequent processing stages. The conventional winders are quite simple machines where majority of the necessary mechanisms being of mechanical type. On the other hand, the modern automatic winders are equipped with variety of electronic devices and computerized control panels to achieve high speeds of winding at a better quality. Further more arrangement of automatic bobbin creeping, automatic doffing and auto splicing of broken yarns are also provided on these modern winders.

The yarn unwound from the ring cop passes through yarn tensioning and control systems, and with the help of a grooved cylinder, is wound evenly around the package; the yarn enters the recess in the cylinder, thus the rotary

movement of the cylinder corresponds to the translation of the yarn.

Ginning

Objectives: At the end of this lesson you shall be able to
- **state the objectives of ginning**
- **list the different types of ginning machine**
- **state the about knife roller gin and saw gin**
- **state the about single and double acting macarthy gin**
- **state the working process of double acting macarthy gin**
- **state the ginning performance on yarn quality**
- **state the defects and causes in ginning**
- **state about mixing and blending.**

Object of ginning: The primary object of the ginning consists in separating the fibres from the seed, and a Perfect ginning operation would be performed if the separation of fibres from seed was effected without the slightest injury to either seeds or to the fiber.

Different types of ginning machine: Previous to the introduction of Modern Machinery, ginning was performed by hand or by machines of a primitive character such as the “Foot Roller” and its improvement the “Churka”.

As the cotton industry developed, greater production than these were capable of was necessary, and machines driven by power were introduced.

Numerous forms of gins have been tried, but at the present time only three are used to any large extent. They are

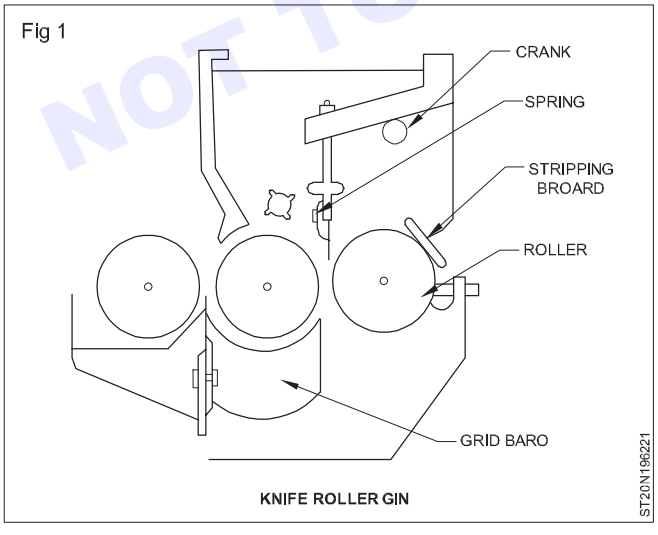
1 Knife roller gin

2 Saw gin

3 Three types of macarthy gin
   - Single acting macarthy gin.
   - Double acting macarthy gin
   - Double roller macarthy gin.

Knife roller gin (Fig 1)

Fig 1



KNIFE ROLLER GIN

The constructional detail of the machine is clearly shown in fig. The seed cotton is placed in bulk on the table. By means of the reciprocating motion of the table by the crank arrangement, the seed cotton comes into contact with knife roller (formed of a number of knife discs).

Auxiliary roller breaks the large cluster of seed cotton and maintains a constant supply of cotton to knife roller. Knife portion being arranged in such a manner that anything coming into contact with it is given a reciprocal or to and fro motion as well as being subject to a striking action due to its revolution.

The seed cotton is carried forward in the direction of knife roller’s motion until it is brought into touch with leather roller.

This roller, which has a much roughened surface, due spirally-formed saw cuts. Has pressing against, it by means of spring and steel doctor Knife.

The cotton fibres brought into contact with the leather adhere to it, and are carried round past. The knife. It is impossible for the seeds to follow. So, seeds will remain at the point of contact of the doctor knife and leather roller, with the fibres still connected with it. The essential feature of this gin now comes into play.

The knife roller is so set as to act upon, these adhering seeds, and it gives to them a gentle to and fro motion, repeated very quickly ‘and at the same time a slight striking action or pressure also repeated quickly. The combined action soon causes the seeds to separate from the fibres and to fall down through the grid to floor. The freed fibre passing forward is stripped from the roller by some arrangement of the stripping board.

The seed cotton not taken up by one leather roller is brought round into contact with another 1eather roller where same process as described above is gone through and to which the same parts equally apply.

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Setting

1 Seeds cannot get between dish rail and knife roller. Carelessness here produces large quantities of crushed seeds

2 Sharp edge of the doctor knife does not cut the fibres.

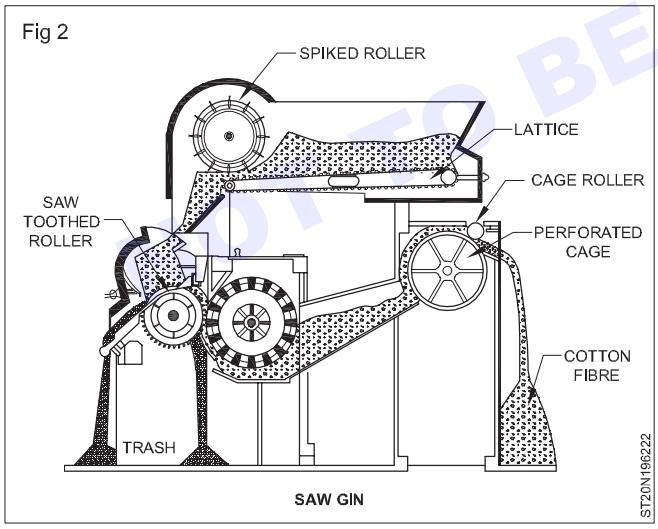
3 The degree of pressure of the doctor knife upon the leather roller can be varied by means of spring and thumb screw according to the tenacity with which the fibres adhere to the seeds.

4 The leather roller should be parallel to the knife roller and the setting between leather roller and knife roller, should be 1/3 of the diameter of the largest seed.

If this setting is too near - the seeds would be broken. If this setting is too wider large seeds would not be acted upon by knives and m/c would block itself by an accumulation of un stripped seeds.

Knife roller gin is suitable to process coarser and medium Types of Indian cotton. The Indian Cotton fibres are not too easily separated ' from seeds, so heavier beating on seed is required to. Separate the fibres. This is achieved in this gin by giving heavier beating of the rapidly revolving knives of the roller on the seed cotton.

Saw gin (Fig 2)



Working: The seed cotton is fed upon the lattice and carried forward to the spiked roller, which loosens the cotton and throw; it into the hopper. In hopper, the seed cotton comes into contact with rapidly revolving saw roller. App.70 saws are threaded on a shaft.

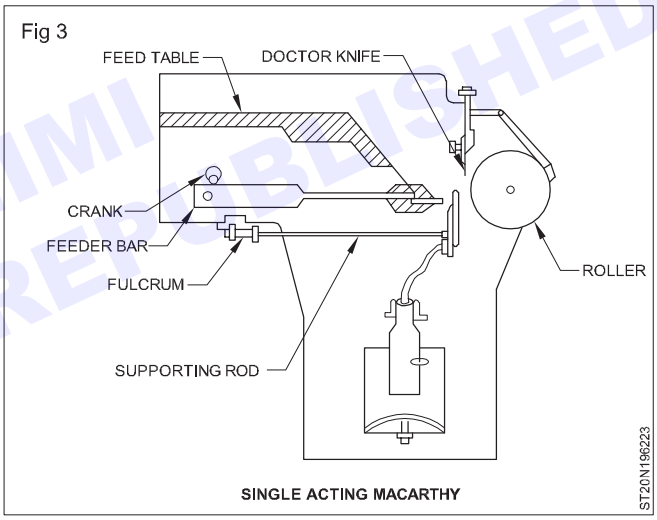
As the saws revolve, the teeth carry the fibres forward, but it is impossible for the seeds to follow and also, due to the heavier beating of the rapidly revolving saws on the seed cotton, the fibres are separated from seed and taken round until the brush strips the fibre from the teeth. Empty seeds husks and other broken seeds are thrown into grid, through which they pass into suitable receptacle. An air current from the cage draw the fibres along the trunk passage, and on reaching the revolving cage are brought under the pressure roller and delivered as a sheet, from which it is taken to the baling press.

Settings: The bars (I) are adjusted at K. The plate, adjustable at H, can be regulated to prevent the seeds falling away until thoroughly cleaned. An air current from cage should be optimum to 'suck only fibres. If air current is high - it will "suck seed also with fibres. If air current is low - fibre accumulation underbrush roller causes to block the machine.

Saw gin is suitable to process American cotton and wherever American cotton is grown, such as west Africa-India, Ceylon etc.

These cottons are oil a type in which the fibres are not too easily separated from the seeds, so heavier beating on seed is required to separate the fibres. This is achieved in this gin by giving heavier beating of the rapidly revolving saws on the seed cotton.

Single acting macarthy gin (Fig 3)



The seed cotton is placed on the table. By means of the reciprocating motion of the table by the crank arrangement, the seed cotton comes into contact with the revolving leather covered roller. Some cotton fibres are carried in the direction of leather roller, but seed cottons are arrested by the doctor knife.

A steel beater blade is connected by means of a connecting rod, with a crank on the driving shaft. Due to the seeds being acted upon by the rapid reciprocating motion given to the beater blade by the crank, the seeds are separated from fibres.

Ginned cotton fibres are carried onward in the direction of leather roller, stripping board strip the fibres from the leather roller and empty seeds are thrown into grid, through which they pass into suitable receptacle.

Setting

1 The supporting rod which is connected with beater blade and centered as shown in fig. is used to adjust the distance between blade and leather roller.

2 The vertical movement of the beater blade should be 3/8 inch above the doctor knife.

3 Sharp edge of the doctor knife-does not cut the fibres.

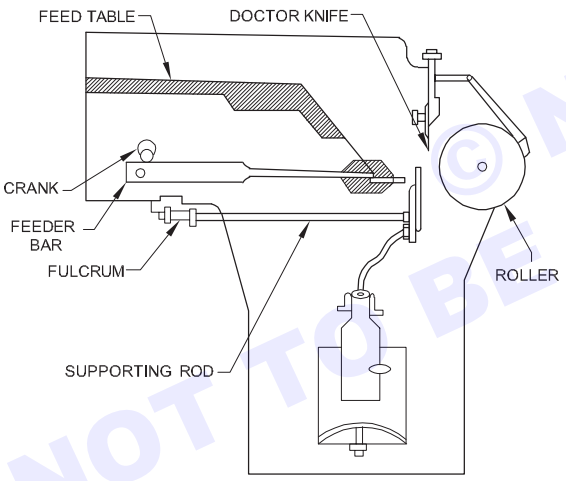
4 The degree of pressure of the doctor knife upon the leather roller. Can be varied according to the tenacity with which the fibres adhere to the seeds. This is done by adjusting the spring and thumb screws.

5 The pressure of the doctor knife and distance between leather roller and doctor knife should be in such a way that no seed will be allowed to pass in the direct ion of leather roller.

Suitability: All type of macarthy gins are suitable to process long stapled cotton such as Sea Island cotton, Egyptian cotton and long stapled Indian cottons. Long stapled cottons are of a type in which the fibres are easily separated from seeds, so light beating on seed is enough to separate the fibres, this is achieved in this gin by light beating action of the beater blade on seed, fibre damage & broken seeds are the results if processed through other gins of heavier beating points such as knife roller gin and saw gin.

Double acting macarthy gin (Fig 4)

Fig 4



BY-PASS ARRANGEMENT

Here also due to the seeds being acted upon by the reciprocating motion of the beater blade by the crank, seeds are separated from the fibre. But there are two beater blades A and B actuated from cranks C and D. They rise and fall alternatively. Other working procedure is same as the single acting macarthy gin.

Advantage

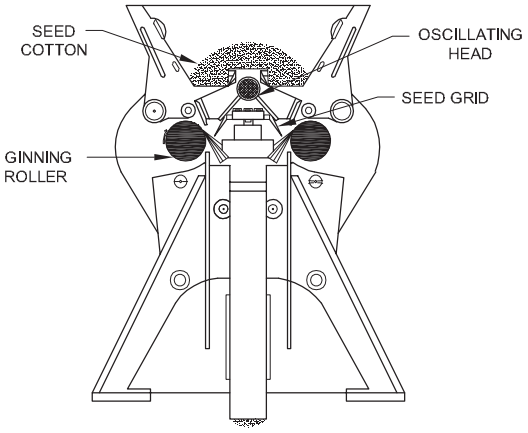
1 Larger production

2 Two beater blades are well balanced each other. So, vibration is reduced.

Double roller macarthy gin (Fig 5)

Construction: As shown in the figure, there are two leather roller and a" doctor knives is pressed against each leather roller. The beater knives act from above, and are given a reciprocating motion from a crank. Crank pin slide in a slot of arm carried by a vibrating shaft. Beater blades are fixed on arms projecting from vibrating shaft. Also grid and fingers are fixed on vibrating shaft.

Fig 5



DOUBLE ROLLER MACARTHY GIN

Working: Seed cotton is fed into hopper 56 spaces. The c movement lowers this cotton into contact with leather roller in one side and raises it away from the roller on other side.

When the cotton comes into contact with leather roller, some cotton fibres are carried in the direction of leather roller but seed cottons are arrested by the doctor knife due to the seeds being acted upon by-the rapid reciprocating motion given to the beater blade by crank,{ the seeds are separated from fibres. Ginned cotton fibres are carried forward in the direction of leather roller. Empty seeds are thrown into grid. As the grid lowers, the space in it permit the fixed finger to pass between them, and so shake the seed to cause them to fall out readily.

Ginning performance on yarn quality

- Unginned and broken seeds in cotton cause lot of difficulties in subsequent spinning preparation process.
- At scutcher, these seeds get crushed under the calendar roller and expel cotton seed oil which affects quality of the lap.
- At the card, the metallic wires get loaded with seed coats, seed oil and wax substances. Sometimes seeds get crushed under feed roller or calendar roller and expel the seed oil, which affect the carding quality.
- Neps formation in ginning will tend to produce curly cotton in blow room, neps in card sliver and undrafted material, end breaks, in-sufficient twist insertion in fly frame and Ring frame.
- At every stage, control of material depends upon the fibre length.

So fibre damage or gin cut fibres in the ginning directly affect the subsequent spinning process.

For example fibre damage in gin causes to produce short fibres, fly liberation, fibre loss, in subsequent spinning departments and short fibre content greatly influences

regularity of yarn. Fibre length influences the yarn strength and spinning value.

Defects in ginning and causes

Causes for broken seeds

1 Improper setting between knife roller and dish rail.

2 Improper setting between knife roller and leather roller.

3 Improper setting between beater blade and doctor knife in Macarthy gin

4 Improper setting of the adjustable plate, Bars in saw gin.

Causes for fibre damages

1 Too much pressure of doctor knife on leather roller.

2 Knives of the knife rollers are sharp.

3 Sharp edge of the saw disc.

4 Improper setting between doctor knife and leather roller.

5 Too close setting between knife roller and dish rail.

Causes for neps formation

i High speed of knife roller and saw roller.

ii Blunt edges of knife and saw disc.

To avoid defective ginning, (i) various settings in the gin should be proper (ii) speeds of the rollers should be in correct range (iii) condition of the knife disc and saw disc should not too sharp or too blunt and it should be optimum.

Mixing: Cotton is a hygroscopic material, hence it easily adopts to the atmospheric air conditions. Air temperature inside the mixing and blow room area should be more than 25 degree centigrade and the relative humidity (RH%) should be around 45 to 60 %, because high moisture in the fibre leads to poor cleaning and dryness in the fibre leads to fibre damages which ultimately reduces the spinnability of cotton.

Cotton is a natural fibre. The following properties vary very much between bales (between fibres) fibre micronaire fibre length fibre strength fibre color fibre maturity Out of these , fibre micronaire, color, maturity and the origin of growth results in dye absorption variation.

Therefore it is a good practice to check the maturity, color and micronaire of all the bales and to maintain the following to avoid dye pick up variation and barre in the finished fabric. When manufacturers desire to produce a fabric that requires a certain size of yarn, they do not always buy merely the one kind of cotton, which, according to the table, will make that size. It is not always possible to get a full supply of any one of the kinds named; further more the list contains only a few of the many varieties that come to market, each with its own special qualities. There may be a crop failure in some one variety of cotton, or perhaps there is strong competition for this variety, making the price too high for ordinary use. In order to produce yarn of a certain size a manufacturer usually buys part of his supply of cotton of better grade than necessary, and part of poorer. These he mixes in such proportions as will give just the grade desired. Sometimes as many as six or eight kinds of cotton are mixed in order to get the right quality in a yarn. Consequently, mixing cottons is a science in itself, and requisite not only in order to get a yarn of a certain size, but also to get the right smoothness, fineness, strength, and glossiness, or the right feeling to the sense of touch. Those who manufacture certain well-known brands of goods desire to maintain exactly the same qualities in those goods year after year. But all of the cottons naturally vary from year to year according to the season. The same variety will not have exactly the same qualities every year. To insure fixed qualities in his standard goods, the manufacturer employs blends or mixtures that will give the same result every time. The proportions of the various kinds of cottons are varied as may be necessary to preserve the same qualities in the mixture.

Blending cotton with other fibres: Concerns related to the basic fiber attributes may arise, however, when cotton fiber is blended with other types of fibers (e.g. polyester). In this situation, the two fiber types may represent a truly odd couple about to be combined. On average, polyester has more than twice the flexibility of cotton fiber under tension, yet cotton has more flexibility under bending (24%) and also under torsion (65%) than polyester. The aspect ratio of the two fibers can be made equal; however, the increasing trend toward the use of very fine polyester fiber (e.g. micro denier polyester of 0.9 denier or less) creates compatibility problems. The surface friction of the two types of fiber is never the same despite the millions of dollars invested in the spin finish of polyester.

The lack of basic compatibility between cotton and polyester fibers may not be directly reflected on the average values of the blend yarn which will tend to exhibit higher strength and elongation and lower hairiness than those of 100% cotton or of lower percentage cotton. It will, however, be reflected in all variability measures of the blended yarn (C.V% of count, Uster C.V%, C.V% strength, C.V% elongation, and yarn imperfections). This point was clearly demonstrated in Uster Statistics 97 as shown in Appendix II. In these statistics, variability measures were either increased or remain unchanged as the polyester content increases in the polyester/cotton blend. This observation was consistent in all types of spinning (ring, rotor, and air-jet). Traditionally, it has been claimed that the increase of the percentage of synthetic fibers in the cotton/synthetic blend will always reduce yarn irregularity.

$$\text{Ginning percentage} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

Introduction: The four Ginning Technologies - 1) Saw Ginning (about 55%) 2) Double Roller Ginning (about 35%) 3) Rotobar or Rotary Knife Roller Gin (about 5%) and 4) Single Roller (about 5%) being used in the world. These technologies are having their own considerations and the competitiveness of the cotton processing which in turn affects their adaptation .Ginning at the proper moisture content (typically between 5 % and 7 %) and

maintaining the gin stand's manufacturer-recommended settings are the best way to achieve performance.

Monitoring of residual lint content on the seed (keeping it typically at 10 % or below by weight) is an excellent measure of effective seed cleaning, and when this goes above that figure, it is time to perform maintenance on the gin stand. In India about 90% of cotton produced is subjected to ginning by using double roller gins. The productivity of this machine is about 100 kg lint/h. The operating cost per kg of lint ginned has been reduced drastically due to increased productivity and also because of no additional requirement of power and labour for improved versions of double roller gin.

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Maintenance of ginning

- Gin housekeeping provides a clean, safe work space.
- Never repair machinery while it is running (shut it off /lo)
- Take time to think before attempting repair.
- Keep adequate and appropriate repair parts available.

During operation

- Check for smooth flow and spread of cotton acrc
- Check for excessive noise or vibration.
- Check for excessive amount of cotton in the translation
- Check Hydraulic systems for leaks or overheating
- Check air systems for leaks or loose connections
- Check for hot bearings, chattering gears or shafts

Saw gin

Check

- **Adjustments**
  - Saw cylinder for sharpness and damage or embedded seeds.
  - Brush cylinder for wear. Cylinder must be dynamically balance at operating speed.
  - Trash chamber and grid bars for trash build-up. Check suction if needed.
- **Adjustments**
  - Gin saws for sharpness and damage. Keep a spare gin s gin ribs. Seeds should not pass through at the ginning | breast linkage. The breast must move fully in for proper brush cylinder.
  - V-belt drives (gin motor, agitator motor, picker roller a timing belt drive, if any (agitator roller). bearings; pre-lubricated, sealed bearings do not require fasteners.

Identifying blow room machines

Objectives: At the end of this lesson you shall be able to
- **state about blow room and its objectives**
- **state the basic operation in blow room and modern blow room**
- **state the principle of opening and cleaning**
- **state about opening machine and degree of opening**
- **state about bale opening machine and its function**
- **state about hopper feeder, MBO, mono cylinder, and AXI flow cleaner**
- **state about ERM cleaner, unimix, porcupine opener.**

Blow room: Blow room consists a number of machines used on succession to open and clean the cotton fibre. Since the tuft size of cotton becomes smaller and smaller, the required intensities of processing necessitates different machine configuration.

objectives of blow room

1 **Opening**

a To open the compressed bales of fibres.

b To make the cotton tuft as small as far as possible.

2 **Cleaning**: To remove dirt, dust, broken seeds, broken leaves, and other foreign materials from the fibre.

3 **Mixing & Blending:** To make good value of yarn and to decrease production cost mixing and blending is done.

4 **Lap or flocks formation:** To transfer opened and cleaned fibre into sheet form of definite width and length which is called lap or in modern system directly feed to the carding machine into flocks form.

Basic operations in the blow room

- Opening
- Cleaning
- Mixing or blending
- Micro dust removal
- Uniform feed to the carding machine
- Recycling the waste

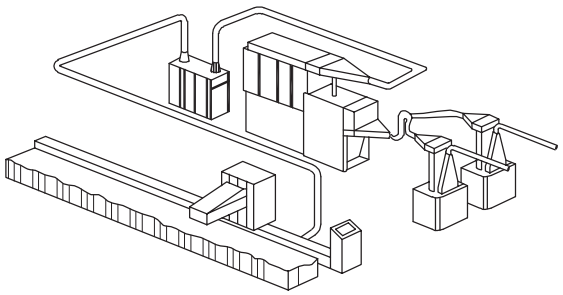
Blow room installations consist of a sequence of different machines to carry out the above said operations. More over Since the tuft size of cotton becomes

Modern blow room line: In processing the material, different types of machines are necessary, namely those suitable for opening, those for cleaning and those for blending. Different intensities of processing are also required, because the tufts continually become smaller as they pass from stage to stage. Accordingly, while a coarsely clothed cleaning assembly is ideal after the bale opener, for example, it is inappropriate at the end of the line. Therefore, there are no universal machines, and a blow room line is a sequence of different machines arranged in series and connected by transport ducts. In its own position in the line, each machine gives optimum performance - at any other position it gives less than its optimum. Also there may be advantages in different modes of transport, feeding, processing, and cleaning and so on from one machine to another along the line. Finally, the assembly of a blow room line depends among other things on

- The type of raw material
- The characteristics of the raw material
- Waste content
- Dirt content
- Material throughput
- The number of different origins of the material in a given blend.

In most cases a modern blow room line consists of the following machines, (Fig 1)

Fig 1



BLOW ROOM MACHINE

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Principle of opening and cleaning: The basic principle of opening and cleaning in the blow room line are as follows

- The action of opposing spikes
- The action of air currents
- The action of beaters

The action of opposing spikes

The spikes of the evener lattice pick up the pieces of cotton and carried them to point lattice, where they are met by a series of spikes of the evener roller which move in the opposite direction and oppose any further passage. Rough combing action occurs and the spiked lattice carries

a small part of the fed cotton along with it. The tearing action is taking place between the two opposing spikes.

The action of air current: Air and cotton enter the chamber of the machine together at the bottom or at the center of the beater chamber where the cotton starts to receive one of the many blows from the strikers of the beater. The cotton is thrown against the grid bars by centrifugal force. This action forces the heavier impurities through the bars into the large duct box under the grid bars.

The action of beaters: This involves the holding of the mass of fibres while the beater strikes it. The holding of fibres can be done in three ways.

- Feeding by two rollers
- Feeding by a feed roller and a feed plate
- Feeding by a feed roller and pedals

Two feed roller arrangements gives the best forwarding motion, but unfortunately results in greatest clamping distance between the cylinders and the beating element.

Feed roller and pedal arrangement gives secure clamping throughout the width and a small clamping distance, which is very critical for an opening machine.

In a feed roller and table arrangement, the clamping distance can be made very small. This gives intensive opening, but clamping over the whole width is poor, because the roller presses only on the highest points of the web. Thin places in the web can be dragged out of the web as a clump by the beaters.

Opening machines: Opening is the first operation it means, tearing apart the compressed and matted cotton until it is very much loosened and separated into small tufts with a gentle treatment, and a fibre loss as small as possible.

Opening is also related to cleaning as where is opening there is also cleaning

The term opening in the technological sense, means while number of fibres is remaining constant volume of the flock is increased i.e. the specific density of the material is reduced.

There are two different level of opening

- Opening into fibre tufts (performed in blow room)
- Opening into individual (performed in carding and rotor spinning)

Two different type of opening

- Breaking up of larger tufts into several tufts to create new surfaces (bale breaker)
- Opening of individual tufts to increase the volume (with weight remaining the same)

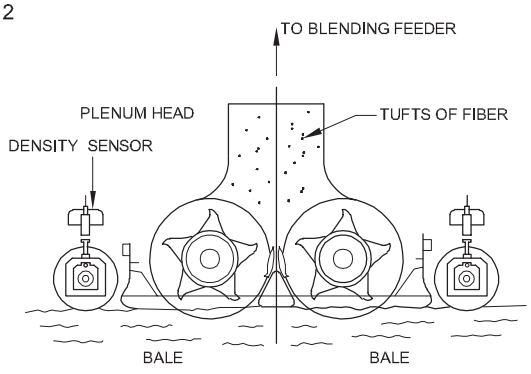
Both ways are performed, with different intensities in different processing steps (i) in the opening, the breaking up of tufts is dominant (ii) fine cleaning the opening up of a single tuft is mainly performed.

Degree of opening: It increases when number of machine increase in process. It depends on,

- Raw material (thickness of feed, fibre alignment and size of flock in the feed)
- Machines (arrangement of the pins, teeth, needle, type of clothing, spacing between the material and opening device)
- Speed
- Condition (humidity, temperature).

Bale opening machine (Fig 2)

Fig 2



BALE OPENING MACHINE

Objectives

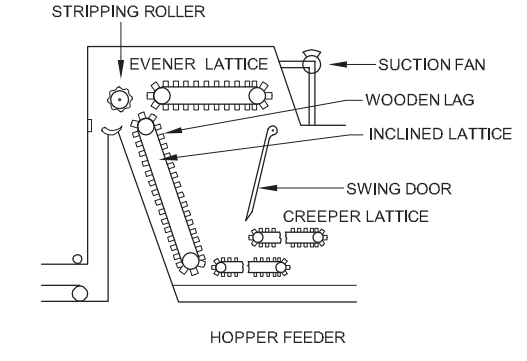
- To open the tuft of cotton.
- To mix & blend the fiber.
- To remove a considerable amount of trash from fiber which is taken out by fan.
- To act as a reserve boxer for the next machine.

Function of bale opener machine

- Regulating motion by swing paddle.
- Air suctioning.
- Beating action.
- Spiked lattice action.

Hopper feeder (Fig 3)

Fig 3



HOPPER FEEDER

In hopper feeder the following objects are achieved: The material is thoroughly blended in main bin. The material is combed by the spikes of the inclined lattice. The cotton is well opened when passes in between evener roller and spiked inclined lattice. Sand, heavy trashes are extracted through grid bars and iron particles are removed

from the cotton by the magnet. Fan is provided in the top of the machine and sucks the dusty air which is settled down in the cellar. Also, the principle object of the hopper feeder is to provide uniform feeding of cotton on lattice across the full width of the machine. The hopper feeder is repeated in the blow room line

The cotton coming from previous machine is deposited on creeper latticed reserve bin. Creeper lattice will deliver the cotton on feed lattice of main bin. Feed lattice will take cotton forward close to the inclined lattice. Swing door is used to maintain the constant level of cotton on feed lattice. Due to the spikes on the inclined lattice and direction of movement, lumps bf cotton will be carried upwards by the inclined lattice.

Hard pressed layers of cotton are well combed by the spikes of inclined lattice. Revolving spikes of the evener roller or lattice beats and open the cotton. Due to the close space between evener lattice and inclined lattice and rotation of evener roller in a opposite direction, unopened excess lumps of cottons are thrown back into mixing bin. Stripping roller strip the cotton from inclined lattice and projects it over a grid bar system where sand, heavy trash are passed through the spacing of the grid.

From stripping roller the cotton is deposited, layer by layer in. the reserve box and is taken into next machine by lattice in the form of uniform feeding across the full width of the scutcher.

Importance of feed control in hopper feeder: the volume of cotton contained in the reserve bin determines the regularity or uniformity of the lap.

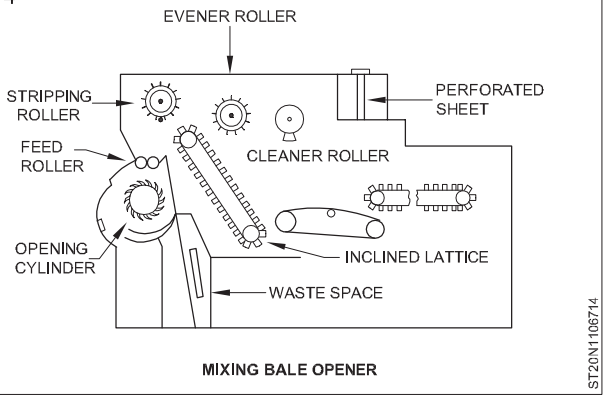
Front sheet should be set properly according to the lap weight per yard required.

Improper feeding in the hopper and improper setting of front sheet will tend to produce too heavy or low weight lap (or) non uniformity lap which causes to reject the lap.

So feed control in hopper feeder is important in the blow room line to produce uniform lap.

Mixing bale opener (Fig 4)

Fig 4



MIXING BALE OPENER

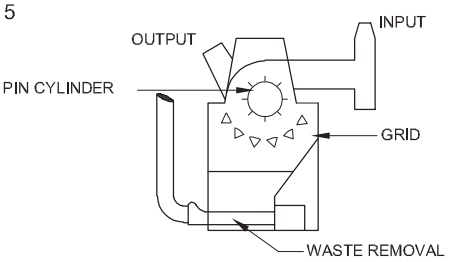
Object, passage of cotton & working procedure of Mixing bale opener is same as the hopper bale opener, but the difference. From stripping roller, the cotton flocks are thrown into trunk, which guides them into the pair of feed roller which is spring loaded.

The compressed sheets of cotton which are delivered from feed roller are heavily beat by saw toothed cylinder. This beating action divides the material ' into smallest flock. Saw toothed cylinder projects the flocks over the grid, where sand and heavy trash particles are extracted.

The cotton falls into an outlet funnel are taken away pneumatically to the next machine. In addition to the cleaning through grid bar system an exhaust fan at the top of the machine will suck the dust, air and short fibres from inside of the machine through perforated sheet. This pepper trash is taken by pneumatic pipe to the cellar (dust chamber).

Mono cylinder (Fig 5)

Fig 5



MONO CYLINDER

Objective: To open and clean the cotton.

Advantages: Impurities are separated without being crushed.

This proves favorable during subsequent operations. The well opened tuft of cotton from mixing bale opener enters the machine at right angles to the pin cylinder axis. The pin cylinder has 8 rows of six pins each, arranged spirally around its circumference. Due to the collision of the cotton tufts with rapidly revolving pin cylinder against grid bar, impurities from cotton is extracted and passed through the spacing of the grid bar.

After the tufts come into the contact with the grids for the first time, they are flung into the top part of the housing. Owing to the guide plate, the tufts moves along a helical path, so that they fall on the pin of the cylinder again and retaken past the grid a second time. At the same time the tufts are turned over, so that their entire surface is brought into contact with grid, assisting the removal of dirt. The spiral path is continued by the guide plate and the tufts pass over the grid a third time, after which they leave the machine at the outlet.

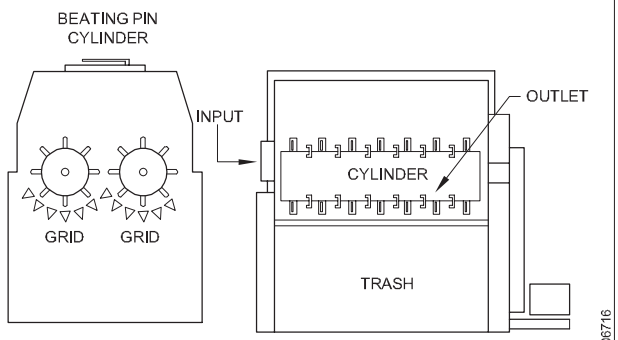
The grids are arranged in two separate sections which can be adjusted individually. The grid can be adopted to handle any degree of impurities and opening in the cotton to be processed by means of the lever provided with the scales. The grid can be adjusted regarding spacing (0 to 12 mm) between the grid bar, as well as inclination (angular setting of the grid bar -0° to 30°). It is thus possible to adjust the amount of waste and its quality to the requirements and the different types of raw material,

Magnetic double elbow: This is installed in mono cylinder to remove larger or smaller solid foreign bodies of metallic and non-metallic origin. By deviating the fibre-air stream through a sharp angle, heavy particles are thrown in to

the metal box by inertia. Light metallic parts are further more attracted by a permanent magnet plate.

AXI-flow cleaner (Fig 6)

Fig 6



AXI - FLOW CLEANER

Opening and cleaning of cotton is achieved by the repeated beating action of the rapidly revolving two beating cylinder on cotton against grid bar. A trash particle from the cotton is extracted through the grid bar and is collected below the grid bar.

Smaller tufts that are already sufficiently opened for a quick and thorough cleaning thus leave the Axi-flo earlier without receiving unnecessary beating. This prevents loss of good fibre, formation of neps and fibre entanglement. Fibre contained in large tufts cannot get entangled or lost through the grid. They remain in the machine till they are transformed in to small tufts and release their impurities easily.

An adjustable guide plate fixed to the inlet pipe control the angle at which the tufts approach the right beating cylinder.

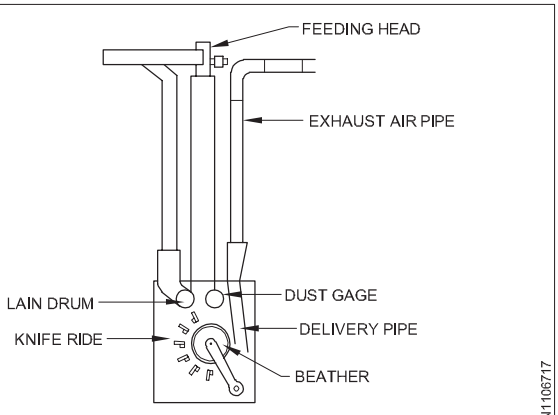
This cylinder takes the tuft downwards, guides them over the broad waste grid and throws them up against the adjustable defector plate. The defector plate directs the tuft stream within the reach of the left cylinder which then passes the material over its own grid and transfers the 1arger tufts back to the right cylinder. The position of the adjustable guide plate between the two cylinders decides how long the tufts remain under the influence of each cylinder.

The angular position of the bar is adjustable for each set separately. Each set of grid bar can be raised or lowered to alter the distance between the grids to the end of the spike. It is thus possible to adjust the amount of waste and its quality to the requirements and the different types of raw material.

ERM cleaner (Fig 7)

Type: Gripped and controlled feeding & saw toothed disc opener the fibre is blown into the laminar chute by an integrated fan. The filling of the chute is monitored by 2 photocells. The pair of spring loaded feed roller in it ensure a controlled feed of the fibre tufts. Due to the heavier beating of the rapidly revolving saw toothed disc on cotton tufts against knife grid, highest possible degree of opening and cleaning of the fibre is achieved.

Fig 7



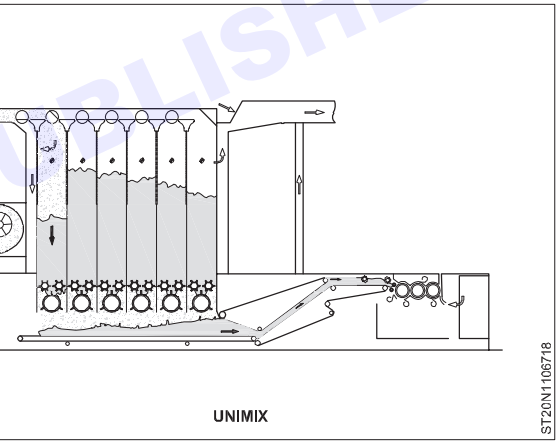
ERM CLEANER

By means of graduated lever, the grid bar can be adjusted regarding spacing between the knife grid bar & brought into proper position relative to opening Roller according to handle any degree of impurities and opening in the cotton to be processed. It is thus possible to adjust amount of waste and its quality to the requirements of different types of material.

After opening and cleaning, the material is conveyed pneumatically through outlet pipe to the next machine.

Unimix (Fig 8)

Fig 8



UNIMIX

A fan feeds the material into the miner. The individual chambers are filled one after the other. The dust fade transport air escaper through perforated plates in the chamber and is then fed to a filter. The filling of the multiplier mean starts with the last chamber. All chambers are successively filled in several stages until one chamber reaches its minimum filled height. Then the delivery rolls underneath each chamber are activated and the material is fed via the opening roll onto the conveyor belt.

As the chambers empty, they are again filled one after another. A loss layer of tufts from the several chambers builds up on the bleeding conveyor. At its end there are material layer from all chamber layer on top of each other. [From the web in directed fed into a clearer or an open]. This process of filling mining and feeding a cleaner are controlled and monitored by the integral control.

In this machine, an intensive, instantaneous perfect and homogeneous blending of mini tufts (.005-.010 gram) together with simultaneous mixing by doubling over an extended period time is achieved.

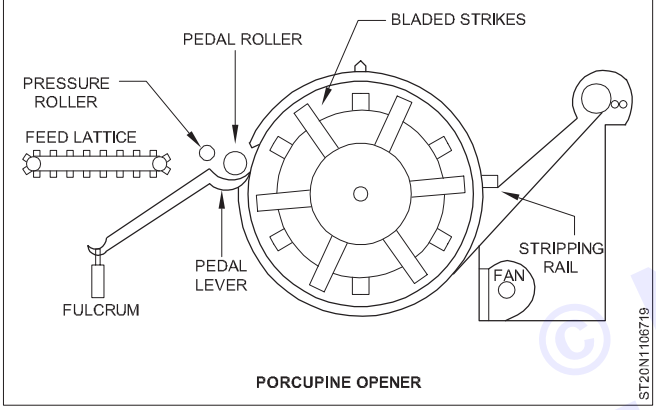
Storage section: It consists the material distributing duct into which the tufts are blown. Over a adjustable separating noses, a relevant turbulence is formed which creates a thorough instantaneous blending. Six vertical filling trunks of varying heights are arranged in the direction of flow of material.

Condensing funnel: This brings about a 2-3 fold mechanical condensation of six layers of material. In this way, holding capacity of 350 kg is obtained. A conveyor belt together with conveying roller carries the material to the opening & mixing section.

Opening & mixing section: This section directs the flow of material to the action of two pairs of pressure roller each with an opening roller. Owing to the different stretches to be traveled the Constituent comprising the mixing, which have been fed simultaneously to the trunks, arrive at the delivery and sucked-off by the subsequent machine.

Porcupine opener (Fig 9)

Fig 9



PORCUPINE OPENER

The cotton fed by the previous opener is carried forward by the feed lattice. The sheets of cotton now pass between pedal and pedal roller. The weight of cotton fed per unit time is maintained constant by this pedal feed regulating motion.

Pedal roller feed the sheet of cotton in between pair of feed roller which is weighted to give necessary grip on the cotton. 16 circular discs are mounted on the shaft of this opener. 14 to 18 striker blades are riveted alternatively on each circular disc. Each striker is bent to a slightly different angle.

The compressed sheet of cotton delivered from the feed roller is heavily beated by the rapidly revolving striker of the porcupine beater against grid bar. Because of this beating action, the cotton is effectively opened and extracted trash particles are passed through the spacing of the grid bar.

At the end of the grid bar, stripping rail is provided; this is a metal bar which is set about 1/16 inch away from the end of the striker. This small clearance between stripping rail and striker prevents bunches of cotton being carried around by the beater. Cotton from the beater region is taken out by the air current set by the fan and is deposited on to the cages.

During the passage of cotton between beater section and cage, it passes over a series of suspended leaf bars where lighter impurities are removed. The compressed sheet of cotton is delivered from the cage by means of pair of delivery roller to the next process. While processing fine cotton and viscose rayon, porcupine opener is not recommended, in this case this opener is by passed by suitable by-pass arrangement provision in this opener.

General maintenance of textile machines

Objective: At the end of this lesson you shall be able to

- **state the introduction of maintenance**
- **list the two systems of maintenance and state it**
- **state the installation of flat belts and reinstalling an old belt**
- **state the maintenance of V belt and V pulley**
- **state the lubrication of gear wheel, bearing and its effects**
- **state the precautions while lubricating a bearing**
- **state the mounting of different bearings in blow room machine.**

Introduction: In the context of modern machinery and rising costs, the penalties for maintenance lapsed are too severe. For instance, if the production per spindle in a 25,000 spindle mill spinning 40sNe yarn is about 1% lower than that is possible by maintaining machinery in good condition, then this under-maintenance is costing that mill nearly Rs.25 lakhs a year.

The modern textile machineries are very intricate. Some of the very advanced engineering techniques are incorporated and machineries are operated much closer to their limits. For their reliability and efficiency, they require more precise and finer settings, and demand closer attention than their predecessors. Also, high speed and unconventional spinning machineries introduced in the past decade are controlled with built-in electronic monitor devices, both on-line as well as off-line. They need prompt renovation and replacement as and when they are due. This is not, however, to suggest that old and ageing machines need any less attention. Whether it is old or modern machine, maintenance has to be planned and directed in a systematic manner for its efficient functioning.

There are also ever increasing economic pressures which compel a mill to use its high capital equipment to the fullest extent so that it can survive in the intensely competitive conditions of today. For this, a proper maintenance is essential.

Two systems of maintenance: Before going into these concepts, it is useful to make a few remarks about the maintenance systems in general. Basically, the systems can be distinguished into two types

1 Breakdown maintenance

2 Planned maintenance

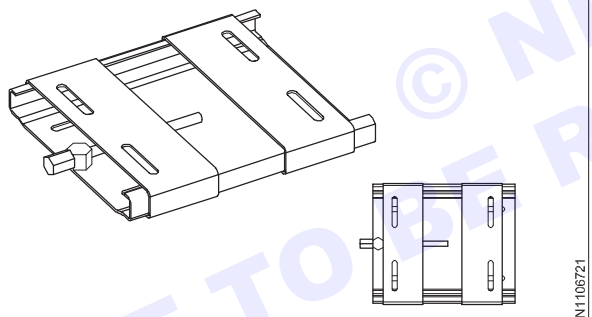
Breakdown maintenance: In this system, attention is given to a machine only when it breaks down. Essentially, this is an unplanned system and found wide acceptance chiefly because of the advantage of low direct costs.

The system suffers from two main drawbacks. Firstly, in this system the machinery and equipment will wear out prematurely, and as a consequence will produce sub-standard quality, the penalties for which are quite heavy. In the second place, because of the lack of regular servicing the machines will be prone to frequent breakdowns, which will lead to proportional losses in productivity. For these reasons, it is generally agreed today that this ideal of machinery maintenance is highly unsatisfactory and should, therefore, be best avoided to prevent obsolescence in spinning mills.

Planned maintenance: As the term implies, in this system, maintenance is planned in advance as against unplanned or haphazard activities characterising the previous system. But the differences are more fundamental than that. The system is based upon scientific and technical principals, and therefore provides for proper preservation of machinery and equipment and their rational, economical and technical use.

Motor plate (Fig 1)

Fig 1



A sole plate is a base plate grouted into a concrete foundation in order to provide vibration support and levelling support for a machine, such as a pump or a compressor. Depending upon the design engineering, there are usually bolt holes or pre-installed anchor bolts required to secure the feet of the machine to the machined plate. Often times, levelling pads or steel footings or shims are required in order to adjust to a flat, level surface during installation.

Although mainly used for inside machine floor support applications, many base plates are used to support heavy equipment such as compressors, generators, motors, and pumps outdoors. As an example, machine base plates are installed underneath machines located at utility distribution sites as well as alongside industrial buildings.

Belt and pulley systems: A belt and pulley system is characterised by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realised.

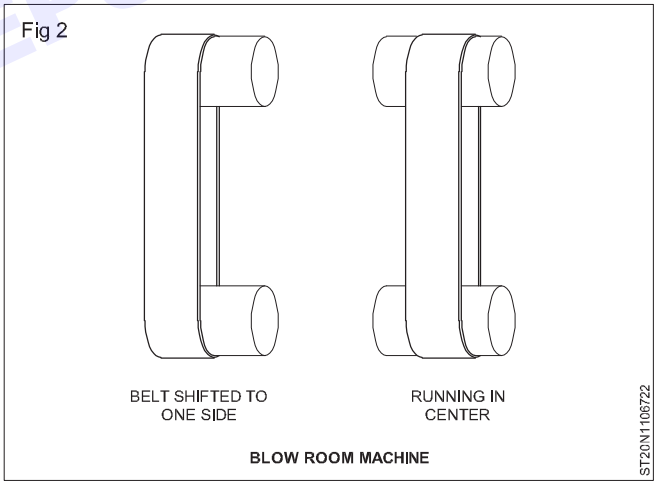
A belt drive is analogous to that of a chain drive, however a belt sheave may be smooth (devoid of discrete interlocking members as would be found on a chain sprocket, spur gear, or timing belt) so that the mechanical advantage is approximately given by the ratio of the pitch diameter of the sheaves only, not fixed exactly by the ratio of teeth as with gears and sprockets.

In the case of a drum-style pulley, without a groove or flanges, the pulley often is slightly convex to keep the flat belt centered. It is sometimes referred to as a crowned pulley. Though once widely used on factory line shafts, this type of pulley is still found driving the rotating brush in upright vacuum cleaners, in belt sanders and band saws. It has been replaced by other mechanisms with more flexibility in methods of use, such as power take-off and hydraulics.

Just as the diameters of gears (and, correspondingly, their number of teeth) determine a gear ratio and thus the speed increases or reductions and the mechanical advantage that they can deliver, the diameters of pulleys determine those same factors. Cone pulleys and step pulleys (which operate on the same principle, although the names tend to be applied to flat belt versions and V belt versions, respectively) are a way to provide multiple drive ratios in a belt-and-pulley system that can be shifted as needed, just as a transmission provides this function with a gear train that can be shifted. V belt step pulleys are the most common way that drill presses deliver a range of spindle speeds.

Installation of flat belts (Fig 2)

Fig 2



The procedure for installing new flat belt is different from those old belts.

a New flat belt

1 Before installing the belt, check parallelism of shaft and alignment of pulley and ensure that both are true/OK.

2 Make a mark 1000 mm apart on the un-tensioned belt. In case the centre distance is small make a mark of 500 mm and 200 mm apart.

3 Mount the belt on the pulley.

4 Tension the belt by increasing the distance between the driving and driven pulley till the distance

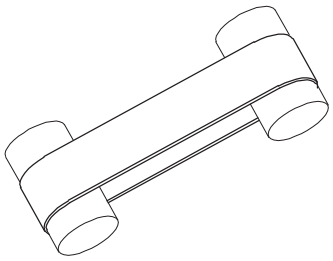
between the measuring marks increases to the value of initial tension.

For example if the initial tension was 2.30%, then the distance between the measured mark on un-tensioned belt of 1000 mm should be increased till the it reaches 1023 mm.

To verify that tracking of belt is proper give several full turns to pulley and ensure that the belt does not run off.

Reinstalling an old belt (Fig 3)

Fig 3



FLAT BELT

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1 Before relaxing the belt for reinstalling, measure the distance between the existing measuring marks with the help of measuring tape.

2 Completely relax and demount the belt.

3 For reinstalling, mount the belt on, and increase the tension on the belt until originally measured distance between the marks is reached.

Maintenance of V belt

1 In a multiple V drive belt, always replace the set of belts if one or more belt breaks. Replacement of one belt only results in undue stretching of the new belt and which moves with a different velocity. This will reduce the life of new belt.

2 In multiple V drive, putting one or two belts less than the number required, reduces the life of the belt by 30-50%.

3 Check the pulley for wear before putting the belt.

4 When the drives are expected to remain stationary for long period, relax the operational tension.

5 Always give proper tension to the belt and check the belt tension regularly.

6 Do not use sharp tools to mount the belt forcibly.

7 Keep the free from oil and grease and belt dressing lubricant should never be used.

V pulley

These are used to transmit full power along with V belts without undue wear.

V pulleys must have correct groove dimensions. Other important factors are listed below.

1 V pulleys should be free from porosity or blow holes in the groove faces.

2 Sides of the grooves should be free from burrs.

3 Top corners of all grooves should be rounded.

4 Worn out pulleys should be replaced by new pulleys.

5 Any V pulley smaller than the recommended minimum pitch diameter should not be used.

6 Side wobble and run out should be within tolerances.

Lubrication of gear wheel

1 **Open gear**: Gears should be properly lubricated to: minimize wear, prevent the generation of excessive heat, improve efficiency through the reduction of friction between the mating tooth surfaces, reduce noise and inhibit the formation of rust. Good lubrication depends on the formation of a film thick enough to prevent contact between the mating surfaces. The relative motion between gear teeth helps to produce the necessary film from the small wedge formed adjacent to the area of contact. It is important that an adequate supply of the correct lubricant is properly applied. In open gears mostly extreme pressure grease are used.

2 Gear box lubrication

I **Recommended oil:** In all machineries, a certain amount of power is required to overcome friction within the lubricating film itself. Friction of this kind is largely a function of the viscosity of the lubricant. To minimize power consumption, it is necessary to use oil with optimum viscosity compatible with satisfactory lubrication, while taking account of considerations like splashing and the rate of oil consumption. Oxidation tends to cause thickening of oil in service; therefore, it is advantageous to use lubricants with high oxidation stability. Such lubricants change less in viscosity with increase in temperature.

II **Recommended oil level:** Industrial gears may be either of the enclosed type or of the open type. In the enclosed type a minimum level of oil is maintained. In the gearbox, teeth of the bottom gears are just dipped into the oil and gear are lubricated by means of splash. In case of splash lubrication it is necessary that oil level should not be too high. A high level results in churning of oil which in turn results in consequent rise in oil temperature and in power loss. The depth to which the bottom wheel is dipped is twice the tooth depth.

This is sufficient for splash lubrication and to keep the churning effect to the minimum. Secondly, a pressure circulating system may be used in which oil is sprayed on the teeth close to the point of engagement. The oil is then recirculated either directly from the bottom of the gear box or by way of a separate tank with the help of oil pump.

Reasons for the failure of gear teeth

1 Fatigue - When two gears mesh with each other to transmit a load, the teeth of each gear are under bending action. The bending stress will be maximum at the root of tooth. Due to the periodical effect of the load, fatigue cracks may occur near the tooth base resulting in ultimate failure of tooth.

2 Wear - When some foreign material like dust particles deposited in between the mating teeth there will be wear of tooth surface.

3 Improper meshing.

Lubrication of bearing: The objective of lubricating a bearing is to form a film of oil on the rolling and sliding surfaces to prevent metal parts from making direct contact with each other.

Lubrication provides the following effects

1 Reduces friction and wear,

2 Discharges friction heat,

3 Extends bearing life,

4 Prevents rust and

5 Prevents foreign material from getting inside.

In order to get the most from the lubricant, one must choose a lubricant and lubrication method that suits your usage conditions, and must make use of sealing devices for preventing dirt from getting in and lubricant from leaking out.

Grease is widely used because it is easy to handle, it facilitates sealing device design, and is the most economical lubricant. The technique of varies lubrication according to whether bearings are either separable or non separable and whether their housing are split type or one piece.

Sealed bearing: Sealed bearings where the grease is sealed inside the bearing. These sealed bearings do not need any re-lubrication. It is not advisable to open the seal/shield for lubrication, as the seal/shield will not fit tight properly again.

Non-separable bearing: The deep groove and angular contact ball bearing are non-separable bearings. These should be filled with grease from both ends. In self-aligning and spherical roller bearings, the outer ring can be swivelled so that rolling elements are accessible. Grease can be then injected into all free spaces between them.

Separable bearing: These include cylindrical, taper roller and all types of thrust bearings. These bearings are greased in separate steps, the same order to determine by mounting sequence. After mounting the first ring, if this ring has a non-separable ball/roller and cage assembly attached to it then grease the ring and fill the internal space with grease. If the ring is separate, it is sufficient to grease it lightly so that it will not get damaged when the outer ring with cage and ball/ roller is pushed on it.

Ball bearing in housing: When ball bearings are contained in housing with removable cover and no grease nipple, they are managed with long-greasing intervals. Before regreasing, these bearings are to be dismounted and flushed out thoroughly. When fitting the bearing again the bearing and its housing is to be filled with grease, about one-third for shafts running at more than 500 rip. If the bearings are packed full then balls have no room to turn and the bearing gets hot. Slow running bearings may be packed full.

Bearing with grease nipple: These bearings are lubricated with a grease gun as per schedule. These bearing require a very little quantity of grease (one or two strokes of the grease gun). Bearings in housing equipped with grease nipple require 10 - 15 stroke of grease gun (10 - 15 g) of grease at every re-lubricating interval).

Precautions while lubricating a bearing

1 Use only the recommended grade of grease. If a higher grade of grease is used, it would become stiff at very low temperature results in poor lubrication. The rolling elements of the bearing rotate with difficulty and may slow down or stop completely in unloaded zone. When the elements pass back into the loaded zone, they are immediately forced to accelerate under load which results in heavy sliding. Lower grade grease is used then at high temperature, there is a risk of leakage of grease. At extremely high temperatures, the lubricate grease particularly metallic soap grease oxidize rapidly and then grease hardens and bleeding oil stops completely.

2 When a bearing is to be lubricated then first clean the grease nipple and area around the fitting to avoid any combination.

3 Never mix the grease of different thickener then resulting mixture will be either softer or sometime even much stiffer.

Mounting of different bearings

The following precautions should be taken while mounting the bearings

1 Clean the shaft and abutment shoulders and check the seating with regard to the diameter tolerance and accuracy.

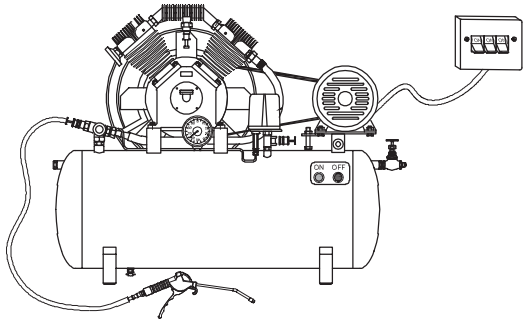
2 Do not remove the bearing from packaging till mounting.

3 Protect the new bearing from dirt to the extent possible.

4 Leave the rust inhibiting compound intact except in the bearing bore and on the outer ring's outside surface. Wash these surfaces with a petroleum-based solvent and dry.

Air compressor (Fig 4)

Fig 4



The basic components of the air compressor the electric motor, pump, pressure switch, and tank. The electric motor powers the pump. The electric motor is equipped with an overload protector and an automatic reset. If the motor becomes overheated, the overload protector will

shut it down to prevent damage to the motor. When the motor sufficiently cools, it will automatically restart. The pump compresses the air and discharges it into the tank. The tank stores the compressed air. The pressure switch (located internally) shuts down the motor and relieves air pressure in the pump and transfer tube when the air pressure in the tank reaches the kick-out pressure. As compressed air is used and the pressure level in the tank drops to the kick-in pressure, the pressure, the pressure switch restarts the motor automatically, without warning, and the pump resumes compressing air. Body of the air compressor is made of metal

Maintenance practices of air compressor: Good and proper maintenance practices will dramatically improve the performance efficiency of a compressor system. Following are a few tips for efficient operation and maintenance of industrial compressed air systems.

Lubrication: Compressor oil pressure should be visually checked daily, and the oil filter changed monthly.

Air filters: The inlet air filter can easily become clogged, particularly in dusty environments. Filters should be checked and replaced regularly.

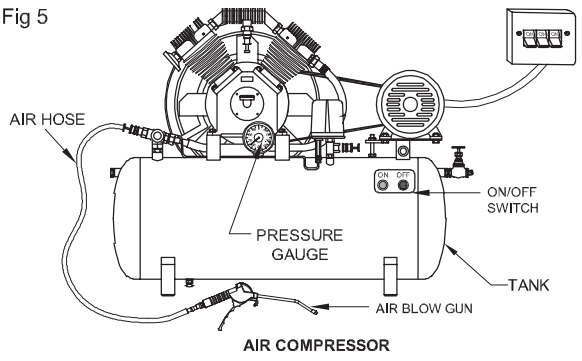
Condensate traps: Many systems have condensate traps to gather and (for those traps fitted with a float operated valve) flush condensate from the system. Manual traps should be periodically opened and re-closed to drain any accumulated fluid automatic traps should be checked to verify they are not leaking compressed air.

Air dryers: Drying air is energy-intensive. For refrigerated dryers, inspect and replace pre-filters regularly as these dryers often have small internal passages that can become plugged with contaminants. Regenerative dryers require an effective oil-removal filter on their inlets, as they will not function well if lubricating oil from the compressor coats the desiccant. The temperature of deliquescent dryers should be kept below 100°F to avoid increased consumption of the desiccant material, which should be replenished every 3-4 months depending on the rate of depletion.

Parts of air compressor (Fig 5)

Basic principle of pneumatic transport: Air is not inherently a very efficient transport medium. Very large quantities must be moved at high speeds in order to keep the tufts that are being transported floating. The current of air itself is a further disadvantage, since the air flows in a turbulent fashion through the ducting, i.e. vortexes are created.

Fig 5



AIR COMPRESSOR

Since the tufts are subjected to these vortexes, entangling of tufts can arise in long ducts and finally neps can be formed. A closed duct (generally a pipe) and a source of partial vacuum (a fan) at one end of the duct are needed to move the air. The air speed should be at least 10 m/sec, and 12 - 15 m/sec is better; it should never exceed 20 - 24 m/sec. At a given air speed, the required quantity of air can be calculated as

L ({m^3}/s) = A \times v

where L is the quantity of air; A is the cross section of the duct in m2; v is the air speed in m/s. The duct must terminate in a device that separates the air from the material.

Separation of air and material: By far the most widely used assembly for this purpose is the perforated drum. It is used in various machines and parts, often in so-called suction boxes (condensers).

A partial vacuum is created in the drum, and thus in the duct, by a fan at one end of the drum. Air and material flow toward the drum. However, while the air can pass through the perforations in the drum, and is then passed to filters for cleaning, the fiber tufts remain on the surface of the rotating drum and are carried along with it. In the lower region, the drum surface is screened off from the partial vacuum in its interior. The tufts are no longer retained by suction and fall into a chute. Another assembly for separating air and material is the slotted chute, where the transport air is extracted through the slot, while the material slides down on the aluminum ribs of the rear wall of the chute.

Maintenance schedule of blow room machine

Objectives: At the end of this lesson you shall be able to
- **state the about preventive maintenance of blow room line**
- **state about routine maintenance of blow room line**
- **state about maintenance audit and examination of maintenance system**
- **state about safety audit and inventory system audit**
- **state about duties of maintenance personnel, in-charge and fitters**
- **state the different settings of blow room line.**

Maintenance is a program to keep all the parts of the machine in perfect condition with minimum wear and tear.

Preventive maintenance in blow room: it means to attend and check the machines regularly and systematically and defects are discovered and remedied before them because a need for, major repair and before the wear & tear of the machine starts affecting the quality and production.

Activities	Frequency (month)
Cleaning and greasing of all machines in blow room	1
Grid bar polishing	6
By pass valve checking	6
Ventilator checking and greasing	6
Saw tooth beater wire	20,000 - 40,000 kg of material completed
Disc beater	20,000 - 40,000 kg of material completed
Pin roller beater	100,000 kg of material completed
Oil change	Manufacturer recommendations

Routine maintenance in blow room line

Nature of operation	Frequency
Dismantling -Checking- thorough cleaning & resetting of i) Cage Unit,ii) Lap doffing unit, iii) Lap measuring motion, iv) Lap hardening mechanism & v) Piano feed regulating motion	Every month
Cleaning of grid bar	Every shift
Removal of droppings from beneath the grid bar	Twice per shift
Straightening of bent pins of kirschner beater and sharpening the beater blade	Whenever needs
Polishing of grid bar	6 Months
Reversal of beater blade	1 year
Redressing of beater blade	2 Year
Clean inside the cage	Each shift
Applying Black-lead powder inside the cage	Periodically
General cleaning	15 days
Lubrication of all the gear wheel & bearing	Daily & greasing at the time of frame cleaning
Correct the leakage places in the entire pneumatic duct line	Every week

Maintenance audit

Introduction: Maintenance audit helps in improving the existing maintenance system. It also helps in early detection and prevention of mechanical faults, which may remain undetected and unidentified for too long if one relies only on instrumentally testing of the product. Machinery audit may be defined as “Methodical in-depth examination of the total operating system with relevance to the maintenance of the machinery.”

Maintenance audit includes the physical inspection of the machine parts that have a large effect on the productivity of the machine and/or on the quality of the product delivered by machine.

The overall objective of the maintenance audit is to review and critically assess the existing maintenance system to judge the reliability and maintainability of the plant with a view to suggest improvements.

The specific objectives of maintenance audit are as follows

1 To study the existing systems and procedures with respect to maintaining health of machines and safety of workers.

2 To review the implementation status of the existing maintenance systems, procedures, plans and programs/schedules.

3 To carry out physical inspection of the machines with regard to safety, standard and uniform setting, and mechanical condition of individual parts of machines.

4 To recommend measures for improving effectiveness of implementation of the total maintenance system, for improving the existing procedures and for setting up of new procedures if required.

Methodology

The overall methodology consists of the following five stages

Preliminary information gathering Collection of preliminary information regarding the maintenance system through a questionnaire developed by auditor before undertaking actual field work.

Examination of maintenance system

Types of maintenance system

1 Unplanned maintenance,

2 Planned maintenance includes preventive maintenance,

3 Planned maintenance includes both preventive and predictive maintenance. Now-a-days, modern mills having 50% of the maintenance activities must be based on the condition-based monitoring system.

The auditor should go through all the maintenance records like schedule register, history register corrective action and preventive action register, etc form a tentative judgment on the efficiency of the maintenance system and of the condition of the machines.

Safety audit: The objective of a general safety audit in maintenance is to review and assess the safety methods employed to prevent and control hazards in the plant with a view to suggest improvements wherever necessary.

a Are working surfaces even, free from dust, wastes, spillages, loose objects, cables/hoses lying around?

b Are floor openings kept covered or guarded with rails while working?

c Is there a schedule for periodic floor cleaning? Has man power been assigned or time allocated for this work?

d Are tools and fixtures kept on racks instead of machine?

e Are platforms, benches, seats in good condition?

f Are drip trays provided and regularly cleaned?

g Is material properly stacked in racks?

h Is there a schedule for depositing the scrap to the scrap yard?

The specific safety precautions connected with each machine are covered in the maintenance checklists for physical inspection of the machines.

Inventory system audit: The object of auditing the inventory system is to check how they are linking the spare part management with the maintenance schedule. Auditor must check the following points

1 Downtime was high due to part shortages.

2 Spare parts were kept haphazardly in cabinets and on open shelves.

3 Maintenance technicians wasted time looking for parts.

4 Parts were often not labeled, mislabeled, obsolete or unidentifiable.

5 Emergency purchase orders were frequent and expensive.

6 Automatic reordering capabilities were not used.

7 Ordering practices were loosely defined, leading to incorrect inventory levels.

8 No one knew what items had been or needed to be ordered.

9 No one knew when items were due to arrive or if they had already been received.

10 Received parts were frequently lost, resulting in unnecessary and expensive reorders.

11 Inventory records are created for all parts with the following details

- Item number
- Description
- Inventory type
- Quantity on hand by location
- Minimum and maximum stock level

Maintenance effectiveness: In maintenance is there any system that records the number of failures and then analyses the root cause of failure. To see the effectiveness of the maintenance department, one must check the following points

1 Number of failures,

2 Root cause of failures,

3 The maintenance cost associated with no. of failures,

4 The production cost associated with no. of failures, and

5 The ratio of planned maintenance work to unplanned maintenance work.

Secondly, maintenance system must have key performance indicators for maintenance cost, utilization loss and overtime hours for each machine, etc.

Maintenance budgeting and cost control: Maintenance cost is defined as the cost associated with maintenance activities. Maintenance budgets including expenditure budget and utilization budgets are made on the basis of assessment of activities they expect to perform. One must check how many report the actual cost against the budgeted activities.

Daily scheduling and job control: There should be a system that determines how the work is allocated.

Suggested duties of maintenance personnel: The previous chapter outlined the minimum organisation essential for machine maintenance in a spinning mill. Number of personnel required to be employed in the different categories were also given. For these personnel to function effectively in a co-ordinated manner and also without duplicating each other's duties, it is essential to define the duties of each class of the worker and this chapter lists them. For the sake of completeness, even the maintenance duties of workers like machine tenters, doffing boys, etc., are also given. It should, however, be emphasised that this list is not exhaustive, and much less meant for adoption in all mills without regard to their peculiar circumstances.

Suggested duties of maintenance In-charge

- Responsible for establishing and executing routine and preventive maintenance programmes.
- Maintain proper and adequate maintenance records.
- Ensure spares of machinery available at proper time for which he should liaise with stores and purchase departments.

- Prepare necessary store indents and ensure that consumption of lubricants etc. are well within standards.
- Supervise conversion, overhauling, erection and repairs.
- Keep himself well aware of the technical know-how of machinery under his control.
- Keep in touch with the modern developments in the field of textile machinery and arrange for the installation of new machinery / incorporation of new modifications to the existing machinery.
- Conduct periodic review of stores to eliminate duplications of unnecessary item or low usage items.
- Control waste by checking settings at various processes.
- Ensure effective utilisation of men and machinery.
- Co-ordinate with Mechanical/Electrical Engineer in attending to machinery erections, conversions, breakdowns, repairs, etc.
- Maintain current technical data on all phase of lubrication theory, techniques and problems.
- Decide the feasibility of less frequent lubrication of grease lubricated bearings.
- Co-ordinate with production in charges by giving a patient hearing to the problems connected with the performance of the machines.
- Liaise - with SQC department for evaluating the performance of the machinery in all the departments and to take corrective actions.
- Find out the rogue machines/parts and plan for crash programmes to set right those machines/parts.
- Plan the maintenance crew requirements and distribute the operations appropriately.
- Inculcate the capacity to guide, motivate and handle the maintenance crew.
- Should maintain close contacts with top management to discuss about his achievements as well as constraints.

Fitters and assistant fitters

Blow room

- Inspect the condition of spikes on lattices, and repair or renovate.
- Set correct tension of lattices and conveyors.
- Inspect the length, shape and condition of all belts and ropes for dressing.
- Inspect beaters and set.
- Dismantle cage unit, inspect the condition of wire mesh, linings, etc., and set.
- Inspect the fan, channels, ducts and fan bearings.
- Inspect bearings and condition of feed roller and delivery rollers.
- Dismantle piano feed regulating motion, inspect thoroughly for wear, and re-set.
- Check the condition of racks and bevels, and set for true running.
- Remove brake drum, clean off greasy substance, if any, and arrange for proper running.
- Dismantle calender rollers and lap rollers, check for wear of bearings and other parts, and re-set.
- Inspect general condition of synthetic/leather linings and leather flaps, and examine lattice tension, etc., during the general cleaning.
- Check lap measuring motion.
- Examine the timing of auto doffing.
- Inspect general cleaning of beaters.
- Inspect the function of photocells and diaphragm switches.
- Check the laps for unwinding performance especially for lap licking at cards.

Function of various motors and door stop motion switches

Objective: At the end of this lesson you shall be able to
- **state about induction motor**
- **state about synchronous motor and its parts**
- **state about emergency stop button**
- **list the various places of emergency stop motion switch in blow room machine.**

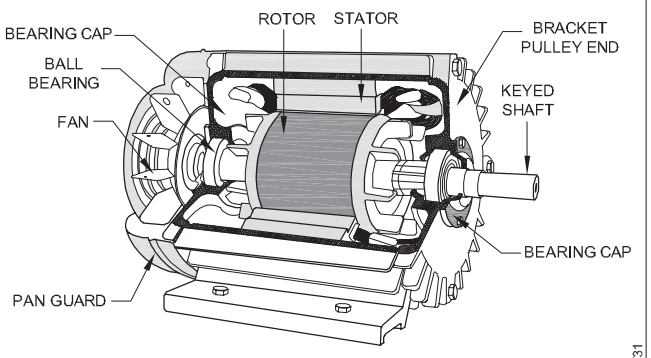
Induction motor (Fig 1)

An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor therefore does not require mechanical commutation, separate-excitation or self-excitation for all or part of the energy transferred from stator to rotor, as in universal, DC and large synchronous motors. An induction motor's rotor can be either wound type or squirrel-cage type.

Three-phase squirrel-cage induction motors are widely used in industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service. VFDs offer especially important energy savings opportunities for existing and prospective induction motors in variable-torque centrifugal fan, pump and compressor load applications. Squirrel cage induction

motors are very widely used in both fixed-speed and VFD applications.

Fig 1



INDUCTION MOTOR

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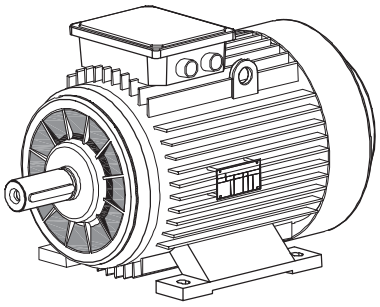
Synchronous motor (Fig 2)

Fig 2



SYNCHRONOUS MOTOR

ST20N1106732

Synchronous motors are like induction motor in that they both have stator windings to produce a rotating magnetic field.

Unlike an induction motor, the synchronous motor is excited by an external DC source and therefore requires slip rings and brushes to provide current to the rotor and produce magnetic field.

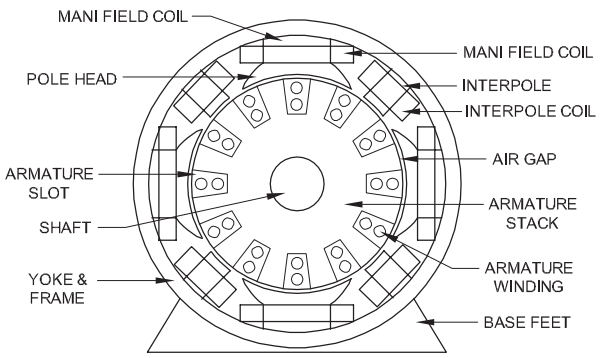
An AC Synchronous motor rotates at a fixed speed, despite of any increase or decrease in load. The motor will keep its fixes speed until the torque required reaches its pull out torque (maximum torque). If the load becomes greater then reach motor's pull out torque, the ac synchronous motor will not slow down because it reaches a point at which it will stall and stop turning. The pull-out torque is generally 1.5 Times the continuously rated torque. The ac synchronous motor is an effective way to obtain a fixed speed at a very low motor system cost. No expensive driver or amplifier is necessary. Most synchronous motors are used where precise timing and constant speed are required.

Parts of synchronous motor (Fig 3)

Door stop motion switches

Push button plunger: The oil tight constructed plunger mechanism prevents any ingress of oil including coolant. The position of switch mounting is adjustable with the two look nuts provided.

Fig 3



PARTS OF SYNCHRONOUS MOTOR

ST20N1106733

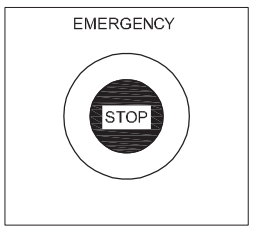
Roller lever: Roller lever with a steel roller mounted on either top and right hands side or top and left hand side provides operation in both sides.

Roller plunger: The similar oil tight constructed roller plunger either in line with the contact block or right angles to it, allows the cam or any other devices to operate in any of the four directions.

Six-inch lever: Operators provide either top and right hand mounting or top and left hand mounting or top and left hand mounting. The lever may be cut or bent to any desired length or shape to safety the user requirements.

Emergency stop button (Fig 4)

Fig 4



EMERGENCY STOP BUTTON

ST20N1106734

An Emergency Stop is defined as a fail-safe control switch or circuit that, when de-energized, will stop the operation of associated equipment and will shut off all potential hazards outside the main power enclosure.

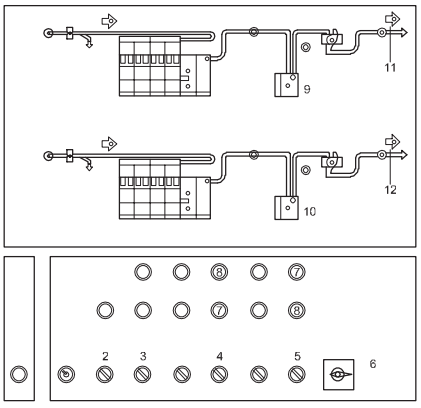
Emergency Stops, or "E-Stops", are a special type of pilot device that perform the emergency shutdown operation on a machine or electrical system. E-stops are different from a typical "OFF" button in that they must pass a rigorous line of testing and meet a long list of specifications. Many of these specifications will be described later in this manual.

Various places of emergency stop motion switch in blow room machine (Fig 5)

1 **Switch off key:** In the event of a malfunction in al line or in a feed system, the corresponding beacons flash. At the same time, an acoustic signal sounds.

2 / 3 = Rotary switch: Position 0: No material is fed to the UNImix including the blow room machines that are ready for production.

Fig 5



VARIOUS PLACE OF EMERGENCY STOP MOTION SWITCH

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Position 1: The opening machines supply material to the unimix as long as it is demanding material.

4 / 5 = Rotary switch

Position 0 = No material is fed to the cards including the blow room machines that are ready for production

Position 1 = the blow room machines that are ready for production supply material to the cards.

6 = Step switch

Allocation of the cards to the appropriate feed machines in an installation with 2 feed systems

7 = Green push buttons

Switch on feed machines

8 = Red push buttons

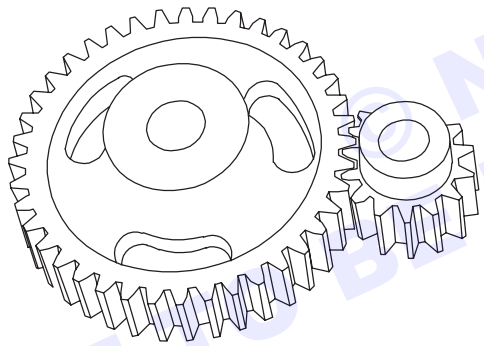
Switch off feed machines

Different types of gears, belt, tool kits and bearing

Objective: At the end of this lesson you shall be able to
- **state the different types of gears**
- **state the different types of belt drives**
- **state about bearing**
- **state the different types of tools.**

Spur gear (Fig 1)

Fig 1



SPUR GEAR

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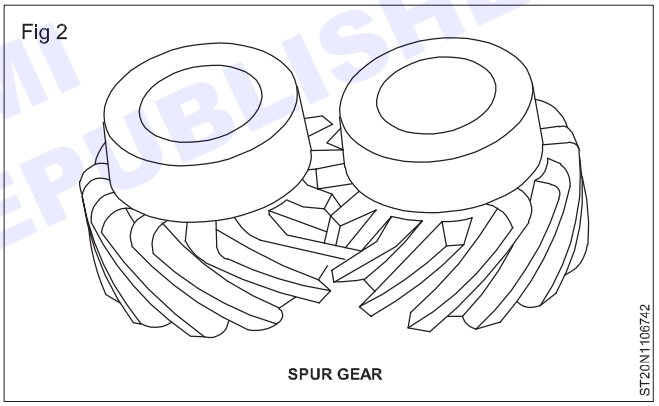
It is the simplest and most common type of gear that is used to connect two parallels and coplanar shafts, which rotate in opposite direction. Spur gear has teeth parallel to the axis of the shaft and is similar in profile throughout. It can be observed that line of contact between corresponding teeth is always parallel to the axis of shaft. These gears can only mesh correctly if they are fitted to parallel axles. The major advantages of these gears are simplicity in design and economic to manufacture. These gears are used for slow speed but if run on high speed they create noise.

Helical gears (Fig 2): Helical gears are similar to spur gears except that their teeth are cut at an angle to the hole (axis) rather than straight and parallel to the hole like the teeth of a spur gear. The line of contact between two teeth is not parallel to the teeth but inclined. This ensures gradual engagement of teeth from one end of tooth to other rather than a sudden engagement as in case of spur gear. This gradual engagement makes the gears function smoothly without much noise.

Fig 2



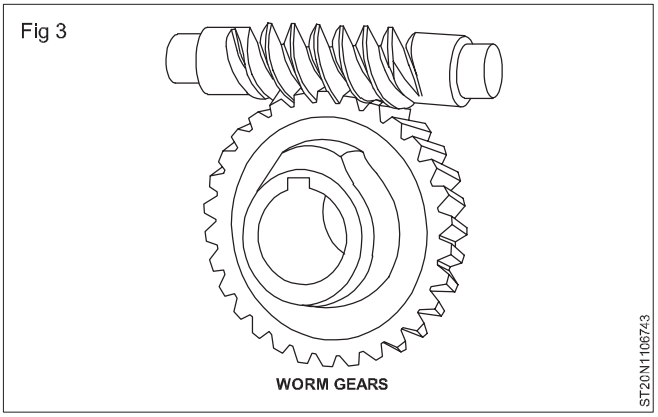
SPUR GEAR

ST20N1106742

Pair of helical gears can be meshed in two ways: with shafts oriented at either the sum or the difference of the helix angles of the gears. These configurations are referred to as parallel or crossed, respectively.

Worm gears (Fig 3)

Fig 3



WORM GEARS

ST20N1106743

A worm is a gear that resembles a screw. It is a species of helical gear, but its helix angle is usually somewhat large (i.e., somewhat close to 90 degrees) and its body

is usually fairly long in the axial direction; and these attributes give it its screw-like qualities. A worm is usually meshed with an ordinary looking, disk-shaped gear, which is called the 'gear', the 'wheel', the 'worm gear', or the 'worm wheel'. The prime feature of a worm-and-gear set is that it allows the attainment of a high gear ratio with few parts, in a small space. Helical gears are, in practice, limited to gear ratios of 10:1 and under; worm gear sets commonly have gear ratios between 10:1 and 100:1, and occasionally 500:1. The worm gear gives a line of contact between mating teeth unlike the point of contact.

Note: Worm gears differ from spur gears in that their teeth are somewhat different in shape and are always formed on an angle to the hole (axis) in order to mate with worms. In order to transmit motion and power at various speeds and speed ratios, worms and worm gears work in sets, rotating on shafts at right angles to one another. The worm usually drives the worm gear. In worms and worm gear sets, both the worm and worm gear are of the same hand. Right-hand sets are considered standard.

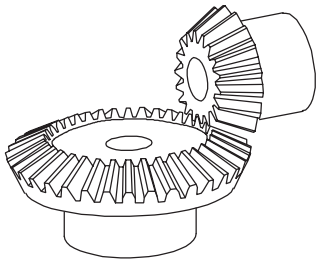
This improves the load carrying capacity and also reduces the speed. Worm gear is always changed in a set, i.e. both worm and worm wheel needs replacement at the time of wear.

A worm wheel of one diameter will not operate satisfactorily with a worm of different diameter even if thread pitch is same. The thread of worm may be single start, double start and so on. The velocity ratio depends whether the worm is one start or multiple start. To determine the number of threads on a worm, look at an end view so you can see the 'start' of each thread. One start means that you have a single thread, two starts a double thread, three starts a triple thread, and four starts a quadruple thread.

Bevel gears: These are used to connect two shaft axes which arc intersecting and coplanar. They are kinematically. equal to frustums of cone with their apices meeting at II point. The shaft angle may be of any value between 0° and 180° but one most common is 90°. The teeth of bevel gears are similar to that of spur gears in that they make a line contact across the face of teeth. The teeth are smaller at the front than at the back.

Straight tooth bevel gears (Fig 4)

Fig 4



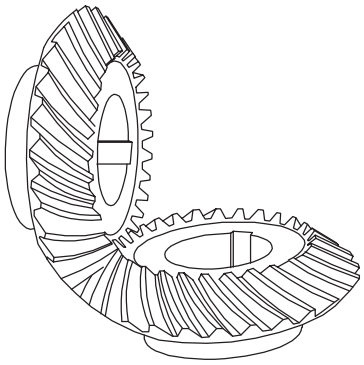
STRAIGHT TOOTH BEVEL GEARS

ST20N1106744

In these gears the teeth of gear converge to the common point along straight lines. This point is called apex and also point of intersection of gear axis. At high speed they give more noise.

Spiral tooth bevel gears (Fig 5)

Fig 5



SPIRAL TOOTH BEVEL GEARS

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Spiral bevel gears have spiral angles, which give performance improvements. They are designed for an angle change of 90°, where the two axes are concurrent and in the same plane. These gears have a double function of being helical and beveled at the same time. The contact between the teeth starts at one end of the gear and then spreads across the whole tooth. In this type of gears the shaft must be perpendicular to each other and must be in the same plane. They are the most complex forms of bevel gears.

The teeth are curved by cutting them obliquely, resulting in higher overall contact ratios. Because of higher contact ratio, these have better load carrying capacity and this allows them to be of smaller in size for a given load capacity than an equivalent gear. Thus, they can transmit more power with smaller gears. These gears have the following advantages over the straight gears

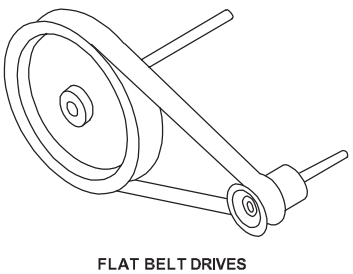
1 Due to curvature there is an overlapping of mesh and teeth mesh with each other gradually resulting in smooth and quiet operation.

2 There is a gradual transfer of load from one tooth to another eliminating sudden impacts and change in tooth pressure.

Note: Spiral bevel gears of the same hand will not operate together, a set of spiral bevel or spiral gears consists of one left-hand gear and one right-hand gear.

Flat belt drives (Fig 6)

Fig 6



FLAT BELT DRIVES

ST20N11067H6

Flat belt mostly consists of two outer layer made of elastomer called friction cover and two intermediate layers covering the traction layer which absorbs the force extended on the belt when power is transmitted. Friction cover ensures the peripheral force acting on the belt pulley is transmitted to the belt and vice versa.

Advantages

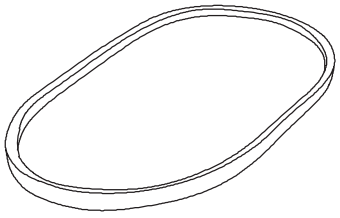
1 Flexibility, shock absorption and efficiency at high speed.

2 It allows long distances between the shafts.

3 Simplicity, low cost smoothness of operation, low maintenance cost long life and noiseless as compared with gear transmission.

V belts (Fig 7)

Fig 7



V BELTS

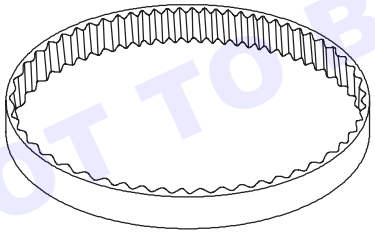
ST20N1106747

A V belt is required when a machine is driven by a separate motor located very close to the driven pulley. Hence V belts are used to transmit power from one pulley to another when the centre distance between two pulleys is less.

These belts are trapezoidal in cross-section and are manufactured endless belts. These belts transmit power owing to wedging action between the belt and V groove in the pulley. The included angle is ?/2 = 40°. The more power and load to be transmitted, the more is the number of belts. In such multiple drives all the belts should get stretched at the same rate so that the load is equally distributed on the belts.

Timing belts (Fig 8)

Fig 8



TIMING BELT

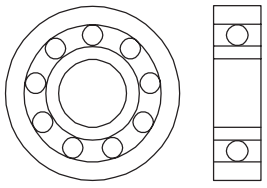
ST20N1106748

Classical timing belts offer a maintenance free and economical alternative to conventional drives like chains and gears. Capable of transmitting up to 100kW and speeds of 10,000 rpm. Classical timing belts can be used in a wide range of applications from light duty office machinery to heavy duty industrial drives. To select a drive it is necessary to know the driver and driven shaft speeds, the demand power, proposed centre distance and duty cycle. The chart below can be used to select the optimum belt size for a drive. For further information or help in selecting a drive contact Naismith Engineering. Naismith Engineering stocks the OPT belt range of Classical timing belts.

Bearing (Fig 9)

1 Bearing consists of the following elements: inner ring rolling element, cage, outer ring and seal/shield.

Fig 9



BEARING

ST20N1106749

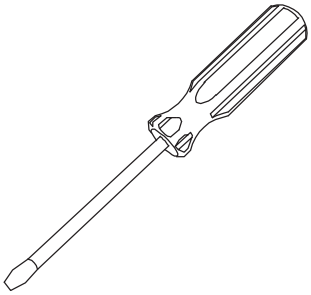
Inner ring/outer ring: The surface on which the rolling elements roll is referred to as the 'raceway surface'. The load placed on the bearings is supported by this contact surface. The inner ring is used fitted on the shaft and the outer ring on the housing. These are made of high-grade carbon chromium steel with a high degree of cleanliness and surface finish. Both rings are made of different sizes and shapes depending upon the type of bearing. Both rings have a groove throughout the circumference compatible to the size and type of rolling element. Each ring is given heat treatment so as to possess hardness between 59 and 65 HRC.

Rolling elements come in two general shapes: balls or rollers. Rollers come in four basic styles: cylindrical, needle, tapers and spherical. Rolling elements function to support the load while rolling on the bearing ring. The rolling element is held by the cage at a certain distance from each other between the inner ring and the outer ring. Rolling elements are made of carbon chromium steel, stainless steel or alloyed quality steel with hardness between 58 and 65 HRC.

Different types of tools

Screw driver (Fig 10)

Fig 10



SCREW DRIVER

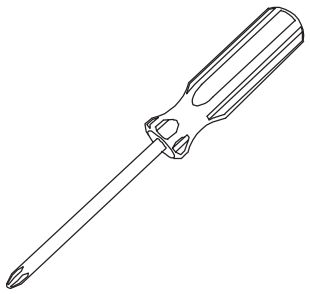
ST20N1106674A

It is very useful tool for rotating screw with line slots on their head. It consists of a wooden or plastic handle, and a steel blade shaped at the end. The flat end of the tool is inserted into the slot provided on the head of the screw for rotating it. Screw drivers are made in various sizes to suit the corresponding sizes of slot on the screw head and made of different lengths to tighten and to open screws with different torque. These are available in sizes 5 × 75, 6.5 × 80, 6.5 × 100, 8 × 125, 8 × 150, 11 × 200 and 13 × 250 mm.

Star screw driver (Fig 11): For rotating screw with star shape at the head, it is necessary to use a star shaped driver. It is also made in different sizes to suit the corresponding star shape on the screw head. These are available in sizes in 5 × 100, 6.5 × 125, 8 × 150, 4 ×

75 and 5 × 75. It is important not to use a simple screw driver to open or close a star headed screw so as to avoid damage to screw head.

Fig 11

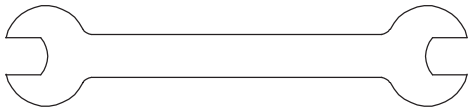


STAR SCREW DRIVER

ST20N110674B

Open-ended spanner (Fig 12)

Fig 12



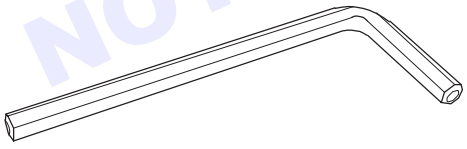
OPEN-ENDED SPANNER

ST20N110674C

These can be single-ended or double-ended. Single-ended spanners are provided with holding mouth at one end only and the size of mouth is different according to the size of the bolt and/or the nut. In double-ended spanner, openings are provided on both ends and are of different considerable sizes. These spanners are forged from chrome vanadium steel and heat treated. The size of the opening between the jaws determines the size of the open end wrench. The length of the wrench is determined by the size of the opening since the lever advantage of the wrench is proportional to its length; spanners with larger openings are made longer and heavier to increase leverage and strength.

Allen key (Fig 13)

Fig 13



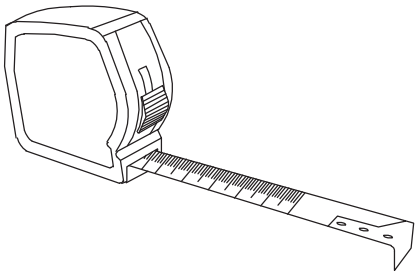
ALLEN KEY

ST20N110674D

An allen key is used for tightening or loosening set-screws. The allen key is made of steel in hexagonal cross-section throughout its length. It is mostly made in L-shape, and in different shapes and sizes to suit the different sizes of set-screws. These are also available in sets, ranges from 1 to 18 mm.

Measuring tape (Fig 14): The tape is a thin flexible steel strip. It is folded around a centre pin attached with a small handle. It is marked with inches and millimetres. It is available in different lengths from 1 to 100 m. The tape is spring loaded, so that as soon as it is released it will automatically return to the case. On some cases a lock is provided to hold the tape when extended.

Fig 14

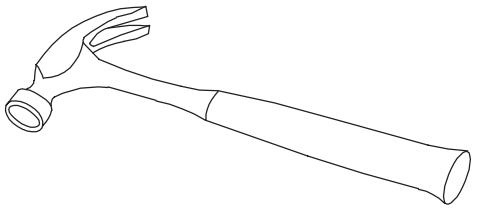


ST20N110674E

Claw hammer: Hammer is used to hammering the nail and remove the nail. (Fig 15)

Hammer is made of metal.

Fig 15



HAMMER

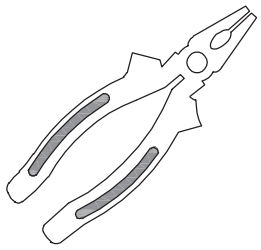
ST20N110674F

A claw hammer is a tool primarily used for pounding nails into, or extracting nails from, some other object. Generally, a claw hammer is associated with woodworking but is not limited to use with wood products. It is not suitable for heavy hammering on metal surfaces (such as in machining work), as the steel of its head is somewhat brittle; the ball-peen hammer is more suitable for such metalwork.

Pliers: They are specified with their overall dimensions of length in mm. The pliers should have insulated grip.

Combination pliers with pipe grip, side cutter and insulated handle. (Fig 16).

Fig 16



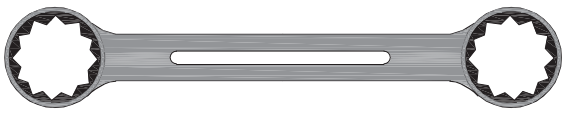
PLIERS

ST20N110674G

Size 150 mm, 200 mm etc. It is made of forged steel. It is used for cutting, twisting, pulling, holding and gripping small jobs in wiring assembly and repairing work.

Ring spanner set (Fig 17)

Fig 17



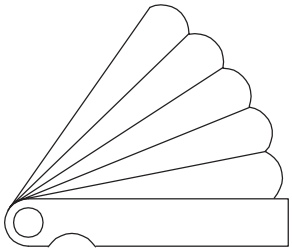
RING SPANNER

ST20N110674H

A spanner with an enclosed opening that grips the faces of the bolt or nut, the recess is generally a six-point or twelve-point opening for use with nuts or bolt heads with a hexagonal shape. The ring spanner is used in places where the space is restricted and where high leverage is required.

Feeler gauge (Fig 18)

Fig 18



FEELER GAUGE

ST20N110674I

These are used to measure the width of the gap between two parallel flat surfaces. A feeler gauge is a narrow strip of steel sheet of a given thickness.

A complete set consists of number of gauging blades of different thickness from 0.03 to 1 mm assembled together and fulcrum med at one end. Their use depends entirely upon the sense of feel of the user.

The blades are made of heat treated bright polished steel with tensile strength of 70 kg /cm$^{2.}$ Generally, the blades are 100 mm long and 12 mm wide at heel (fulcrum end) and tapered from the outer half of their length so that the width of the tip is approximately 6 mm (Fig 18.13).

These are hinged in a sheath on a screw and a nut of such a design that each blade is removable. The nut is in the form of bush passing through both sides of the sheath and forms a hinge or a fulcrum upon which the blades can rotate. The sheath is so designed as to fully protect the blades when not in use. The different blades should be assembled in such a way that each thin blade is given maximum protection by interleaving it between two thicker blades.

The maximum deviation in thickness of blade should not exceed 0.004 mm for blades up to 0.3 mm thick, and 0.006 mm for blades over 0.3 mm thick.

Tachometer (Fig 19)

Fig 19

TACHOMETER

ST20N110674J

A tachometer (revolution-counter, tach, rev-counter, RPM gauge) is an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated analogue dial, but digital displays are increasingly common.

Auxiliary blow room machines

Objectives: At the end of this lesson you shall be able to
- **state the setting of blow room line**
- **state about cages, condensers, distributors, filters and micro dust separators**
- **state about gravity traps and dust extraction**
- **state about cellar less blow room, dust filter bag, dust filter drum and dust trunk**
- **state about two way distributor and by-pass arrangement in blow room line.**

Delivery cages: Delivery cages are useful in the pneumatic arrangement of conveying cotton from one point to another and also in the extraction of dust fine pepper trash carried by the air system.

Condensers: The cotton has to pass through a number of machines in blow room process before it is sufficiently opened and cleaned. The transport of fibres from one machine to another often through pneumatic pipes with the help of condenser and fan.

Distributors: The production capacity of the opening and blending section is normally twice or thrice depending upon the production of finisher scutchers. Therefore the material has to be distributed uniformly to two or sometimes three finisher scutcher with the help of distributors.

Filters: During the beating and opening action of the machines large amount of dust is generated. This has to be removed affectively by means of filters for two reasons.

1 To safeguard the health or the operatives.

2 To reduce the micro dust content in the cleaned cotton

Micro dust separators: The removal of micro dust has acquired great significance since the introduction of open end spinning. Modern blow room lines have been incorporated with many special devices to extract micro dust.

Gravity traps: Ginned and unginned seeds in cotton are one form of trash which must be removed at the blow room itself failing which they may cause lot of difficulties in further spinning process due to generation of oil while crushing between calendar rollers at the scutchers. It is found that gravity traps can effectively remove impurities such as seeds, stones and other heavy particles.

Dust extraction: During the beating & opening action of machines, large amount of dust is generated. This has to be removed effectively for 2 reasons.

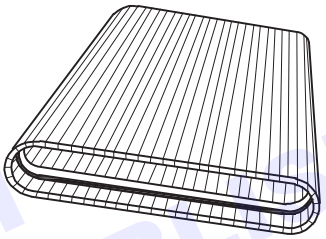
i To Safe guard the health of operative.

ii To reduce, the micro duct in cleaned cotton.

- No. of fans are used in the scutcher carry the cotton from one machine to another.
- The air is heavily charged with dust & short fibres.
- This dust laden air exhausted by the fan is blown into cellar, which is the dust room under, the scutcher.
- Cellar is necessary to collect the dust which the air carries. If the fans exhausted directly outside, the Mill yard would be very dusty.
- Leading from the dust room (Cellar) there is a dust chimney dust tower) through which the dust air passes from the dust room to outdoors.

Mechanical transport (Fig 1 & 2)

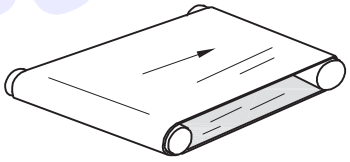
Fig 1



FEED LATTICE

ST20N118011

Fig 2



CONVEYOR BELT

ST20N1118012

This comprises conveyor belts, lattices and spiked lattices. Conveyor belts permit high speeds.

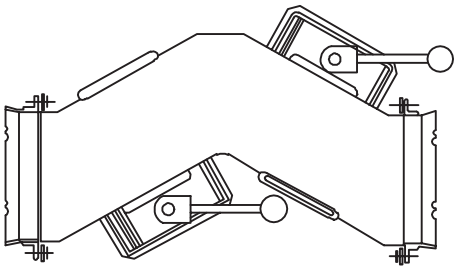
They are used as collector belts in mixing batteries or as in feed or horizontal conveyors in openers and hopper feeders. They have the disadvantage that sometimes the material slips on them.

The forwarding effect is often better on lattices. They are used as horizontal feed lattices and as short transport belts within a machine. They are endless and consist of circulating belts to which closely spaced, individual hardwood crossbars are screwed or riveted. Today's conveyor belts no longer use crossbars. The belts consist of different layers with a fiber-free surface. The belts are driven by shafts that simultaneously serve for belt tensioning. The forwarding speed is usually very low.

Inclined lattices or spiked lattices are the same in terms of structure and drive. However, steel spikes are set at an angle in the crossbars, so that the raw material can be transported upward. Inclined lattices are operated at speeds up to 100 m/min. They usually interact with evener rollers, and thus function mainly as opening devices.

Magnetic metal extractor (Fig 3)

Fig 3



MAGNETIC METAL EXTRACTOR

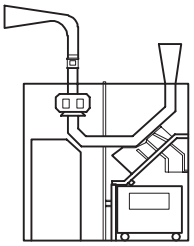
ST20N1118013

Magnets have been used for decades in ducting or in special parts of machines in order to eliminate pieces of ferrous material. The most effective form of device is a knee-bend within the feed duct having permanent magnets at the two impact surfaces. When tufts are driven against the magnets, ferrous particles are retained and can be removed from time to time.

Magnetic extractors provide only a partial solution to the problem because they can eliminate only magnetizable metal particles, and let all others pass. Electronic extractors are needed to remove the other particles, too.

Electronic metal extractor (Fig 4)

Fig 4



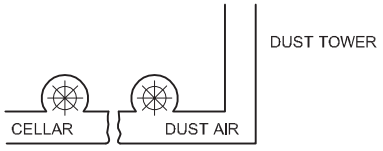
ELECTRONIC METAL EXTRACTOR

ST20N1118014

The material is fed from an opening machine such as Blendomat (1). The next device, normally a fan in front of the mixing machine, extracts the material by suction (5). Spark sensor (2) detects smoldering material and metal detector (3) any kind of metal. In either case, active operating flap (4) is opened by a signal from the detector and feeds the material into the receiving waste container, which is equipped with a fire extinguisher device (7) and a temperature sensor (8) to monitor the container.

Cellar less blow room (Fig 5)

Fig 5



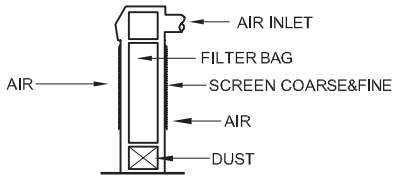
CELLAR LESS BLOW ROOM

ST20N1118015

In cellar less blow room line Filters are introduced to maintain the atmosphere free from dust.

Dust filter bag (Fig 6): By recirculating the filtered air to the room, it maintains the even temperature and R.H% of the room and reduces the humidification cost. , Further, short fibres are collected as saleable waste. Recirculating air Filter

Fig 6



DUST FILTER BAG

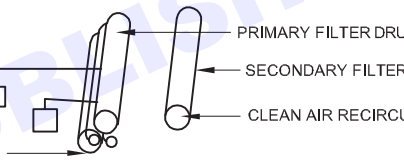
ST20N1118016

This filter receives the dust-ladened air from the fans of scutcher at the top. Air strikes against a baffle and travels downward within the filter case. The sides of the filter are covered with a coarse screen. Outside of this screen is a second screen with fine mesh.

Air laden with dust is drawn by the fan from blow room via under floor or over head ducting and is then blown into primary filter rapidly. Fine screen collects the dust and it built up between fine and coarse screen which form a filter, permitting the filtered pure air to pass out. Dust inside the screen droops into bottom where there is a compartment designed to collect. Fine screen collects the dust and it built up between fine and coarse screen which form a filter, permitting the filtered pure air to pass out. Dust inside the screen droops into bottom where there is a compartment designed to collect it.

Dust filter drum (Fig 7)

Fig 7



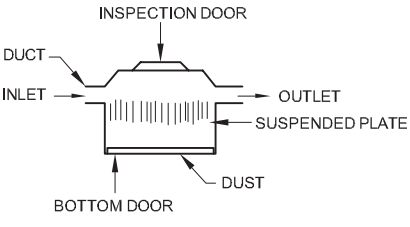
DUST FILER DRUM

ST20N1118017

Fibrous waste being deposited in a thick blanket on the surface of the drum, the filtered air with residual dust emerge axially from the primary filter drum and pass radially into the secondary filter drum, which is covered with thick porous filter medium. Clean air emerges axially from Second filter drum can returned to the department directly or via the air conditioning system filter unit.

Dust trunk (Fig 8)

Fig 8



ST20N1118018

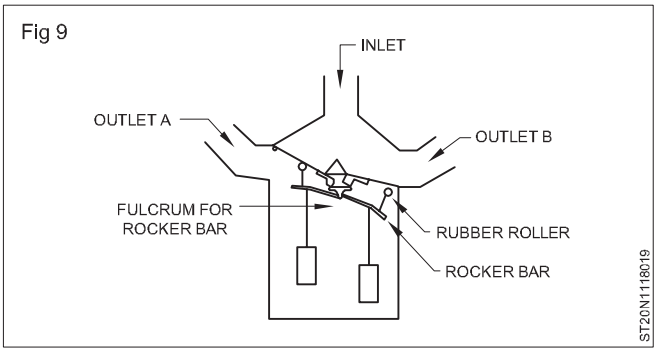
It is a minor cleaning point where the lighter impurities, fine dust and floating fibres are extracted from the cotton by the air current. A No. of dust trunks are provided in series in pneumatic conveyer pipe. During the passage of cotton pneumatically in conveyor duct, the slight resistance of the suspended plate upon the cotton causes the light impurities to deposit/fall under the trunk.

Dust separation by grid bar: Dust & other trash particles which are extracted through spacing of the grid bar of Various beaters & falls into the dead air box(under the

grid, not in cellar) This droppings & dust has to be collected / cleaned frequently (every] shift).

Two-way distributor (Fig 9)

Fig 9



Average production of the opening and cleaning line is 700-800 pounds (lbs) per hour. This is approximately twice the production of the scutcher line. So, it is common practice to distribute the cotton from one opening & cleaning line into two or three scutchers. This is achieved by distributors.

When hopper feeder served by outlet 'a' (to scutcher: 1) is full: Swing door of the reserve bin moves backwards. Micro switch is operated.

Electric circuit energizes the solenoid: Solenoid holds down the right hand side plunger (Refer fig) This causes the rubber covered roller on the left and rocker bar to make contact and lift the valve door of the cutlet A. the valve door on the outlet 'A' is closed and feeding to the hopper feeder served by outlet A is stopped. Now all the cotton will flow through outlet B which distribute to hopper feeder of scutcher No: 2

Similarly when hopper feeder served by outlet 'b' (scutcher; 2) is full: Solenoid holds down the left hand side plunger and closes the valve door of the outlet 'B'

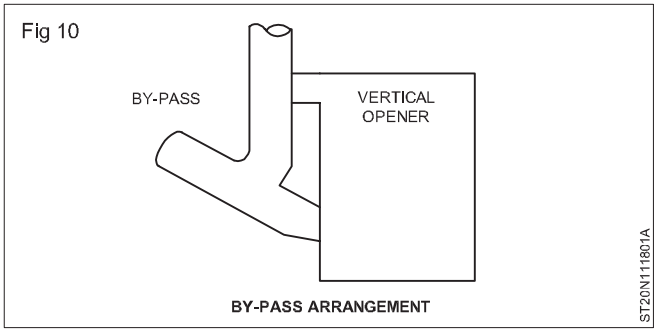
When both outlets are closed

Further circuit is closed, which stop the delivery of cotton from opening line and when hopper reserve bins begins to empty, the circuit is opened and switch on the opening line is automatically operated and feeding recommences.

When both outlets are opened: Stock is distributed equally between two hoppers of scutcher

By-pass arrangement (Fig 10)

Fig 10



- Number of beating points required for low grade cotton with high trash content (Coarser counts-below 40s) = 7
- For medium grade cotton with medium trash content (medium counts- 40s to 60s) = 5
- For good grade cotton with low trash content (Finer counts-above 60s) = 3

The No. of machine should be provided for opening and cleaning is desired by the trash% in the cotton and other important fibre qualities. In such a case, some of the machine will not be needed. During processing fine mixing, vertical opener is not recommended, Porcupine beater need not be used while processing viscose, rayon.

While processing blends such as polyester cotton, Viscose cotton, poly/viscose & finer cotton the No of beating points are reduced. This necessitates an arrangement for by passing a particular harsh machine, this is achieved by providing by-pass arrangement in the opening & cleaning line (in major / harsh opener). By pass arrangement is very important to process various types of cotton in the single/same blow room line to increase the versatility of blow room line.

Settings of blowroom and scutcher

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

- **state about scutcher and objective of scutcher**
- **list the types and working principle of scutcher**
- **state about automatic scutcher**
- **state about piano feed regulating motion and its principle**
- **state about lap hardening mechanism and lap length measuring motion**
- **state the principle and design of cone drum**
- **state about automatic lap doffing system**
- **state the defects and causes in blow room**
- **state the function of PIV gears.**

Scutcher: In addition to the other functions of blow room machines, the scutcher has to form a lap for supplying material to the cards. Previously, most of these machines were double scutchers; they had two beater positions and two pairs of perforated drums. Machines delivered in recent years have been almost exclusively single scutchers: they have only one beater position (Kirschner beater) and only one pair of perforated drums or even a single drum.

Objectives of the scutcher

i To further break down and clean the cotton tufts by a beater

ii To convert the mass of cotton fibres into a uniform thick sheet of cotton both longitudinally and transversely and wound in the form of a compactly built lap.

Following are 3 types of scutcher

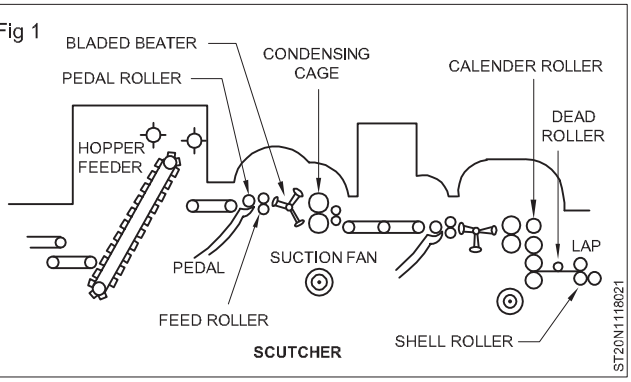
1 Breaker scutcher

2 Finisher scutcher

3 Single process scutcher.

Working system (Fig 1)

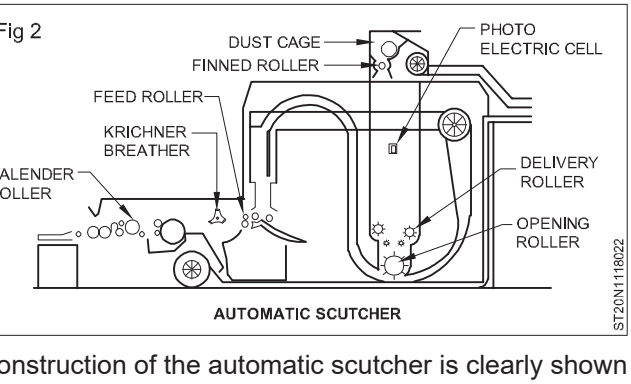
Fig 1



Tow way distributor distribute the cotton from opening and cleaning line of Blow room line into two scutcher equally. Condenser with fan Suck the material from two way distributor and feed it to the reserve bin of hopper feeder. Hopper feeder (with Reserve feed & delivery) mix, comb, open and clean the cotton. At last it provides uniform feeding of cotton upon the lattice, across the full width of scutcher. Pedal feed motion control the feed and maintain the weight of cotton fed per unit time as constant for lap weight uniformity. 3 Bladed Beater Open and clean the cotton. Cage with fan Suck the material from Bladed beater, extract the lighter impurities and it provide uniform feeding as a 3 sheet form on lattice across the full width of the scutcher. Again one set of pedal feed motion, 2 Bladed Beater & cage with fan is placed and above mentioned works are achieved/repeated. At last, calender Roller section Compress the sheet of which is delivered from cage. Compressed sheet of cotton now pass under the dead roller, and is wound on lap roller, which is called lap.

Automatic scutcher (Fig 2)

Fig 2



Construction of the automatic scutcher is clearly shown in the figure. Condensers with fan suck the material from opening line and feed to reserve trunk of the pneuma feeder. An adjustable photo electric cell in the reserve trunk monitor the height of fibre and signals stop or start commands to the preceding machine.

Delivery roller guides the material to a coarse spiked opening rol1er without compressing it too much. This opening roller beat and opens the cotton and then flings the tufts into an air current generated by a fan.

The air current transports the tufts into the feeding trunk. There they are compressed uniformly across the full width by the pressure of air current.

Feeding trunk width can be adjusted according to the fibre bulkiness. An adjustable, sensitive pressure switch located within the feeding trunk monitor the height of fibre and switches off or on the material transport from delivery roller.

Much narrower limits of density of stock are obtained in the feeding trunk than unstable condensation of a conventional hopper feeder. So, scutcher receives a very regular feed in its absolute weight in width and length. No nep formation due to absence of spiked lattice.

Uniform feed to the scutcher due to effective control by P.E. Cell in the reserve trunk and pressure switch in the feeding trunk. Two delivery rollers in the scutcher take over the material from the feed trunk. They pass it on to the feed roller which in turn passes it to the sensing levers and the kirschner beater.

An integration of the sensing lever movements controls the position of the cone regulator. The movements of the cone belt from its basic position actuate a differential drive. It regulate the speed of the feed roller in a definite ratio to the constant speed of v-belt drive for the transfer of drive to the feed roller.

Press button switches are provided for the regulations of the lap weight per yard through servo motor on the P.I.V. drive. The current position of the PIV drive and degree of regulations are clearly indicated on a scale. It is possible to determine the setting very quickly in case of blend or count changes overs. In case of fully automated scutcher, only the basic lap wt/yard is set by using corresponding press button switch. All later adjustments are carried out by the lap weigher.

The fine opening & ultimate cleaning is achieved by the mild combing action of kirschner beater on cotton tufts. The grid under the kirschner beater can be adjusted by manual setting of a hand lever provided with an index plate, and completely closed while processing synthetic fibres. The first four of ten grid bars are separately adjustable.

A compact, one layer lap collects on the dust cage with a large surface area. In this manner with a dia of 55 cm cotton lap of 40 kg and synthetic fibre lap of 24 kg can be prepared which unroll without any peeling on carding. A strong fan exhausts the cage diametrically across its whole width. This ensures a uniform distribution of the material across the cage and also a careful extraction of the dust.

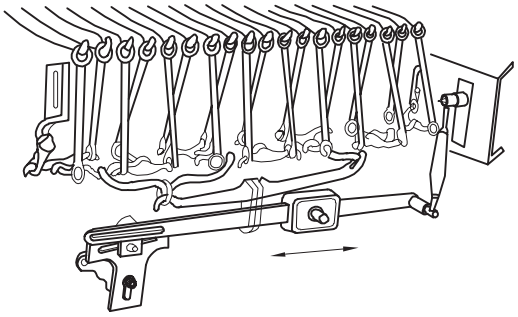
The sheet of cotton delivered from the cage deliver roller runs almost horizontally through the calender, as shown in the fig. By this arrangement a wider surface pressure is achieved, enabling higher compression of the sheet of cotton (LAP) without endangering the fibres. And also

eliminate cracking of lap surface and false draft which occur when lap would have to run around the calender roller in a vertical position in the conventional scutcher.

The calender rollers are loaded pneumatically. This ensures always even pressure on both sides. The applied pressure can be read on a monometer and steplessly regulated to 6000 KP by a pressure reduction valve. The machine stops on the entry of thick places of foreign bodies between calender rollers. This eliminates break downs. Rack heads are pneumatically loaded. The applied pressure can be steplessly regulated up to 100 KP and can be read on a manometer.

Piano feed regulating motion (Fig 3)

Fig 3



ADJUSTING THE HEIGHT OF FULCRUM

ST20N1118023

Object of the pedal feed motion is to maintain the weight of cotton fed to the beater in a scutcher from feed roller as constant per unit time.

The sheet of cotton is fed to the beater of the scutcher through pedal and pedal roller and pair of heavily weighted feed rollers. 16 pedals are provided below the pedal roller. They are swinging depending upon the thickness of the cotton sheet. All the pedals are connected to link system and then to the cone drum regulating box as shown in fig. Bottom cone drum (driving drum) get power from motor. Top cone drum (driven cone drum) drive the feed roller, through worm gear.

Principle: Due to the thick and thin places of cotton, the movements of pedals are utilized to change the position of the belt in the cone drum by means of levers to change the speed the feed roller according to the thick and thin places of cotton in order to keep the feed constant per unit time.

Working of the pedal feed motion: If thick layer of cotton is going through pedal roller, the speed of the feed roller is reduced and increased in the case of thin layers of cotton is fed in order to keep the feed constant per unit time.

If a thick layer is going through the pedal (1 & 2) roller particular ends would be depressed and these pedals are fulcrumed as shown in fig. This causes the ends A, B, C, G, K, N and P will raise One end of the common lever is fulcrumed and also dead weight is provided on another side. Because of these, the upward movement of the p will depress X and shift the belt on the smaller end of the driving cone drum (bottom cone) and so decreases the speed of the top cone which drive the feed roller slowly.

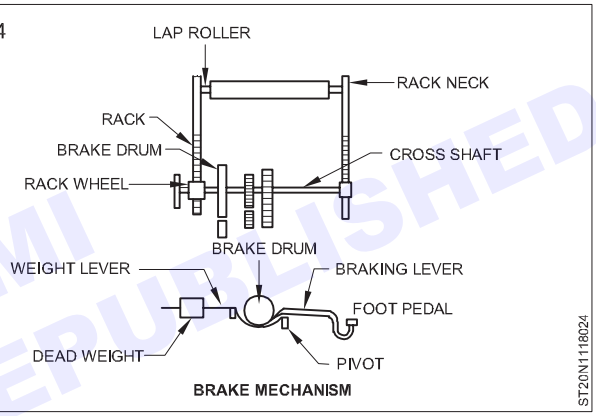
Similarly if a thin layers passes through the pedal (no. 1 & 2) the ends A,B,C,G,.K,N and P will fall and end X will rise and shift the belt on the bigger end of the bottom cone and so increase the speed of top cone drum, which drive the feed roller with fast.

If 'A' rises and 'B' falls equally, the point 'C' remains stationary and no change takes place. If half the pedal ends moves up and other half down, the centre 'N' is not influenced and no change takes place. If all the pedals rise at once, the whole system of lever and links move bodily upwards except center M, and it all falls if the pedal ends are all depressed.

The feed roller rotates in the same speed without any variation, when average weight of the cotton sheet fed to the beater is same so pedal feed regulating motion helps to produce uniform weight per yard of lap, and we can get even lap hank with low C.V % of metre to metre lap weight variation.

Lap hardening or brake mechanism (Fig 4)

Fig 4



BRAKE MECHANISM

ST20N1118024

Objective: To rotate the lap spindle under tension and get the hardened lap or compact lap.

To stop the machine after one lap is completed and to doff the lap and then restart the machine, lap spindle at both ends are pressed by racks.

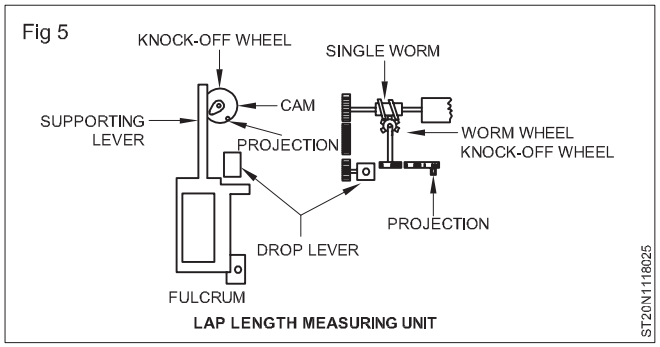
The brake drum against which a brake pad, fitted with suitable brake lining, is made to press by means of the dead weight which adjustable. This dead weight is carried on weighting lever, pivoted at x and with a high ratio of leverage in exerts considerable upward pressure on braking lever which has its fulcrum at N and which carries the brake pad.

The forward end of the weighing lever has a foot pedals which when depressed by the operative, releases the braking pressure on the drum and so permits the operative to raise or lower the lap racks for doffing and restarting.

As the lap increases in diameter, the racks lift, so rotating the pinion and transmitting motion through the gears to the brake drum, which has to turn against the brake action, thus exerting a considerable pressure on the lap throughout the whole period of formation of lap.

When depressed by the operative releases the breaking pressure on the brake drum and so permits the operative to raise or lower the racks for doffing and restarting.

Lap length measuring motion (Fig 5)



Why lap length measuring motion is used in blow room object

i To stop the rotation of bottom calender roller and feed roller, after a particular length of lap is completed,

ii To measure the lap length and change the lap length as per out requirements by changing the lap length change wheel.

The weight per yard of the lap is based on total weight of the lap, on the assumption that the length of the lap is kept constant. If there is any small variation in the yardage of lap, it is reflected in the total weight and weighing to determine the uniformity of the lap is rendered valueless. If the operator assumes that his measuring motion is accurate and discover that the weight of lap is excessive, he will change the evener motion (feed control system) to secure a lighter lap and meet his standard. However, if the additional weight was due to inaccuracy of the measuring motion and hence to excess yardage, the operative has used the wrong remedy he is now producing a lap which is less than required weight per hard.

Working: Figure indicates the position of various parts in this mechanism. As the bottom calender roller rotates the side shaft gets its movement, through the worm and worm wheel connection, and in turn the knock-off wheel (with cam and projection on its surface) is also getting its movement through the change wheel.

A support lever which supports the drop lever is arranged very close to the knock- off wheel. The drop lever will decide the position of the drop shaft end wheel which drive the bottom calender roller. When the knock off wheel rotates the projection and cam on it slowly press the supporting lever and finally move the supporting lever away after the complete of 1 rotation of the knock off wheel. So the drop lever loses its position from supporting lever and drops down and drop wheel gets disengaged from the carrier wheel and the bottom calender roller wheel, so bottom calender roller rotation is stopped.

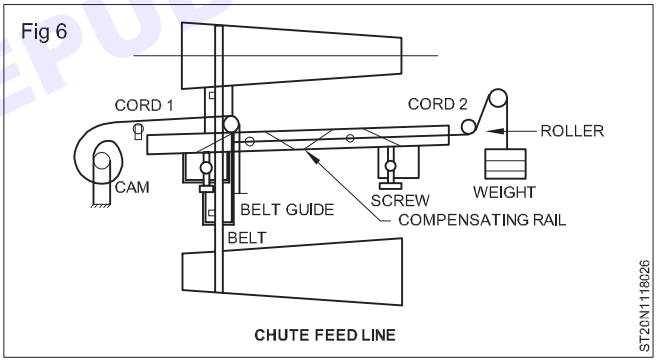
By means of separate lever connection, the feed roller also stopped by disengaging the clutch unit which drives the feed roller. After doffing the lap, again the drop lever is kept in position on the supporting lever and thus drive to BCR is engaged and next lap starts to wind on lap roller.

For one rotation of the knock off wheel one lap is completed. To find out the length of lap, we should know the length delivered by a calender roller for one rotation of the knock off wheel.

Principle of cone drum: The action at the point of detection of feed thickness. Suppose that a 1/8" thickness of cotton is fed between feed roller and pedal represented by A 1 and that of 6 in length AB, length AB is passed forward in one sec. To obtain regularity an equal quantity of cotton must be fed in every sec and it will readily be seen that, if the thickness of the cotton is increased to ¼" as it A2, then to maintain the same amount of cotton passing forward per sec the length must be halved as at AC. To do this, the speed of the feed roller must be reduced accordingly. If another 1/8" is added to the thickness being fed making 3/8" as at 4 then to deliver the same amount of cotton as when the thickness is only 1/8", the length delivered must be 2" as at a AD. Continuing to add to the thickness being fed, the fed, the speed of the feed roller must be reduced in inverse ratio. Substituting 1/8" by 1 thickness and letting the speed of the feed roller be 1, speed of the feed roller for the different thickness will be

Thickness	Feed roller speed
I (1/8")	1
II (1/4")	1/2
III (3/8")	1/3
IV (1/2")	1/4
V (5/8")	1/5
VI (3/4")	1/6

Design of cone drums (Fig 6)



To design a pair of cone drums which will produce the requisite variation of feed roller speed to maintain a given quantity of cotton, it is assumed that the minimum thickness is ¼" and the maximum thickness of 1" with the bottom driving cone drum rotating at a constant speed of 100 rev/min.

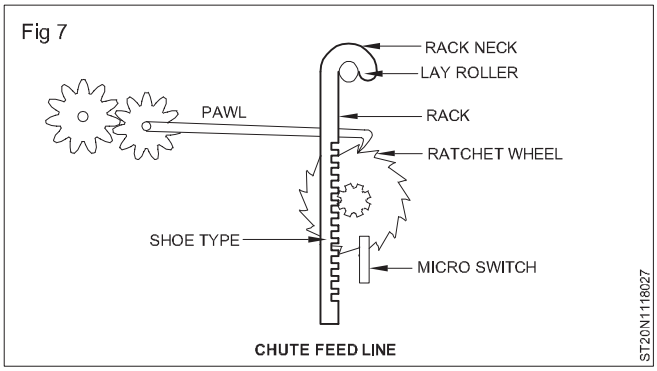
The speeds of the feed roller to compensate for variations in thickness can be obtained as follows

Thickness of feed (inches)	Top cone speed
1/4"	200 rpm
1/2"	100 rpm
3/4"	66" 2/3
1"	50"

Automatic lap doffing (Fig 7): The required length of lap is pre-set by means of counter with decimeter setting. The impulse for lap change is given by limit switch, as

soon as the lap attains a definite diameter. Immediately upon reaching the required lap length, the counter jumps back to preset length.

Fig 7



CHUTE FEED LINE

A 0.75 kw, 105 RPM reduction gear motor accelerate the lap roll in order to cut the lap. Simultaneously the pressure cylinder for the loading of the rack heads is counter ventilated. The rack heads rise and deliver the completed lap into the lap tray. The lap spindle from the stand-by position is placed on the forth coming lap. The beginning of the lap is tightly wrapped around the lap spindle. Rack heads are reloaded. The preparation of new lap begins.

By ventilating the pressure cylinder, the lap tray together with finished lap is moved side wards. The lap together with the lap rod is completely stripped off the lap spindle. The lap Spindle rolls to the stand-by position where it waits ready for next lap doff.

Lap rod inserter: During the sideward movement of lap tray, the lowest lap rod from the rod magazine, that accommodate 20 lap rods, is released and inserted into the lap spindle of the lap under preparation during the return movement of the lap tray.

Lap weighter: The lap rolls into the tray of a lap weigher or a lap reserve tray the lap weigher register the lap weight deviation from the nominal weight on the register tape of the recorder and gives the impulse to the lap colour coder.

Lap colour coder: Every lap receives a washable colour spray marking on its side. This marking may be given a definite meaning eg: blend, the number of the scutcher etc., laps out of tolerance receives an additional marking with another colour. Simultaneously it indicates the deviation on a dial. Should the deviation from the nominal weight be large than the predetermined tolerance, the lap weigher gives an impulse to the servo motor and PIV gear that readjust the lap unit length weight to within acceptable tolerances.

Lap store: Depending on its size, the lap store automatically takes over 6 or more weighed laps. It is also possible to couple 2 or more lap stores in tandem. The lap store can also be connected to automatic lap conveyor system.

Defects in blow room

- Low cleaning efficiency
- High nep generation and fibre rupture
- High variability in the delivered hank
- Formation of cat's tail
- Conical lap
- Lap licking
- Patchy lap
- Holes in lap
- Soft laps
- Ragged lap selvedge

Causes and remedies in blow room line

Low cleaning efficiency: Lower extraction of wastes than required for that mixing considering the trash content is one of the main reasons for low cleaning efficiency. Increase the wastes if the lint in the wastes is normal or nil. If the beater speeds are lesser than required, we get lower cleaning. Check the beater settings and correct them if needed. Increase the space between the grid bars. Close slightly the air-inlets under the grid bars towards the cotton entry side, and open those on the delivery side. Reduce the fan speed following the beaters by 100 to 200 RPM. If the grip of the feed roller is less, we shall get low cleaning efficiency. Therefore check for the grip. Also check the sharpness of the beaters. Check the synchronisation of the machine working. The blending bale openers should work for 80 to 85% of the time of working of the final machine. If there is a back draught because of not cleaning the wastes under the machines, the cleaning efficiency shall come down.

High nep generation and fibre rupture: The main reasons are blunt beaters, burrs in grid bars, bent pins on beaters, higher beater speed, lower fan speed and excessive feed. A higher beater speed shall give more neps, if the material is not moved out of the beating area effectively. If materials return back to beaters, neps shall generate, hence check the setting of leather flaps, stripper knife etc. Excessive of soft wastes fed, and cottons with more immature fibres are major reasons for neps in opened material. Therefore have a control on the issue of soft wastes to mixing and spread them uniformly throughout the mixing.

High variability in the delivered hank: Improper levels in the hoppers, improper action of feed regulators viz, cone drums, pedals, photocells, direct driving gear motors, etc are the normal reasons for variability in delivered hanks.

Formation of cat's tail: If material movement is less and cottons are over beaten, we get this defect. By sharpening beater edges, increasing fan speeds, increasing the air in-let below the grid bar area of cotton entry, closing the striping knife and beater setting shall avoid cat's tail. The very important step in avoiding cat's tail is to avoid chocking of materials in beaters. Excessive use of cotton-spray oil, water etc., also causes cat's tails.

Conical lap: Conical laps are due to, either higher quantity of cottons coming on one side of the lap, or due to unequal calendar and rack pressures in scutchers. Ensure equal opening of air-inlets under grid bars, replace torn leather lining at the cage, clean the cage thoroughly with emery

paper, make pressure on lap spindle uniform on both the sides, remove the pedals and clean thoroughly, and check the pedals where it rests on fulcrum and also pedal fulcrum bar.

Lap licking: Lap licking can be due to excessive addition of soft wastes in mixing, higher rack pressures, lower compacting of laps and excessive dampness in cotton. In case of polyesters, this problem shall be mainly due to static charges and higher bulk of fibres. The problem of lap licking can be reduced by increasing the pressure on calendar rollers, reducing the pressure on racks, increasing the quantity of antistatic, use of roving ends or lap fingers behind the calendar roller nip, blocking of top cage and by reducing the lap length.

Patchy lap: Patchy lap is a result of unopened tufts. Ensure that the mixing is opened thoroughly, and increase opening points if feasible. Check tuft size at the delivery of each beater, and adjust the setting between feed roller and beaters, reduce the gauge between evener roller and inclined lattice, clean the cages, and increase effective suction at cages.

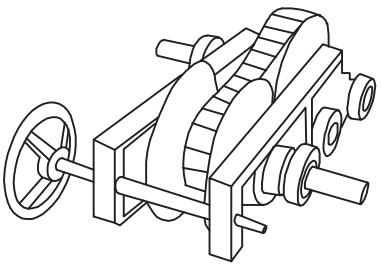
Holes in lap: Holes in the lap can be due to different reasons. Check the cages for damage, and reduce tension draft.

Soft lap: Lower calendar pressure makes the laps soft. Increase the calendar roller pressure.

Ragged lap selvedge: Ragged lap selvedges are mainly due to uneven spots at the edges. Check for the rough spots on the sides of the feed plates, leather linings for the cages, and keep the edges of the scutcher clean.

Function of PIV gears (Fig 8): Maximum Speed Setting adjusts input shaft wheels close together to form a large driving diameter. This automatically separates output shaft wheels to form a small driven diameter. Minimum Speed Setting adjusts input shaft wheels wide apart to form a small driving diameter. This automatically closes output shaft wheels to form a large driven diameter.

Fig 8



PIV GEARS

ST20N1118028

Here is the PIV Chain drive - positive power transmission yet infinitely variable - really step less speed control. The sprockets of the PIV chain drive are two pairs of the cone - shaped radially - grooved wheels mounted on shafts. The chain is made from unique links which contain packs of self - tooth - forming hardened steel slats. Each slat is free to move sidewise and conform to the tooth shape of the paired sprockets.

When the paired wheels are far apart the chain actually operates around a small diameter. When the wheels are close together the chain operates around a large diameter. This principle - varying the driving and driven diameters - is the principle on which all variable speed drives operate. Only the PIV applies the principle to a chain drive and thus combines infinitely variable speed control with positive power transmission.

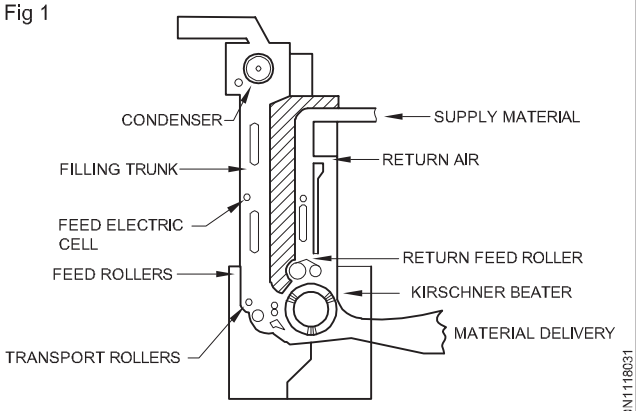
Chute feed system

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

- **state about chute feed system**
- **state the functions of photocell in chute feed**
- **state the advantage and disadvantage of chute feed system**
- **state about lap CV% control technique**
- **state the factors affecting the lap weight variations.**

Chute feed system & Flock feeder (Fig 1 & 2)

Fig 1



FLOCK FEEDER

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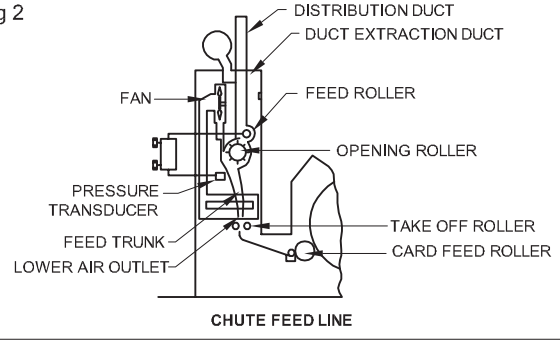
Fig 2



CHUTE FEED LINE

ST20N1118032

The material from the blow room cleaning lines is directed to the chutes which are erected behind individual cards. The material feed is regulated through a pressure transducer and a VFD drive which is fitted at the last feeding point to ensure constant and uninterrupted feed

to cards. The chute consists of top chamber, feed roller, beater, bottom chamber, delivery rollers and in built fan. The material from the chute is dropped in the top chamber through a material transport fan. The air carrying the material escapes through the perforated sheet provided in the top chamber. As the card starts, the material from the top chamber is fed into the bottom chamber through the feed roller and beater. Due to beater action, the material in the bottom chamber is in an open form.

The inbuilt fan air is directed in such a way that it compresses the material in the bottom chamber. The pressure transducer regulates the feed in the bottom chamber so that the material level remains constant during the card working. The sliver of the card is again controlled through auto leveler provided in the cards.

Function of photocell in chute feed: Photo electric cell in the filling trunk regulates the supply of material from blow room. From here, the material is fed to the kirschner beater by way of two ridged roller and two feed rollers. Krischner beater opens the cotton into desired size tufts.

Card feed chute: The feed weight at the card depends on the static pressure in the aero feed system and the chute depth adjusted. Since the pressure diminishes from one feed chute to another, the chute depth must be matched accordingly. It can be varied from 80 mm to 120 mm and is read off on the scale at the arrow mark.

Advantage of chute feed system

- Direct Feeding to cards leads to saving of man hours
- Cleaning efficiency of cards is improved due to open fibre
- The complicated scutcher machine is replaced by the simpler chute feed
- Less space is required
- Less power is required

Disadvantages or limitations of chute feed system

- Blow room should run the same number of hours per week as the cards do.
- The card production must be kept excessive to assure continuous feed to draw frame at the time of stoppages at blow room due to maintenance and other unavoidable problems
- Chute feed system control short term variation but not the medium and long term variations.
- A reliable check on the nominal count can be established in lap forming system by controlling total lap weight and C.V. value of the weight per unit length. There is no such control in the chute feeding system. Change of mixing will result in more waste in chute feed.

Lap CV% control technique: Lap rejection % indicates the variability between lap weight and CV % of 1 metre wrapping of lap indicate the variability of weight/metre of within the lap. Both these measures are particularly importance in control of yarn count.

Both the within and between lap weight & its regularity are the first steps in the control of count variation.

Factors affecting the both within & between Lap weight variations and steps to be taken to control the same are:

- In sufficient opening of cotton.
- Wide variation in tuft size,
- Variation in level of cotton in reserve box of hopper feeder
- Fluctuations in the feeding rate to the scutcher.
- Ineffective working of feed control devices like swing door, BE cell, micro switch, piano feed regulating motion etc.
- Irregular & faulty air flow on cage
- Unnecessary and frequent adjustment of feed regulating motion.
- Uneven mixing of soft waste with cotton
- Worn pedal links, knife and cone drum bearing.
- Malfunctioning of length measuring motions.
- Uncontrolled variations in atmospheric condition in the dept.

Fluctuations in the feeding rate to the scutcher are caused if the different machine's in the sequence are not properly synchronized and if the feed controls like swing door, 1 solenoids, micro switches and relays do not function efficiently. The production rate of the blending hopper feeder and other should be so adjusted that they run for about 80 to 90% of the running of the scutcher and there should always keep the hopper with cotton in 3/4 level at all time.

The cotton should be fed at uniform rate to the scutcher. The 1 front sheet of the reserve box of the scutcher Hopper feeder is capable of moving forward or backward to increase the volume of the chute, to suit the require weight per yard of lap. So front sheet setting should be corrected according to the lap hank & weight required.

Back sheet in the reserve Box of the scutcher Hopper feeder reciprocates alternatively. This ensures the maximum regularity of the feed to scutcher. So back sheet should function efficiently. Swing door in the Hopper Feeder, photo electric cell in the reserve box of hopper feeder, step cleaner should be sensitive to avoid fluctuation in the level of cotton in the reserve bin. Pedal feed regulating motion should be so set that the cone drum belt operate about the centre of the drum, otherwise full correction is not achieved. Free movement of the pedal lever and connecting rod must be ensured and care should be taken to see that the movement of the pedal levers is fully transmitted to the belt fork.

Uncontrolled variation in atmospheric conditions can lead to high lap weigh variation. with an average lap out of 16kg, the natural fluctuations in temperature and humidity may account for as much as 1/2 kg variation in lap weight merely due to change in moisture regain.

To overcome this, direct reading measuring instruments are recommended in preference to the correction table since the later assume that the lap, as it is produced, is in equilibrium with departmental humidity which is not really true because of 1. The effect of heat developed by the machine and huge velocity of air coming in contact with cotton during its passage through the machine. Large variations in weight between lap rods can give factious values of full lap weight. So, lap rods must be weighted once in three months' and standardised.

Setting of blow room line: The cotton enters the beater chamber through an in-let in free condition. Immediately, the typically shaped beater spikes start acting on the cotton. The actual cleaning takes place when the material is struck against the grid bars. In the traditional beaters, this striking action takes place only once because the cotton is passed ahead along with the rotational direction of the beater itself. Whereas, in Uniclean, like Axi-Flow, the cotton moves across the beater length and hence, during its journey, the striking spikes repeatedly strike it against the grid bars. The impurities thus released, are ejected through grid bar openings 2.

In the cleaning field, the cleaning intensity (0.0 to 1.0) is plotted against the relative amount of waste percentage (1 to 10). The 110 number of points in the cleaning field correspond to rotational speed and grid setting through which amount of waste can be controlled.

Beater speed (rpm)	Cleaning intensity	Relative amount of waste
840	0.0	0
545	0.1	1
570	0.2	2
635	0.3	3
680	0.4	4
725	0.5	5
770	0.6	6
815	0.7	7
860	0.8	8
905	0.9	9
950	1.0	10

The beater speed is directly proportional to the relative amount of waste viz. grid bar setting & its cleaning intensity. If relative amount of waste should be less then closer grid bar setting & less amount of trash extract form raw material. If relative amount of waste should be more then open grid bar setting & more amount of trash extract with more good fibre loss from raw material (cotton).

The cleaning Intensity controls both the speed of beater & compensatory setting of grid bars. Increasing the cleaning intensity increases the trash remove in raw materials.

The waste rate changes the grid angle to remove more or less good fibre in trash particles. The material is blown to the Unclean & is circulated seven times inside the machine by the hooks on the drum. The clean fibres are sucked from the machine by transportation fan. The optimum cleaning means maximum cleaning performance, minimum loss of good fibres, a high degree of fibre preservation and minimum nep generation.

Type and setting of grid: Also wider setting is recommended when a very heavy feed is used, so as not to crush the fibres. Wider setting between stripping rail and beater causes unnecessary reprocessing of fibre in the beater section, because of this over treated cotton or repeatedly beaded cotton, curly cotton is produced. Inclination of the grid bars are so arranged that the resistance to the movement of cotton gradual1y decreases, from feeding end to the delivery end. Setting between grid bar and beater will be gradual1y increased from first grid bar to the last grid in gradual stages.

Setting between beater blade and grid: Too close setting will tend to curl the cotton and pass too much good lint through grid bars. If this setting is wider, the action on the cotton will be less which affects the opening action. The beater can be raised or lowered to alter the setting between the striker tips and the grid bars surrounding the beater.

Angle of grid bar: It should be such that the maximum trash extraction is obtained with minimum lint loss. If the angle is too wide - There will be loss of good fibre. If it is too narrow cleaning efficiency is affected. Hence adjustable grid bars have been introduced in latest models, By means of proper adjustment, the optimum angle can be obtained by trial to suit the particular grade of cotton being processed.

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Relation between beater speed and cleaning intensity

Grid bar setting

Setting <1> Low: (Fig 1)

Grid closed, lowest waste rate

Setting <10> High: (Fig 2)

Grid open, highest waste rate

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By means of proper adjustment, the optimum angle can be obtained by trial to suit the particular grade of cotton being processed.

Types of fibre: Synthetic fibre need only gently opening does not require beating action because fibre does not contain any trash particles. Natural fibres need both the opening and beating action trash particles is will be more. The stable lengths also determine opening and cleaning actions. Long stable cotton with low trash would require lesser beating and more opening than short stable, trashy cotton. Synthetic fibres require no beating and only gentle opening.

Action of air current: If too strong - Cotton will raise and pass through too and affect the opening and trash extraction. If too weak - Cotton will move slowly and will be over treated. This may give good opening but there is a danger of fibre damage and production of curly cotton.

Settings

- Setting between the beater and feed roller
- Setting between the beater and first grid bar
- Setting between the beater and last grid bar
- Setting between the stripping rail and the beater
- Setting between the bottom of the feed roller to first grid bar

A wider setting is mainly used for long stapled cottons to prevent too severe treatment of the fringe. If a very heavy feed is used, the settings should be wider, so as not to crush the fibres too much between the beater and the feed roller or pedal, which would cause nep and broken fibre.

Function of various motors and door stop motion switches

Refer to Exercise 1.10.67-79

Determination of CV%, cleaning efficiency, production and trash % of blow room machine

Objectives: At the end of this lesson you shall be able to
- **state about CV% and cleaning efficiency**
- **state about production and trash % of blow room machine.**

Coefficient of variation: A frequently used relative measure of variation is the coefficient of variation, denoted by CV. This measure is simply the ratio of the standard deviation to mean expressed as a percentage.

Coefficient of Variation, C.V. % = (S.D.X 100)/Mean

When the coefficient of variation is less in the data it is said to be less variable or more consistent. The CV% expression is particularly useful in evaluating the precision of tests having different mean and standard deviation values.

Cleaning efficiency: It means the cleaning performance of cotton with extracting trash from material. Cleaning efficiency of the machine is the ratio of the trash removed by the machine to that of total trash fed to the machine, expressed as percentage.

$$\text{Cleaning Efficiency \%} = \frac{\text{Trash in the feed material - Trash in the delivery material}}{\text{Trash in the feed material}} \times 100$$

Production of blow room machine =

$$\text{Production} = \frac{\pi \text{ x Diameter of BCR x Speed of BCR x 60 x 8 x 90}}{\text{36 x 840 x Lap hank (Ne) x 2.205 x 60 x 8 x 100}}$$

Trash and lint content

$$\text{Trash content \%} = \frac{\text{Weight of trash}}{\text{Weight of sample}} \times 100$$

$$\text{Lint content \%} = \frac{\text{Weight of lint fibre}}{\text{Weight of sample}} \times 100$$

Basics of carding and wire specifications

Objectives: At the end of this lesson you shall be able to
- **state the introduction and objectives of carding**
- **state the purpose of carding**
- **state the function and passage of material through carding**
- **list the different action in carding machine**
- **state about heel and toe mechanism.**

Introduction: Carding is the most important process in spinning. It contributes a lot to the yarn quality. The following process parameters and specifications are to be selected properly to produce a good quality yarn with a lower manufacturing cost cylinder wire (wire angle, height, thickness and population) flat tops specification licker-in wire specification doffer wire specification feed weight draft between feed roller and doffer cylinder grinding doffer grinding flat tops grinding cylinder, flat tops, doffer wire life licker-in wire life cylinder speed flat speed licker-in speed setting between cylinder and flat tops setting between licker-in and feed plate setting between licker-in and under casing elements like, mote knife, combing segment etc. Setting between cylinder and doffer setting between cylinder and back stationary flats setting between cylinder and front stationary flats setting between cylinder and cylinder under casing.

Objectives of carding

- Opening into individual fibers
- Elimination of impurities
- Elimination of dust
- Disentangling neps
- Elimination of short fibers
- Fiber blending
- Fiber orientation
- Sliver formation

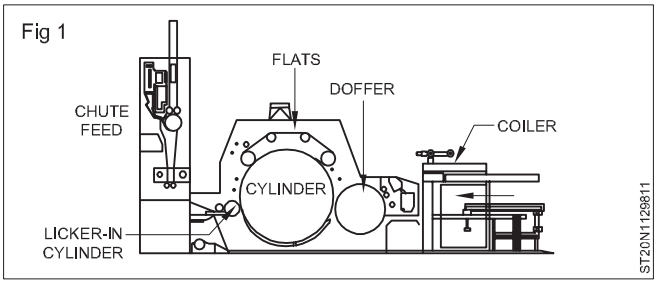
Purpose of carding: Chiefly, carding should separate the flocks into individual fibers. Additionally, carding results in cleaning, reduction of neps, aligning, blending, and elimination of some short fibers. The elimination of short fibers must, however, be viewed in proportion.

The main eliminated material is in the flat strips. Assuming flat waste at 1 to 2%, with about half in the form of short fibers there is such a minor percentage of short fiber elimination that it could hardly be measured with the current coarse staple measuring equipment. The operation of carding is performed with the aid of oppositely disposed sets of teeth or small wire hooks.

Passage of material through carding machine (Fig 1)

Material passage: The material is passing through various zones in the carding machine such as

Fig 1



Feed zone: (Chute device to feed roller), This consists of feed arrangement, card mat opening roll and chute assembly. In the feed roller-taker-in zone, materials are stored, opened and cleaned to prepare them for intensive combing. The feed zone comprises the lap stand, lap roller, and feed roller in conventional card frames.

Pre-opening zone: (Feed roller to taker-in): This zone comprises a feed roller and spring loaded feed plate, beaters known as takers, and a motel knife for cleaning. As a result of intensive combing, 30% of the tufts are opened to single fiber in this zone, while the rest pass to the cylinder as taftlets and micro tablets.

Pre-transfer zone: (Taker-in to cylinder): The taker-in and the cylinder are in this zone, where fibers are transferred from the taker-in to the cylinder through the clothing arrangement back-of-tooth (taker-in) to point-of-tooth (cylinder). Between the taker-in and the cylinder clothing, a back-of-tooth (taker-in) to point-of-tooth (cylinder) doffing action occurs as the fiber mass on the taker-in clothing is taken up by the cylinder wire. Fiber is treated gently in this zone, and approximately draft 2 is maintained between these two carding rollers.

Carding zone: (Cylinder to flat): There are cylinders, revolving flats and fixed flats in this zone, which is the primary operating area. By arranging fibers from point-of-tooth (flat) to point-of-tooth (cylinder), the fibers are opened to single fibers in this zone. Between the main cylinder and work-in flats, the card opens to individual fibers.

Post transfer zone: (cylinder to doffer)

There are two parts to this zone: a cylinder and doffer. Despite the fact that the clothing arrangement follows a point-of-tooth pattern, fiber transfer occurs here at a slower rate. As the individual fibers attach to the cylinder clothing, they collectively form a very light web on the cylinder surface. In this zone, fiber mass transfer, doffer

web formation and consolidation take place. Through the point-of-tooth to point-of-width stripping action, the web contacts the doffer clothing, which removes the fibers from the cylinder. This area of the cylinder-doffer is called the transfer zone.

Condensation & consolidation zone: (Sliver formation): Basically, this zone consists of stripping rollers, crushing rollers, condenser and calendar rollers, coiler calendar rolls, coiling mechanism, sliver cans and can changer assemblies. In this zone, the first intermediate product i.e. A sliver can be produced which can be transported.

Functions of carding

Carding fulfils a series of precise objectives, serving

- To open the blend fibres fully and definitively
- To arrange (as far as their length allows) the fibres parallel with one another
- To remove impurities
- To blend the raw material further
- To reduce the blend to a web of fibres and to divide it up into rovings of the required count, suitable for feeding to the spinning machines.

Carding plays a crucial role in all spinning cycles, and its role is never more central than in the woollen spinning cycle, in which it incorporates different functions, all essential in order to obtain the level of quality required of the product.

Basically, passing the material over the card undoes tangles of fibres and therefore makes it possible to remove all kinds of impurity. This is achieved thanks to the action of the spikes covering the surfaces of cylinders that rotate around parallel axes.

The equipment also fulfils another function, which is both delicate and fundamental: it has to guarantee the accuracy and evenness of the web count and subsequently of the roving count. Indeed, the definitive spinning machines that operate within the woollen spinning cycle can impart only a very low draft, which means that there is practically no possibility, at this stage, of intervening to correct the yarn count.

The carding room equipment thus performs the same operations already carried out in the preparation stage, this time more thoroughly, supplying the divider with rovings of the right count.

Action in carding machine

The following 4 actions take place in a carding machine

1 Combing action

2 Carding action

3 Stripping action

4 Doffing action

1 **Combing action**: Combing action takes place feed roller and taker in. Here the pin direction of the two surfaces are the same. Combing is the straightening and paralleling of fibre and the removal of short fibres and impurities by using a comb or combs which is assisted by roller and brushed.

2 **Carding action:** Carding action takes place between flat and cylinder.

In carding action

- Directions of wire in two surfaces are opposite.
- The moving direction of roller are also opposite.
- One roller is slower and other is fast.

So carding action is known as point against point action.

3 **Stripping action:** Stripping action takes place between a. Taker in & Cylinder and b. Doffer & Stripper.

In stripping action

- Wire direction will be the same.
- Roller moving direction will be the same.
- One roller will be faster than another.

So stripping action is known as “Point back point” action.

4 **Doffing action:** This action takes place between cylinder and doffer. In this place fibre is transferred from cylinder to doffer. Low speed doffer is called fibre from high speed cylinder and makes a condensed web for formation of sliver.

Speed: Higher cylinder speed helps fibre transfer. Higher the production, higher should be the cylinder speed. Higher cylinder speed improves carding action, thereby imperfections are reduced. Higher licker-in speed for coarse fibres and dirty cotton helps to remove the trash and improves the yarn quality. For fine and long cottons, higher speed results in fibre rupture, therefore, flat waste and comber noil will be more.

Higher flat speed improves yarn quality and at the same time increases the flat waste. With the same flat speed, higher the carding production, lower the flat waste and vice- versa. Very high tension drafts will affect carding U%.

It is better to keep the draft between feed rollers to doffer around 75 to 95. The results are found better with these drafts.

Wire point density of the rollers

Base width (A1): This influences the point density. The narrower the base, the greater the number of turns that can be wound on the cylinder and, correspondingly, the higher the point population.

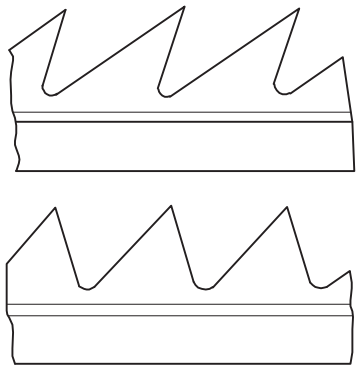
Height of the clothing (H1): The height of metallic clothing on the cylinder today varies between 2 mm and 3.8 mm. The height must be very uniform. It can also exert an influence on the population, since shorter teeth - for a given tooth carding angle - leave space for more teeth. Where shorter teeth are used, the fibers are less able to escape into the clothing during carding and better carding over the total surface is obtained. Clothing with smaller teeth is also less inclined to choke with dirt particles.

Tooth pitch (T)

The population is also determined by the tip-to-tip spacing.

Carding angle (alpha) (Fig 2)

Fig 2



CARDING ANGLE (ALPHA)

ST20N1129812

This is the most important angle of the tooth

- The aggressiveness of the clothing and
- The hold on the fibers

are determined by this parameter. The angle specifies the inclination of the leading face of the tooth to the vertical. It is described as positive (a) negative (b) or neutral. The angle is neutral if the leading edge of the tooth lies in the vertical (0°). Clothing with negative angles is used only in the licker-in, when processing some man-made fibers. Since the fibers are held less firmly by this form of tooth, they are transferred more easily to the cylinder and the clothing is less inclined to choke. Carding angles normally fall into the following ranges

Table 1

Licker-in	+5° to -10°
Cylinder	+12° to +27°
Doffer	+20° to +40°

Table 2

Metallic wire specification

Cylinder wire type	Foot Thickness (mm)	Inclination angle (o)	Ht (mm)	Points / Sq.inch
A & E Matta 0.2815 x 8	0.8	15	2.8	445
B America T2-3215 x 9	0.9	15	3.2	550
C AKALA T2-2820 x 7	0.7	20	2.8	710
D ASPERO H2-3210 X 9	0.9	10	2.8	240

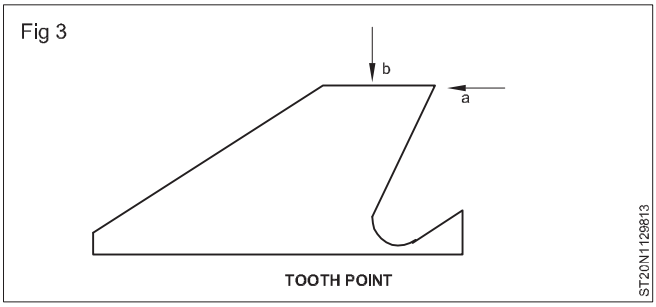
Doffer wire type	Foot Thickness (mm)	Inclination angle (o)	Ht (mm)	Points / Sq.inch
A - E EXOTICA 0.4025 X 9	0.9	25	4.0	395

Licker-in wire type	Foot Thickness (mm)	Inclination angle (o)	Ht (mm)	Points / Sq.inch
A E 5510	-	10	5.5	5 TPI
BCD D5505	-	5	5.5	4 TPI
E C55-5	-	-	5.5	3 TPI

Flat tops	Foot Thickness (mm)	Inclination angle (o)	Ht (mm)	Points / Sq.inch
A RAPPO TOP HS27/1	-	-	-	300
B RAPPO TOP HS27/2	-	-	-	400
C RAPPO FINE H27/31	-	-	-	530
D & E FICCO DIAMOND PD-32	-	-	-	240

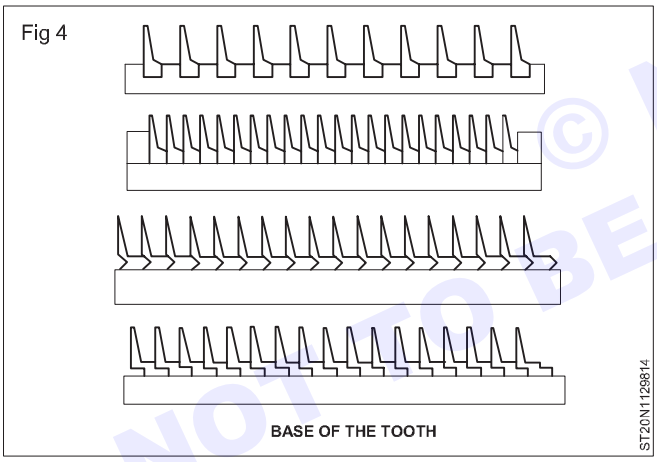
	Fibre Length	Micronaire Bale trash
A - Below 26mm.	Above 4	Above 5%
B - 26 to 30mm.	3. 7 to 4	Below 5%
C - Above 30mm.	Below 3. 7	Below 4%
D- Bleached Cotton and Waste Cotton.		
E - Synthetic Fibres. (38 to 60mm. & upto 2denier)		

Tooth point (Fig 3)



Carding is performed at the tips of the teeth and the formation of the point is therefore important. For optimum operating conditions the point should have a surface or land (b) at its upper end rather than a needle form. This land should be as small as possible. To provide retaining power, the land should terminate in a sharp edge (a) at the front. Unfortunately, during processing of material this edge becomes steadily more rounded; the tooth point must therefore be re-sharpened from time to time. Formation of a burr at the edge (a) must be avoided during re-sharpening. The tooth must only be ground down to a given depth, otherwise land (b) becomes too large and satisfactory carding is impossible - the clothing has to be replaced.

Base of the tooth (Fig 4)



The base is broader than the point in order to give the tooth adequate strength, and also to hold the individual windings apart. Various forms can be distinguished. In order to mount the wire, the normal profile ((a) for the licker-in, (b) for the cylinder) is either pressed into a groove milled into the surface of the licker-in (a) or is simply wound under high tension onto the plain cylindrical surface of the main cylinder (b). (d) represents a locked wire and (c) a chained wire. Both can be applied to a smooth surface on the licker-in; in this case a milled groove is no longer necessary.

Tooth hardness: In order to be able to process as much material as possible with one clothing, the tooth point must not wear away rapidly. Accordingly, a very hard point is needed, although it cannot be too hard because otherwise it tends to break off. On the other hand, to enable winding of the wire on a round body, the base must remain flexible. Each tooth therefore has to be hard at the tip and soft at the base. A modern tooth has hardness structures.

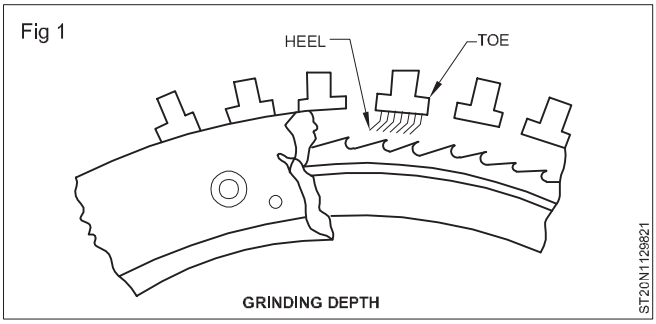
Card clothing - Technical data

Clothing - Technical data		
Fiber		**Points/inch^2**
Fine cotton	Cylinder Wire	800 to 1000
Man-made	Cylinder Wire	450 to 650
Coarse cotton	Cylinder Wire	600 to 800
Fine cotton	Flat Clothing	500
Man-made	Flat Clothing	270
Coerse cotton	Flat Clothing	350 to 400
Universal Wire	Doffer	340
Special wire for fine fibre doffer	Doffer	400
Licker-in clothing wire wounds or pins		
Cotton, general	10° positive	36
Synthetic and rayon	0° - 5° positive	27

Effect of heel and toe and components speed on web quality

Objectives: At the end of this lesson you shall be able to
- **understand the working of heel and tow mechanism**
- **effect of various component speed on web quality.**

Heel and toe mechanism (Fig 1)



The wire surface of the flat is not parallel to that of the cylinder.

Wire point setting between cylinder and flat is wider where the cotton enter and closed where the cotton leave. This arrangement is called as heel and toe arrangement. Object of heel and toe arrangement is to achieve gradual carding action at each flats.

Necessity: When the cotton is carried forward from one flat to another, the air current, centrifugal force, elasticity of fibre causes the fibre to raise from the surface of cylinder. These raised fibres would be rather severely dealt with if they were dragged into the narrow setting between

cylinder and flats. This suddenness action is avoided by heel & toe arrangement.

Effect of component speed on web quality

Licker-in speed: The variation in the licker-in speed has an effect on the variation of the neps content per gram of card sliver. When licker-in speed is raised, more flat come into touch with the fibre treatment process. So, the increase of licker-in speeds reduces the neps content per gram in the card sliver.

According to the literature, the variation in licker-in speed does affect the variation in the NRE% of card sliver. There is more beating and opening of fiber flocks as licker-in speed is increased. So, the increase of licker-in speeds leads to decrease in the NRE% of the card sliver. The U% gradually increases as speed of licker-in increases due to fiber rupture or damage. This occurs due to the peripheral speed difference between the licker-in and the cylinder as the licker-in speed changes. The hairiness increases as licker-in speed increases due the high rupture of fiber and generation of short fiber in yarn.

Effect of cylinder speed: The amount of short fiber content, trash content and trash amount of card waste increases with increase of cylinder speed.

The U% gradually increases as the speed of the cylinder is increased due to the fiber rupture or damage which is more when the speed of the cylinder is increased. The fiber state-to-state separation is more when the cylinder speed is lower.

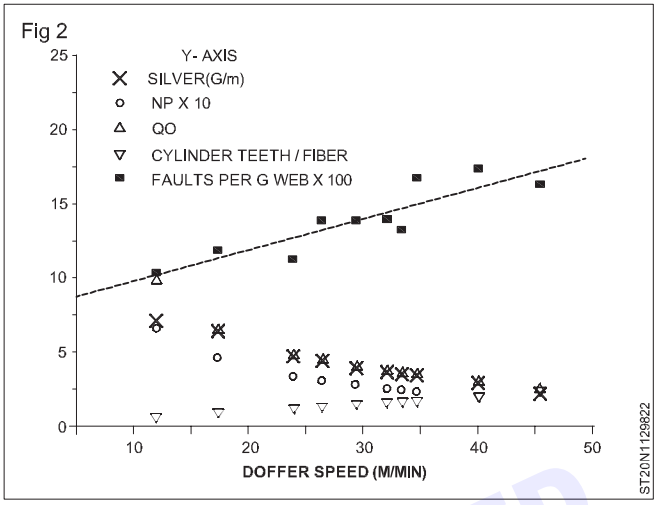
Flat speed: It is observed that as the flat speed increases, the neps content per gram decreases and NRE% increases. One reason why neps have declined is that when flat speed is increased, more number of flats comes in contact with fiber treatment operation which promotes more reduction of neps. In addition, there is a brush roller on the top of the flat for cleaning them. So, as the flat speed increases, more number of flats per time comes in contact with the brush roller, which improves the cleanness of flats and results in better carding action.

The short fiber content is decreased with the increase of flat speed. As the ML and UQL are inversely proportional to the SFC, the fiber lengths, that is, ML and UQL, increased with the increase of flat speed.

This is because the increase of flat speed reduces the neps content and short fiber content. Therefore, degree of parallelization of fiber becomes higher because of better carding action. As a result, the increase of flat speed reduces the irregularity of card sliver. Hence, it can be concluded that the increase of flat speed of carding machine reduces the irregularity of card sliver.

Doffer speed (Fig 2)

Fig 2



For a given cylinder speed and sliver count, increased doffer speed increases K and reduces Pf , whereas keeping the doffer speed and sliver count constant and increasing the cylinder speed increase both K and Pf . For constant cylinder and doffer speeds, increased sliver count was found to reduce Ka

Higher cylinder speed helps fibre transfer. Higher the production, higher should be the cylinder speed. Higher cylinder speed improves carding action, thereby imperfections are reduced. Higher Licker-in speed for coarse fibres and diry cotton helps to remove the trash and improves, better the yarn quality. For fine and long cottons, higher speed results in fibre rupture, therefore, flat waste and comber noil will be more.

Higher flat speed improves yarn quality and at the same time increases the flat waste. With the same flat speed, higher the carding production, lower the flat waste and vice-versa. Very high tension drafts will affect carding U%. It is better to keep the draft between feed rollers to doffer around 75 to 95. The results are found better with these drafts.

Note: Refer to Exercise 1.12.03, 1.12.04A

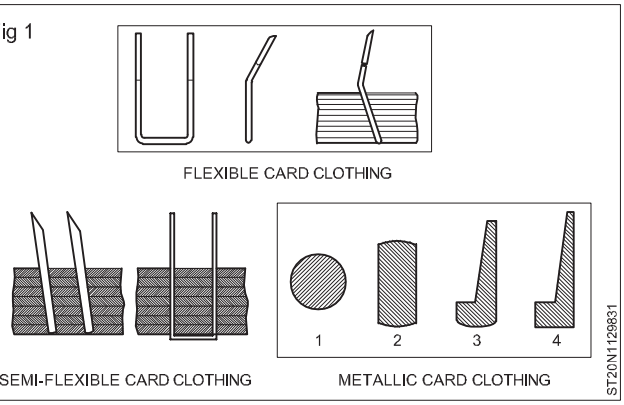
Methods of wire mounting

Objectives: At the end of this lesson you shall be able to
- **understand the types of wire clothing**
- **understand the factors deciding the wire selection**
- **recommend the wires for various fibres.**

Selection of carding clothing (Fig 1)

Flexible card clothing: The hooks are bent into a U-shape and have a knee that flexes under bending load, returning to its original position when the load is removed. They are set in elastic, multi-ply cloth backings with round or oval wire hooks. This clothing is now found only on card flats in short staple spinning mills. The point density is between 240 and 500 points per square inch on the flats.

Fig 1



Semi-flexible card clothing: The structure of this clothing is similar to the flexible type, but with more layers and sharp points and squared cross sections. In addition to not clogging with fiber, it eliminates fewer flat strippings and requires less sharpening than flexible clothing types. Additionally, they are found only on flats.

Metallic card clothing: As in a punching operation, teeth are cut at the smallest possible spacing by a continuous, selt-supporting, square wire structure. If the teeth are relatively large, such as in the licker-in, the clothing is referred to as saw-tooth clothing. Nowadays, metallic clothing is used without exception for the licker-in, main cylinder, and doffer.

Types of card clothing

Factors deciding the wire clothing selections are

1 **Type and design of card:** The selection of card cloth depends primarily on the type and design of card cloth, such as jute card, cotton card, and woolen card, for example.

2 **Rotation speed of the cylinder:** A cylinder surface is the main carding surface where fibers travel for longer distances and the fundamental carding action is carried out here, i.e. the level of signalization of fibers, the level of maximum cleaning, the orientation of fibers. In terms of cylinders to flats and cylinders to dots, the cylinder surface is active. In these three operating zones, all operations and actions are involved, so cylinder surface or momentum should be considered important. A cylinder clothing's performance determines the degree of stressing, the amount of heat generated, the amount of cleaning, the amount of signalization, and the extent of unzipping. Therefore, the rotational speed of the cylinder dictates the choice of card clothing.

3 **Degree of loading**: The degree of loading determines the service life of card cloth. It can be determined by the production rate of the material, that is, the amount of material treated per unit time by the card cloth. A high-performance card cloth is necessary for higher levels of loading.

4 **Material throughput:** The selection of a cylinder clothing depends also on the material throughput of the card cloth. Cylinder clothing has a material throughput capacity ranging from 850 tons to 900 tons to 1050 tons and 1200 tons.

5 **Raw material type:** The type of raw material can be determined by the type of card cloth to be used. For example, in the case of manmade fibers (polyester), low point density and low carding angle are recommended.

6 **Fiber characteristics:** The type of card clothing to be selected depends on the characteristics of the fiber i.e. fiber fineness, length, bulk, dirt content.

7 **Grade of yarn:** There are different grades of yarn depending on the grade of card cloth to be selected. Here the grade of yarn refers to weaving grade yarn, knit grade yarn, denim grade yarn. For finer yarn we use long staple fiber and card cloth that has a higher point density.

8 **Price of the clothing:** The price of clothing will contribute to the cost of the product. Therefore, the load life of the card cloth and thereby the cost of the product are the factors to be considered.

9 **Service offered by the clothing supplier:** The type of card cloth to be selected will be determined by the technical service offered by the supplier.

10 **Overall quality of yarn:** There is a wide range of card cloth profiles that can be chosen based on the quality level of yarn.

a Mention wire details for various fibre processed. Select the wire requirements for processing cotton, polyester, viscose and other fibres.

The formula used for calculations are

$$\text{Points Per Square Inch} = \frac{645}{\text{Base width (mm) x Pitch (mm)}}$$

$$\text{Points Per Square Centimeter} = \frac{100}{\text{Base width (mm) x Pitch (mm)}}$$

$$\text{Points Per Square Centimeter} = \frac{\text{Points Per Square Inch}}{6.45}$$

The table 1 of C60 card clothing and wire specifications are given below

Table 1

C60 Card Clothing (Points/sq. inch - Front angle					
Fibres	Very fine Yarn combed Ring	Med-Fine Yam combed Nm 100	Coarse Yarn Carded/OE	Man Made > 1.0 dtex-3.3	Man Made <1.0 dtex-0.6
Yarn count	> Nm 80 (>Ne 48)	Nm 40.... 100 (Ne 24 .... 60)	< Nm 35 (< Ne 20)		
Production	50 kg/h	>70 kg/h			
Licker-in - points	41	41-61	41-61	32	41
- angle	10 deg.	10 deg.	10 to 15 deg.	0 to 5 deg.	0 to 5 deg.
-rmp	1000-1350	1200-1600	1400-1800	?	1430
Example	Graf VE-5010V--8	Graf VE-5010V--8	Graf VE-5010V--8	Graf VD-5005V--8	Graf VE-5005V--8
Cylinder - points	800-1080	965 to 1080	600-865	450 to 650	720
- angle	30 deg.	35 deg.	30 deg.	20 deg.	25 deg.
-rmp	750-850	800-850	850-900	600-750	600-700
Example	Graf P-2030 x 0.4 CS	Graf IR 1535 x 0.4	Graf R-2030 x 0.5	Graf R-2520 x 0.7	Graf P-2025 x 0.5
Flat clothing	550	550	410	350	430
Example	Graf RSTO F55/0	Graf RISTO F55/0	Graf RSTO C41/0	Graf ILXT M35/0	Graf PT 43/0
Doffer - points	340-365	340-365	280-340	280-340	340-365
- angle	30 deg.	30 deg.	30 deg.	30 deg.	30 deg.
Example	Graf N-40308 x 0.9	Graf M-5030 x 0.9	Graf L-40308 x 1.0	Graf L-40308 x 1.0	Graf M-5030 x 0.9

Similarly, the GRAF wire recommendations for cotton, manmade fibers, blends and regenerates are shown below

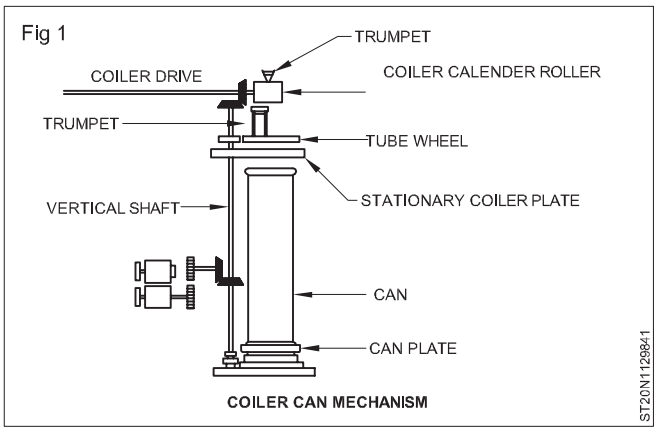
Table 2

Clothing types for the widest range of requirements for various raw materials and card capacities are available. Below is a selection from our product range									
Production		**Cotton**			**Man-made fibres (MMF)**			**Blends Co/ MMF**	**Regener-ates**
		OE-yam	carded	combed	<1,0 dtex	1,5-3,0 dtex	> 3 dtex	or MMF 1,0-1,4 dtex	
<15 kg/h	Cylinder	R-2525 x 0,6	R-2525 x 0,6	R-2530 x 0,6	R-2520 x 0,6	R-2515 x 0,7	0-3215 x 0,9	R-2520 x 0,6	R-2525 x 0,6
				R-2530 x 0,5					
	Doffer	N-40258 x 0,9	N-40258 x 0,9	N-40258 x 0,9	N-40258 x 0,9R	N-40258 x 0,9R	N-40258 x 0,9R	N-40258 x 0,9R	N-40258 x 0,9R
15-40 kg/h	Cylinder	R-2030 x 0,5	R-2030 x 0,5	R-2530 x 0,5	R-2525 x 0,6	R-2520 x 0,7	0-2515 x 0,9	R-2525 x 0,6	R-2525 x 0,6
		R-2030 x 0,6	R-2030 x 0,6	R-2030 x 0,5					R-2530 x 0,6
		R-2530 x 0,6	R-2530 x 0,6	P-2030 x 0,4					
	Doffer	N-40258 x 0,9	N-40258 x 0,9	N-40258 x 0,9	N-40258 x 0,9R	N-40258 x 0,9R	N-40258 x 0,9R	N-40258 x 0,9R	N-40308 x 0,9R
>40 kg/h	Cylinder	R-2030 x 0,5	R-2030 x 0,5	R-2030 x 0,5	P-2025 X 0,5	R-2520 x 0,7	0-2515 x 0,9	R-2525 x 0,6	R-2525 x 0,6
		P-18405 x 0,4	P-20405 x 0,4	P-2030 x 0,4				P-2025 x 0,5	R-2530 x 0,5
		P-20405 x 0,4							R-2530 x 0.6
	Doffer	N-4030B x 0,9	N-40308 x 0.9	N-40308 x 0,9	N-40308 x 0,9R	N-40308 x 0,9R	N-40308 x 0,9R	N-4030B x 0,9R	N-40308 x 0,9R
		L-40308 x 1,0	L-40308 x 1,0						
	Lickerin	E-5510 x 1...	E-5510 x 1...	E-5510 x 1...	E-5505 x 1...	D-5505 x 1...	C-5500 x 1...	D-5506 x 1...	E-5510 x 1...
		VE-5010V-8	VE-5010V-8	V.E-5010V-8	V.E-5005V-8	V.D-5005V--8	VC-5000V--8	V.D-5005V-8	VE-5010V-8
		VE-5010V-12	V.E-5010V-12		V.E-5005V-12				VE-5010V-12

General maintenance in carding machine

Objectives: At the end of this lesson you shall be able to
- **maintain the coiler unit**
- **maintain the wire points.**

Coiler can mechanism (Fig 1)



The object of this mechanism is condenser further the silver delivered by the calender rollers and to lay them in an orderly manner in a cylindrical can for easy withdrawal at subsequent processing. The coiler gets its drive from the bottom calender roller shaft as shown in fig.

This coiler calender rollers are driven at a surface speed slightly higher than that of the calender rollers so that the sliver is maintained in a taut condition as it passes from the calender rollers through the trumpet and into the nip of the coiler calender roller below the trumpet.

A tube wheel driven by gear on the upright shaft has an inclined tube with its upper end below the trumpet and coiler calender rollers. The lower end of the inclined tube is provided with an exit for the sliver at a point near to its periphery so that the sliver delivered by the rollers passes down the tube and is led in circular coil into the can. The can is positioned on a plate driven through reduction gearing from the bottom of the upright shaft at a slow speed.

The slow rotation of the can changes the position at which each coil is laid, so that overlapping coils are formed around the can. This continues until the can is full. A stationery coiler plate, which surrounds the tube-wheel, assists in. Dressing the sliver firmly in the can and prevent the sliver from being damaged by the coiling mechanism.

Maintenance of coiler unit (Table 1)

Activity	Standard setting and condition	Responsibility & Frequency
Coiler	It should not wear out, i.e, there should not be any scratches on the surface of coiler which comes in contact with the silver	Fitter, Cleaning
	Coiler speed should not be too high to create false draft	Fitter, Cleaning
	Silver coil should be of 20mm less than the diameter of can	Fitter, Cleaning
	Coiler stop motion. i.e. machine should stop if there is any jam in the coiler	Fitter, Cleaning

Card sliver unevenness more than 3 - 4% is considered to be higher if the size of coiler trumpet not adjusted to proper hank.

Wire maintenance: For a modern cylinder wire of 2 mm height, grinding with the normal grinding stone is not recommended. It is better to use TSG grinder to grind the wire every 2nd or 3rd month, so that the sharpness of the wire is always maintained.

TSG grinder does not grind the wire, therefore if the wire is worn out very badly the quality improvement using this grinding machine will be nil.

Frequent grindings are recommended. If TSG grinder is not available, it is better not to grind 2mm wires.

The number of traverse should increase depending upon the life of the wire. The number of traverse for successive grindings should be like this 3, 5, 10, 17 etc. Anyway the best method is to confirm with the microscope. If the grinding is not sufficient, the number of traverse should be increased.

Doffer is still working with a concept of Land formation. A normal grinding machine will be good for doffer grinding. All the wire points should be touched by the grinding stone. A slow and gradual grinding with the grind-out concept will give the best results. Harsh grindings will result in burr formation on the land. This will increase the number of hooks in the fibre; thereby the effective length of the fibre from this card will be reduced.

Flat tops grinding is very important. Every time a flat top is ground, yarn quality is improved. It is better to use a grinding machine with the emery fillet. Frequent flat tops grinding will result in less neps and the yarn quality will be consistent.

Some mills increase the life of the flat tops compared to cylinder wire. But it is better to change flat tops

and cylinder wire together for better and consistent yarn quality. It is a good practice to check the individual card quality before changing the wire. Licker-in wire should be changed for every 150000 kgs. Earlier changes will further improve the yarn quality.

Stationary flats should be changed for every 150000 kgs. But it is a good practice to change the first 3 or 6 stationary flats at Licker-in side for every 100000 kgs. This helps to maximize the carding effect between cylinder and doffer which is critical for better yarn quality.

Grinding, polishing, control of neps and waste generation

objectives: At the end of this lesson you shall be able to

- **state about the grinding operation and stripping operation**
- **control the neps in the carding**
- **control the waste level in the carding**
- **state about troubleshooting techniques and advantages of stationery flats.**

Grinding operation

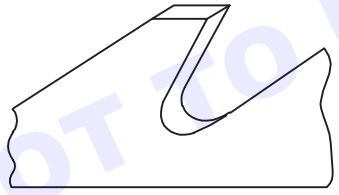
1 Grinding a cut to point

Cylinder wire

Wire points of cylinder have become finer and the tip is cut to point. Because of this new profile, it has become necessary to recommend a little or no grinding of the cylinder wire following mounting. TSG grinding machine of GRAF (wire manufacturer) can be used to sharpen these modern wires. TSG grinding is a safe method of grinding. Before grinding, the wire should be inspected with a pro-table microscope to ascertain the wear. Based on this and the wire point land width, no. of traverse for TSG grinding should be decided. If the width of the wire point tip is bigger and the wear out is more, the number of traverse during grinding should be more. For a new wire, 3 or 4 traverses may be enough. But it may require 10 to 30 traverses for the last grinding before changing the wire, depending upon the maintenance of the wire.

Grinding depth (Figs 1 - 3)

Fig 1



GRINDING DEPTH

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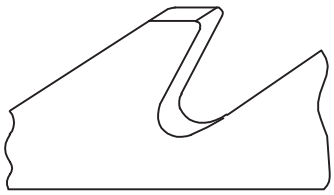
Fig 2



GRINDING DEPTH

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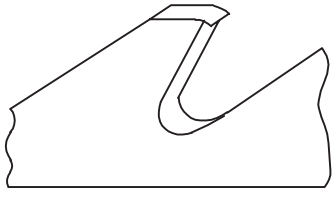
Fig 3



GRINDING DEPTH

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1 Grinding is carried out with the cylinder rotating in its normal direction at normal speed, so that the grinding roller moves with (not against) the teeth of the clothing. The grinding depth is such that a plane surface with a sharp edge is produced at the point of the tooth.

2 Satisfactory carding will not be achieved if too little material is ground away so that the front edge stays rounded,

3 If the grinding operation is too harsh (too much pressure on the grinding roller) so that a burr is formed at the tooth edge (c).

b Grinding a normal cylinder and doffer wire

1 The first grinding of the metallic wire on the cylinder and doffer is the final and most important step leading up to providing the card with a cylinder in the best possible condition for carding well at maximum production rate. Grinding the lands of the teeth provides the leading edge of each tooth with the final sharpness required for maximum carding power.

2 The first grinding should be allowed to continue until at least eighty percent (for cylinder) and 100% (for doffer) of the lands of the teeth have been ground sufficient to sharpen the leading edge of the tooth.

3 To ascertain this stage of grinding, it is necessary to stop the cylinder regularly and use a simple

4 Microscope to examine the teeth at random across and round the cylinder.

5 If the wire on the cylinder is of good quality and has been correctly mounted, the initial grinding period should be completed within 20 min.

6 It is essential to avoid overworking the wire before taking corrective action. The regrinding cycle must be determined accurately for the conditions applying in the individual mill, by using the microscope.

If regrinding is done properly, there are several advantages

- Carding quality will remain consistent
- There is no risk of overworking the wire
- Time required for regrinding is very short
- The exact condition of the clothing is known

- The working life of the wire is likely to be longer because the points are never allowed to become worn beyond recovery

7 To obtain acceptable grinding conditions at the low grinding speed, the grindstone must always be SHARP, CLEAN and CONCENTRIC. If the grinding stone is gradually allowed to become dull and glazed through constant use, the limited cutting action available will eventually disappear, resulting in burning and hooking of the carding teeth.

8 Due to the low peripheral speed of the grindstone which has to be used, it is most important that the speed of the wire to be ground is as high as is practicable to provide a high relative speed between the grindstone surface and the carding teeth. If wire speed is low, the individual carding tooth spends too long a time in passing under the grindstone, thereby increasing the risk of hooking and burning the tooth, which is usually irreparable.

9 With cylinder grinding, speed is no problem because the normal operating speed of the cylinder is more than sufficient. The speed of the doffer for grinding is more commonly a problem and this should be driven at a minimum speed of 250 m/min, to avoid damage when grinding the wire, the design which is particularly susceptible to hooking due to the long fine, low angled teeth needed on the doffer.

10 The directions of rotation for metallic wire grinding are normally arranged so that the back edge of the tooth is first to pass under the grindstone. This is termed grinding “back of point”

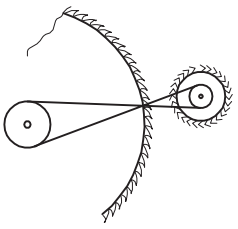
C Grinding flat tops

1 Flat tops provide the opposing carding force against the cylinder wire and hence can equally effect carding quality. It is essential to ensure that the tops are kept in good condition to maintain maximum carding power with the cylinder. Again, the only reliable approach is to examine the tops with the microscope and decide whether grinding is required or not.

2 For cards fitted with regrindable tops, it is good practice to regrind the flats at regular intervals thus ensuring that the conditions of the two principal carding surfaces are always complementary one to other.

Stripping operation (Fig 4)

Fig 4



STRIPPING OPERATION

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If at all, metallic clothing should not be cleaned out with a revolving brush, but rather with a hand scraper while the cylinder is rotated manually (not by the motor drive). Rapidly rotating brushes create considerable metal-to-metal friction (brush on saw-tooth wire) and cause more wear on the clothing points than do the fibers. The life of the clothing is markedly reduced.

Burnishing the clothing: Burnishing should be avoided for reasons already explained under cleaning out. A single burnish wears down the teeth more than processing tens of thousands of kilograms of material. Nevertheless, burnishing sometimes becomes unavoidable, for example if the teeth were ground too intensively in re-sharpening and the raw material is released relatively poorly from the clothing.

Occasionally, this proves necessary on the doffer. In that case, however, burnishing must be carried out in the direction of the teeth and not against them. Rotation of the brush with a stationary cylinder is to be avoided. Cleaning out with a hand scraper is often enough, without burnishing.

Stationary flats: Another attempt to overcome the disadvantages of the revolving flat card consists in more radical solutions that replace the revolving flats by stationary flats. Stationary flats entirely replace their revolving counterparts, they are rigidly fixed to the main frame around a portion of the main cylinder and they do not move.

Stationary flat cards have some major advantages: Cards with stationary flats are built without moving parts in the main carding zone beside the main cylinder. A simple general design and construction are therefore possible, which results in lower manufacturing and maintaining costs.

All the stationary flats are permanently active in the working zone. Therefore, fewer flats are needed in comparison to the revolving flat card. All the flats can be permanently used. There is no motion of the bars of the stationary flats on the flexible bend, therefore wear and tear of those elements are avoided.

Trouble shooting techniques

Control of nep generation

- Wire sharpness of card clothing
- Flat to flat height variation
- Flat to cylinder setting
- Cylinder speed
- SFD setting
- Relative humidity
- Waste %
- Production (doffer speed and sliver hank)

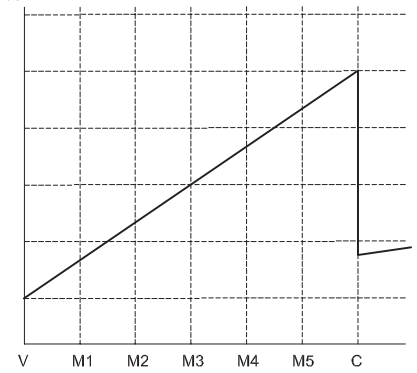
The Uster neps count indicate the number of places where there is a sudden increase in weigh per unit length. Therefore, foreign matter like trash particularly seed coats

will also get counted as neps besides the fibres neps. In fact a very large proportion of neps in the Indian cotton yarns are formed around small seed coats. This is followed by a fair proportion of pure fibre neps.

At carding the neps the counted conventionally in the web itself. The well known Shirley template consisting of 34 holes, each of one sq. in area is placed on the web taken from card on a board of the same size. In case of MMF a sample glass per plastic sheet without holes may be used and the neps counted on the total area of 40 sq. inches. And is converted to neps per 100 sq. inches. By multiplying by 2.5. However, in cotton mixing, the number of holes or more neps is counted. This number is used to estimate the number of neps per 100 sq. in. formed by referring to table.

Controlling the neps in carding machine (Fig 5)

Fig 5



Change in the number of neps in the cotton when passing blow-room and cards

The disentangling of neps can be achieved by lower fibre density on the cylinder using higher cylinder width, closer spacing between clothing surfaces, sharper clothing, optimal licker-in speed, lower throughput and low doffer speeds. The carding segment used also provides higher untangling of neps. The closed sheet of under casing of cylinder provides better fibre orientation on cylinder surface and reduces neps at higher cylinder speeds.

Controlling the waste in carding machine

The following facts should be kept in mind while controlling the waste and cleaning at cards:

1 Use of only one mote knife, placed slightly below the normal position of the top mote knife to give less waste and better cleaning in cotton mixing

2 Higher lickerin speed or greater wire point density on lickerin gives higher cleaning efficiency accompanied by some increase in the lint lost under the lickerin.

3 Use of perforated under casing helps in reducing waste.

4 With other speeds and setting held constant, the flat strip waste varies almost proportionately with the flat speed.

5 Wider front plate and back plate setting increases flat strip waste

6 For controlling cleaning of the card, almost the only place is the lickerin region

7 The tandem card gives 5 - 7% higher cleaning efficiency and better removal of seed coats

Gearing diagram of carding and speed calculations

Objectives: At the end of this lesson you shall be able to
- **draw the gearing diagram of the carding machine**
- **understand the speed particular and technical data**
- **calculate the transfer co-efficient of the machine.**

Gearing diagram of carding machine (Fig 1)

Transfer co-efficient: In carding machine, the fibres are removed from the cylinder by the “doffer”. They rotate so that the cylinder and doffer surfaces move in the same direction at the transfer zone. The doffer rotates at a considerably slower surface speed than does the cylinder and consequently fibres accumulate on the doffer wire. The doffer speed is normally in range of 50 to 120 m/min and the cylinder surface speed is in the region of 1500 m/min. The doffer takes some of the fibres carried by the cylinder, but the majority stays on the cylinder. There is a transfer factor in the order of 0.2 to 0.3, Fibres, on average, pass around the cylinder 3 to 5 times.

The fibres taken up by the doffer are caught (hooked) on the wire and partially combed out by the passing cylinder wire. Consequently, the fibres on the doffer have a majority of “trailing” hooks relative to the movement of the doffer and subsequent sliver.

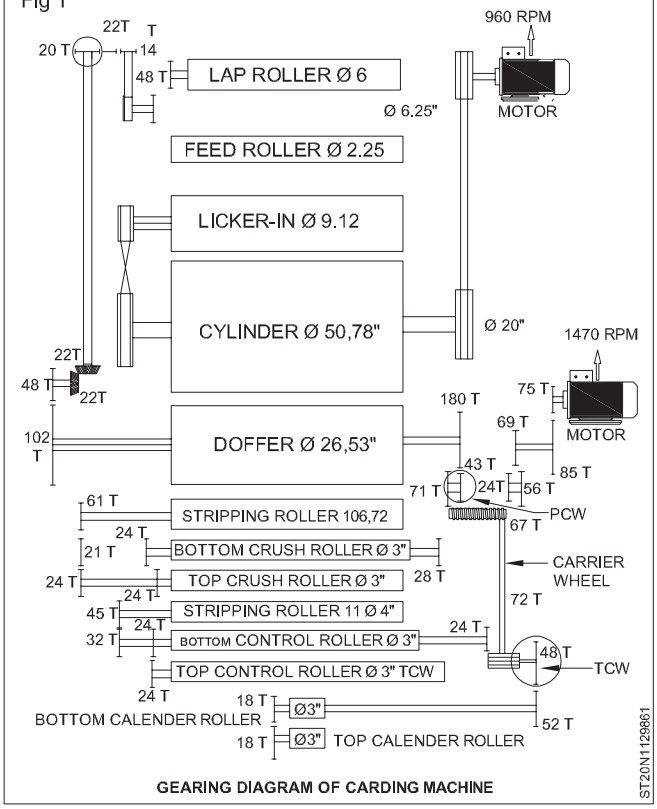
The fibres taken up by the doffer have to be held securely by the wire and must not drop from the wire as the doffer rotates. The fibre transfer factor largely depends upon

- The setting of the doffer to the cylinder,
- The type of doffer and cylinder clothing,
- The wire tooth geometry, particularly of the doffer,
- The number of points on the cylinder and doffer,
- The sharpness of the doffer wire,
- The aerodynamics at the exit region of the cylinder doffer zone.

Assisting factors in the transfer of fibres from cylinder to doffer

- The doffer continuously presents a clean surface to the cylinder at the point of interaction.

Fig 1



GEARING DIAGRAM OF CARDING MACHINE

- The clothing on the doffer is usually 10 counts finer than that on the cylinder and the increases number of points per square inch increases the retentive power of the doffer clothing
- Owing to the curvature of the cylinder and doffer, the working surfaces move rapidly apart after the transfer of fibres to the doffer, so that there is little opportunity for the return of fibres to the cylinder.
- Centrifugal force due to the high cylinder speed tends to throw fibres towards the doffer, whereas the much lower speed of the latter prevents corresponding forces in the reverse direction.
- Air currents may also assist the transfer of fibres to the doffer.

The fibre layer carried to the doffer will be split up in to two parts. If the doffer splits away and retains say ½ of the layer this will pass out from the card. The remaining half remains on the cylinder and after about half a revolution will be joined by a new unit “feed quantity” of fibre transferred to it by the feed roll/licker-in assembly. These fibres are more or less individualized by the time they reach the doffer.

Speed particulars and technical data (Table 1)

Manufacturer	Rieter	Trutzschler	Marzoli
Model	C 60	TC 03	C 601N
Working width	1500	1055	1026
Licker-in (dia)	180/180/253	3x172.5	1x350
Licker-in speed (rpm)	935 - 2306	930 - 2700	640 - 1640
Main cylinder (dia)	814 mm	1287 mm	1290 mm
Main cylinder (rpm)	600 - 900	300 - 560	650
Integrated grinding	IGS-classic	No. by hand only	No. by hand only
Doffer (dia)	680 mm	700 mm	706 mm
Delivery (m/min)	300, 400 mechanically	400, 500 with IDF	400
Flat bars	79	84	85
In working position	27	30	25
Flat direction	backward	backward	Backward
Power required for 75 kg/h	15 KW/h	18 KW/h	-
Pressure (bar)	6	7	6
Leveling	Medium and long term	Medium and long term	Medium and long term
Drafting module	SB (unleveled) max. draft of 3 max. 800 m/min delivery RSB (leveled) max. draft of 5 max. 700 m/min delivery	IDF (leveled) max. draft of 3 max. 500 m/min delivery IDF-R (rectangular can) max. draft of 3 max. 500 m/min delivery	-

The splitting and retaining power of the doffer is called "Transfer Coefficient". Thus, if total volume of fibres were to be retained by a doffer its TC would be 1; if only half of the fibres were retained, the TC would be 0.5; if only one quarter of the fibres retained, the TC would be 0.25 and so on.

Let it be assumed that

- The quantity of fibres fed into the card = a
- If, TC of the doffer = k
- In one revolution the doffer retained of fibres = a x k
- Leaving a quantity on the cylinder = a (1-k)
- During the next revolution, the cylinder receives again a fresh quantity = a
- Now the total fibres on the cylinder surface = a + a (1-k)
- The doffer splits away = (a + a (1-k))k
- Leaving the fibres on the cylinder = (a + a(1-k)) x (1-k)

Thus the quantity of retained fibres on the cylinder goes on increasing until a limit is reached, the cylinder is saturated and the fibre distribution on the card is in equilibrium.

The total load "S" on the cylinder after "n" revolution of the offer is

$S_n = a (1 + (1-k) + (1-k^2) + (1-k^3) + \ldots\ldots\ldots\ldots + (1-k^n)$

The total sum to infinity can be written as

$$S_\infty = \frac{a\,(1-k)}{k}, \quad \text{Equilibrium of the card.}$$

Let us take an example

If feed per doffer revolution (a) = 1

The retaining capacity of the doffer (k) = 10% is 0.1

Then the saturated fibre load of cylinder $S_\infty = \frac{a\,(1-k)}{k}$

$= 1(1-0.1)/0.1 = 9$

After one more revolution of the doffer $S_\infty + a = 9 + 1 = 10$

Transfer co-efficient is defined as the % of fibre in weight transferred from the operational layer of cylinder to doffer per revolution of the cylinder. Mathematically,

$$K = \frac{q}{Q} \times 100$$

Where,

q = amount of fibre (gm) transferred to doffer per revolution of cylinder

Q = load on the operational layer of cylinder at steady state.

During the revolution of cylinder the length of sliver (L) delivered by doffer is

$$L = \frac{1}{\eta_C} \times \pi \times D_d \times n_d$$

Where,

D_d = Doffer dia

n_d = Doffer speed

η_C = Cylinder speed

If h is the count of sliver, then the weight of sliver (q) delivered on one revolution of cylinder,

In order to determine k, Q has been found experimentally

$$Q = \frac{453.67 \times \pi \times D_d \times n_d}{h \times 840 \times n_c \times 36}$$

$$K = \frac{453.67 \times \pi \times D_d \times n_d}{h \times 840 \times n_c \times 36} \times \frac{100}{Q}$$

Salient features and automation in carding machine

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

- **understand the salient features of carding machine**
- **state the recent developments in various parts of the machine**
- **learn about the online quality control.**

Salient features of new generation card

- High production
- Modular construction
- FRC system ensures levelled material
- Aluminium alloy cylinder cover plates
- Easy tongue setting adjustment
- FMC system facilitate symmetric web gathering

High production with superior quality

- Production up to 80 kg/hr
- Delivery Speed up to 300 m/min. (mechanical)
- Cylinder speed up to 550 rpm
- Excellent quality with in-built short term and long term FRC system
- PCL & PCD system ensures less imperfection in sliver

Flexibility

- Suction system through fibre reinforced plastic ducts for waste collection and provision for centralized suction
- Feed from Fine feed or Lap feed
- Manual or Automatic waste evacuation system
- Effective suction by individual or centralized collection system

- Separation of Licker-in and flat waste
- Linear or Rotary Can changers
- Wide range of can coilers to suit various customer needs

Ease of maintenance

- Compact and maintenance free flat drive system
- Replaceable combing segments with special knives and control bars
- Effective suction for removal of trash and micro dust
- Compact doffer drive with inverter, controlled by PLC
- Touch screen display system

Fine Feed LA7/5

Salient features

- Production upto 80 kg/hr per chute
- Batt Weight 600 - 800 gms/m for cotton
- 500 - 600 gms /m for man-made

Consistent quality

- Integrated Inverter driven feed roller for uniform CV of Card sliver
- Multilevel sensing ensures uniform batt density
- Adjustable front wall to maintain batt density for entire range of fibre application

Flexibility

- Easy adjustable air handling system
- Multilevel sensing system

Feeding and opening zone: The journey of fibers through the carding process being with feeding a uniform fiber mat prepared by the chute feed system and supplied to the carding machine using feed roller. The weight of the fiber mat may typically range from 400 to 1000 g/m (Ktex). This weight approximately corresponds to a number of fibers in the mat cross section in the range from 2 to 6 millions of fibers depending on fiber fineness. The task before the carding process is to intensively open and draft this large mass down to about 3 to 5 g/m (the sliver count); or to reduce the number of fibers down to approximately 40,000 fibers in the card sliver cross section. This intense reduction is mainly achieved in the zone between the feed roll and the taker-in (or licker-in).

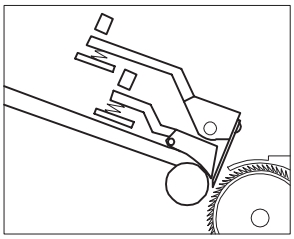
The feeding rate is normally slow to allow exposition of small portion of the fiber mat to the action of the high speed licker in (typically, 25 cm diameter, 700 - 1200 rpm for cotton and 400 - 600 rpm for man-made fibers). The taker-in being clothed with saw-tooth wire removes the fiber tufts from the input fiber mat.

The draft ratio (the ratio of surface speed between the taker-in and the feed roll) is typically around 1000.

The centrifugal force caused by the high rotational speed of the licker-in throws the heavy trash particles, and seed coats fragments out at the mote knives with the assistance of air draft. The taker-in removes about half of all trashes held in the cotton.

Conventional and unidirectional feeding systems (Fig 1)

Fig 1



GEARING DIAGRAM OF CARDING MACHINE

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Another innovation of the opening zone is the so-called WEBFEED system introduced by Trutzschler, which consists of three taker in cylinders of the same diameter (175 mm) In this system, the fiber mat is guided by pressing the mat against the feed roll in 10 small, independent sections of 100 mm width using the so-called “Sensofeed” feed-plate system.

1 A Special clothing of feed roll prevents lap formation

2 Spring loaded feed table

3 Spring loaded measuring lever

4 Spring elements

5 First roll of webfeed

The deflection of all springs elements are processed to become one average signal which is used as actual value of short wave leveling system. As an additional function, the integral feed tray SENSOFEED comprises material feed monitoring. Metal particles of thick places in the web are detected in an immediate stop of the card.

Card analyser (or) uni feed: M/S. Nagoya a leading card clothing manufacturer of Japan has offered an evener roller under the trade name of card analyser.

As shown in fig, this evener roller is placed above the licker in. It opens the large unopened tufts released by the licker-in and also removes the excess fibres on the cylinder which is returned to the feed roller again through a space provided between the taker-in and its cover. Thus it helps to feed the tufts as evenly as possible on the cylinder. It is claimed that the neps formation and the waste are reduced.

Pre carding and post carding: As carding production rates have progressively been increased, it has become necessary to include additional stationary carding segments around the cylinder. They are located between the licker-in and the flats and between the flats and the doffer. In the first versions, the carding segments between the licker-in and the flats were used to progressively open up the tufts carried by the cylinder wire before the fibres encountered the flats. Additionally, carding segments between the flats and the doffer were found to be beneficial in preparing the fibres for the doffing action. In the Rieter card these segments are referred to as the

TREX-system. Developments of the carding elements and of suction channels located between the elements have led to TREX plus that removes dust, trash and very short fibres.

At least one stationary carding element structured according to the invention is arranged in the pre-carding zone between the licker-in and the rearward sprocket supporting the traveling flats. At least one stationary carding segment structured according to the invention is disposed in the post-carding zone between the doffer and the frontal sprocket which supports the traveling flats. At least one stationary carding segment structured according to the invention is disposed in the lower carding region between the doffer and the licker-in. In case only stationary flats elements are associated with the carding cylinder, a plurality of stationary carding segments structured according to the invention are disposed along the carding cylinder.

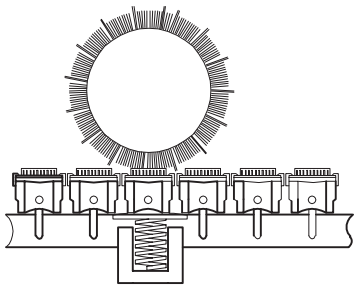
Carding zone: Fibers that are opened and cleaned by licker-in system are transferred to the main cylinder by stripping action. Fibers are stripped by the cylinder from the licker-in are transferred to the carding zone, which is the area between the main cylinder and the flats. In order to remove fibers from the licker-in by the main cylinder, the surface speed of the main cylinder should be higher than that of the licker-in. A typical value of the surface speed of the licker in may range from 700 m/min to 950 m/min. The surface speed of the cylinder may range from 1000 m/min to 2400 m/min. (at diameter is 1290 mm, and 260 to 600 rpm.). Thus the draft is ranging from 1.5 to 2.5. In the cylinder/flat area, cotton tufts are subjected to carding action. In principle, a carding action is accomplished when the wire of the two surfaces are inclined in opposite directions and the direction and the rates of motion are such that one surface passes the other, point against point.

The flats are wired clothed bars rotating at a very slow speed (typically 8 - 20 cm/min) against the high speed cylinder. They are usually set very close to the main cylinder. The setting between the flats and main cylinder is determined by a number of factors some of which are mechanical-related and others are material related. Mechanical related factors include the bearing condition, the shape and dimensions of the wires. Material related factors include fiber length, fiber fineness and fiber to fiber friction. The setting is very critical in relation to the formation of the fiber neps.

- The main cylinder is the central element of the card. It has a diameter of approximately 1.3 m and a working width of one meter. This results in a clothing area more than 4 m2. The carding surface of the cylinder is made up of more than 10.000 m of clothing wire with approximately 6 million single points.
- By shifting the WEBFEED unit and the doffer below the cylinder, more room has been made for the functions of pre carding and post-carding.

Integrated grinding system (Fig 2): A grinding brush is permanently installed behind the flat cleaning device (Fig. 145). Under the grinding brush and the one flat in contact with this brush a spring is provided that presses the flat bar against the brush. The flats are thus raised one by one and ground at this point. With the IGS grinding device grinding takes place for more than 100 cycles during the lifetime of the clothing.

Fig 2



INTEGRATED GRINDING SYSTEM

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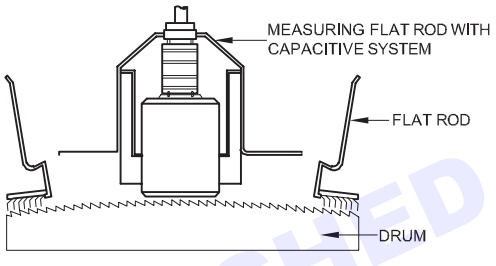
Flat measuring system (Fig 3)

Fig 3



FLAT MEASURING SYSTEM

ST20N1129873

The setting of the distance between the drum and the flat is crucial for carding quality of fibre, e.g. wool. Investigations have shown that manual gap settings with the gauge to the left and right on the carding machine are not equal and that with the machine at standstill slight deviations from the operating conditions arise. The remedy is provided by a measuring flat rod (FCT) with two or three capacitive sensors which are exchanged for a flat rod. The sensors measure the distance to the drum via the drum width. The other distance signals are passed to the PC. The fully automatic measurement sequence eliminates erroneous settings and shortens the setup time. The inspection and documentation of the results facilitates practical quality assurance.

Technical details

- **Measuring range**: 2 mm
- **Accuracy**: 0.02 mm
- **Resolution**: 0.02 mm
- **Band with:** 0-100 Hz

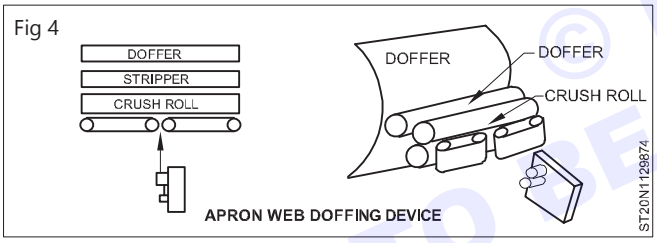
Ambient conditions

- **Temperature:** 0 - 50 °C
- **Medium**: air
- Measurement against a rough drum surface
- Battery backed operation mode (±15 VDC, 7 mA)

Recent developments of carding machine: In previous discussed that on 1748 Lewis Paul of Birmingham, England invented the hand driven carding machine. This carding machine has been added many values and developed for the requirement of spinners.

- The most recent developments are given below
- Higher production rate up to 250 kg/hour
- **Direct feeding system FBK:** Chute feed
- **Feed rate control system**: CFD(CORRECTA FEED)
- **Multiple licker-in system:** 3 Licker-in
- Precision Flat Setting System PFS
- Precision Mote Knife Setting System PMS
- Aluminum flats without bolted connection
- Computer control with Touch Screen
- Electronic Flat Measuring System FLATCONTROL TC-NCT
- ON-line nep counting with NEPCONTROL TCC-NCT
- Waste quality measuring with WASTECONTROL TC-WCT
- Digitally controlled, maintenance-free servo drives
- Integrated Carding Grinding system
  1 IGS Tops
  2 IGS Classic
- **Magnetic flat bar**: MAGNA TOP
- Integrated and continuous suction system
- **Larger can size:** 1000X1200 mm
- Roller doffing system

Apron web doffing device (Fig 4)



Apron web doffing device is used for effective controlling and doffing the web which is delivered from crush roller of roller doffing unit of HP card

i.e., the web delivered from the crush roller is gathered by the cross apron as shown and condensed to form a sliver. It helps to cope up with very high delivery speeds like 300 metre per minute.

Auto leveling system: The mass uniformity of the card sliver is an essential criterion for good subsequent processing.

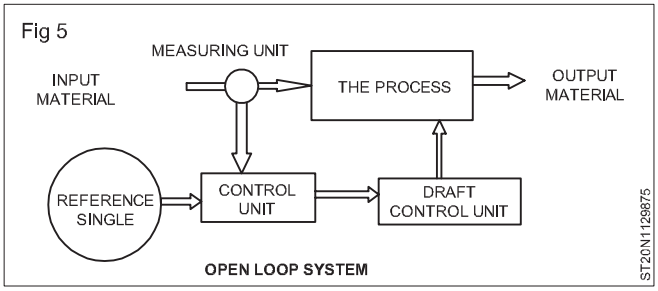
The main objective of an auto leveller is

1 To measure sliver thickness variation on real-time basis, and

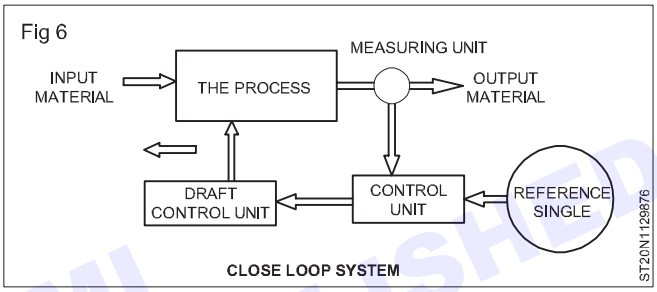
2 To alter the machine draft so that a high consistent sliver thickness is continuously produced. In general,

Auto levelling systems may be divided into two main types

a Open-loop auto levellers (Fig 5): The open-loop system may generally be used for correction of short-term variations. The input material variation is measured using a measurement unit. The measured signal is then compared to a reference signal (nominal value). The difference between signals is determined by a control unit, which sends a signal to a draft control unit indicating the necessary action to be taken. In open-loop system, there is no check on delivered sliver. In other words the changes in draft are solely based on the mass variation in the input material.

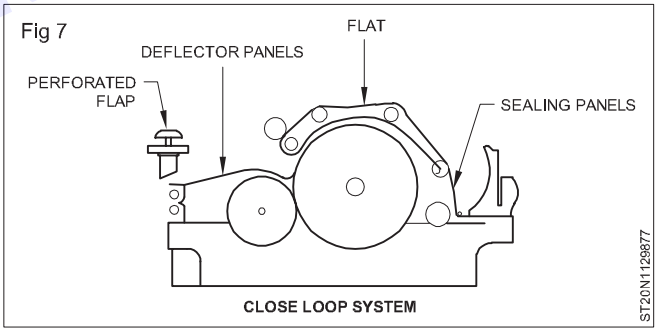


b Closed-loop auto levellers (Fig 6)



In the closed-loop system, is generally used for correcting long-term variation. In this case, the measurement is made on delivered sliver. In other words, the closed loop auto leveller checks the result of its action.

Dust extraction systems in carding (Fig 7)



The high pressure area in the card-at the junction between cylinder and flats at taken-in end-causes ejection of dust over top of the back plate and between the flats.

Another high pressure area- at the junction between the main cylinder and doffer -leads to ejection of dusty air over the doffer

Doffer comb produces air turbulences, which causes dust to rise and at the calender roller the air that is mixed with the cotton in the web is squeezed out, together with dust and fly. Air escaping into the atmosphere from the high pressure zone carries dust with it and is responsible for most of the dust in the card room.

Modern HP cards are equipped with the dust and fly collector such as shirley pressure point system for extracting the dust, fly and fibres which are collected

in a special chamber without rendering unhygienic the atmosphere in the card room.

This has low running cost and useful

1 To prevent the ejection of dust by suitably covering the regions of the machine where the dust is liberated.

2 To move the dust from several forces to a central region from which it can be conveniently removed.

An Exhaust fan, through suitable hoods fitted to critical regions of the card draw off air with fly and dust and after separating these from air, pure air is returned to the department.

The dust passing through the slits between the flats is retained (and then exhausted) by a flexible metal sheet across the full width of flats and placed inside the flat chain to cover about 2/3 of the flats.

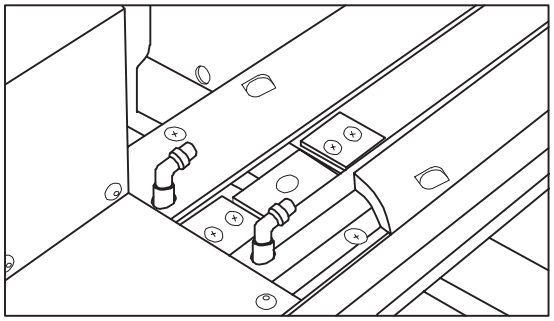
Internal suction system: The integral fan for internal suction creates a vacuum within the outer shell. Thus no dust from the card escapes into the workroom. The suction is very effective in the removal or fly waste, dust and micro dust which are released during carding. Dust and wastes are removed at all points of occurrence, feed, flat entry, flat strips, web delivery and waste chamber under the card. The internal suction operates continuously there by maintaining constant auto dynamic conditions in the card.

The exhaust air is conveyed to air conditioning system. The amount of exhaust air is 2300 m3/h per card. Under card waste removal system. The under card waste are transferred by programmed periodic blasts of compressed air into the vicinity of a suction hood and collected in the rear most filter of the two filters built into the outer shell. The over card wastes including flat strips are collected in the foremost filter.

The intermittently acting central suction system programmed to empty first the foremost filter and then the rear most filter. The card can be connected to a continuously acting suction system in which case there is no need for fan and filters. Manual cleaning of filter is necessary in the absence of central suction system.

Online grinding and quality control (Fig 8)

Fig 8



The wire tips get blunt while the carding machine works. The points of clothes wire lose their sharpness. The reason for this is abrasion between the processing material and the wire's tip. The points on these clothes wires need to be sharpened immediately. The points of clothes wire are ground to a sharp point. The following safety measures and grinding schedule are adhered to in order to keep the points of the clothes wire sharp.

- When grinding modern cylinder wires that are 2 mm in height, a standard grinding stone does not produce acceptable results.
- For grinding these kinds of wires, the conventional grinding stone (TGS grinder) produces superior results.
- In order to consistently keep the wire tips sharp, wire grinding is done every second or third month.
- Using a TSG grinder does not improve the severely worn-out wires' tip sharpness. To get the sharp tips of these severely worn-out clothing wires, frequent grinding is required.
- The number of traverses in the grinding operation is increased based on the wire's lifespan.
- For consecutive grindings, a traverse number of 3, 5, 10, 17, etc. is utilised.
- A microscope is used to assess the quality of grinding.
- The number of grinding traverses is raised correspondingly if the examination finds that the grinding is insufficient.
- A standard grinding stone is used to assist in the grinding of the doffer wires.

  When grinding wire, the technician ensures that every point of the wire comes into contact with the grinding stone.
- The wire becomes sharper as a result of the slow, steady grinding process.
- The number of hooks in the fibres increases if the wire grinding becomes severe for whatever cause.
- The quality of yarn is greatly impacted by how sharp the flat top wires are.

The operating life of wire is decided by the amount of throughput material. For cylinder, it generally lies between 3,00,000 to 6,00,000 kg, but it can be larger sometimes.

For grinding the wires, full width grinding rollers can be used. The drum has an abrasive sheet or abrasive coating extends over the full width of the machine. In case of traverse grinding disc, the grinding head in the form of disc of 90 mm wide, is seated on a guide tube. At any time, it grinds only small portion of the wire points of cylinder. Hence, there is no problem of bending at the middle.

In case of online grinding system, the grindstone is moved over the cylinder clothing by the automatic control during production. The grinding takes place approximately 400 times during the total life period of wire clothing. There is no downtime when the grinding takes place. The required parameters for grinding operation is entered to the card and the program calculates the grinding schedule by distributing the grinding cycle optimally over the life span of the clothing.