# Techno India NJR Institute of Technology

# Lab Manuals

## 1FY3-25/ 2FY3-25: Manufacturing Practices Workshop

Lokesh Malviya
(Assistant Professor)
**Department of ME**

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

# 1FY3-25/ 2FY3-25: Manufacturing Practices Workshop

**Objectives:**

- To develop a skill in dignity of labour, precision, safety at work place, team working and development of right attitude.
- To acquire skills in basic engineering practice
- To identify the hand tools and instruments
- To gain measuring skills
- To develop general machining skills in the students.

General safety precautions in workshop and introduction.

**Course Outcomes:** The student will be able to:

| CO No | Cognitive Level | Course outcomes |
|---|---|---|
| CO1 | Application | know the importance of general safety precautions on different shop floors. |
| CO2 | Application | identify the basics of tools and equipment used in fitting, carpentry, sheet metal, machine, welding and smithy. |
| CO3 | Application | fabrication of wooden joints and understand joining of metals. |
| CO4 | Application | make metal joints and sheet metal work. |
| CO5 | Application | familiarize with the production of simple models in fitting, carpentry, sheet metal, machine, welding and smithy trades. |

| 1FY3-25/ 2FY3-25: Manufacturing Practices Workshop Year of study: 2020-21 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Course Outcome | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | | | | | | | | | | | |
| CO2 | 3 | 3 | | | | | | | | | | |
| CO3 | | 3 | 3 | | | | | | | 2 | | 3 |
| C04 | | | 2 | 3 | | | | | | 2 | | |
| C05 | | | | 3 | | | | | 2 | | | 2 |

**1: Slight (Low), 2: Moderate (Medium), 3: Substantial (high)**

**Texts/Reference:**


1. S K Hajra Choudhury, A K Hajra Choudhury, N. Roy: Workshop Technology Vol I & II; Media Promoters & Publishers Pvt. Ltd.
2. H S Bawa: Workshop Practice; McGraw Hill Education; 2nd edition

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

**I & II Semester**

**Common to all branches of UG Engineering & Technology**

**1FY3-25/ 2FY3-25: Manufacturing Practices Workshop**

**Carpentry Shop**

1. T – Lap joint
2. Bridle joint

**Foundry Shop**

3. Mould of any pattern
4. Casting of any simple pattern

**Welding Shop**

5. Lap joint by gas welding
6. Butt joint by arc welding
7. Lap joint by arc welding
8. Demonstration of brazing, soldering & gas cutting

**Machine Shop Practice**

9. Job on lathe with one step turning and chamfering operations

**Fitting and Sheet Metal Shop**

10. Finishing of two sides of a square piece by filing
11. Making mechanical joint and soldering of joint on sheet metal
12. To cut a square notch using hacksaw and to drill a hole and tapping

**Contents**


*Preface*

*TableofContents* *page*

**1. FittingShop**

1.1 Introduction 1
1.2 Holding tools 1
1.3 Marking andmeasuring tools 2
1.4 Cuttingtools 5
1.5 Finishingtools 8
1.6 Miscellaneoustools 10
1.7 Safepractice 11
1.8 Modelsforpreparation 12
Exercises 13

**2. Carpentry**

2.1 Introduction 15
2.2 Timber 15
2.3 Markingandmeasuringtools 16
2.4 Holdingtools 17
2.5 Planingtools 18
2.6 Cuttingtools 28
2.7 Drillingandboringtools 20
2.8 Miscellaneoustools 21
2.9 Woodjoints 22
2.10 Safepractice 24
Exercises 25

**3. Welding**

3.1 Introduction 28
3.2 Arc welding 28
3.3 Weldingtools 30
3.4 Techniquesofwelding 31
3.5 Typesofjoints 32
3.6 Weldingpositions 33
3.7 Advantages&disadvantagesofarcwelding 33
3.8 Safepractice 34
Exercises 35

**4. MachineShop**

4.1 Introduction 39
4.2 Lathe 39
4.3 Workholdingdevices 40
4.4 Measuringtools 40
4.5 Cuttingparameters 41
4.6 Tool materials 41
4.7 Toolgeometry 42
4.8 Latheoperations 42
4.9 Safetyprecautions 44
Exercises 45
References 48

Chapter 1

# FITTING SHOP

## 1.1 INTRODUCTION

Machine tools are capable of producing work at a faster rate, but, there are occasions whencomponentsareprocessedatthebench.Sometimes,itbecomesnecessarytoreplaceorrepaircomponentwhichmustbefitaccuratelywithanothercomponentonreassembly.Thisinvolvesacertainamount of hand fitting. The assembly of machine tools, jigs, gauges, etc, involves certain amount ofbenchwork.Theaccuracyofworkdonedepends upontheexperienceandskillofthefitter.

Theterm'benchwork'refersto theproductionofcomponents byhandonthebench,whereasfittingdealswhichtheassemblyofmatingparts,throughremovalofmetal,toobtaintherequiredfit.

Boththebenchworkandfittingrequirestheuseofnumberofsimplehandtoolsandconsiderable manual efforts. The operations in the above works consist of filing, chipping, scraping,sawingdrilling,andtapping.

## 1.2 HOLDINGTOOLS

### 1.2.1 Benchvice

Thebenchviceisaworkholdingdevice.Itisthemostcommonlyusedvice inafittingshop.ThebenchviceisshowninFigure1.1.

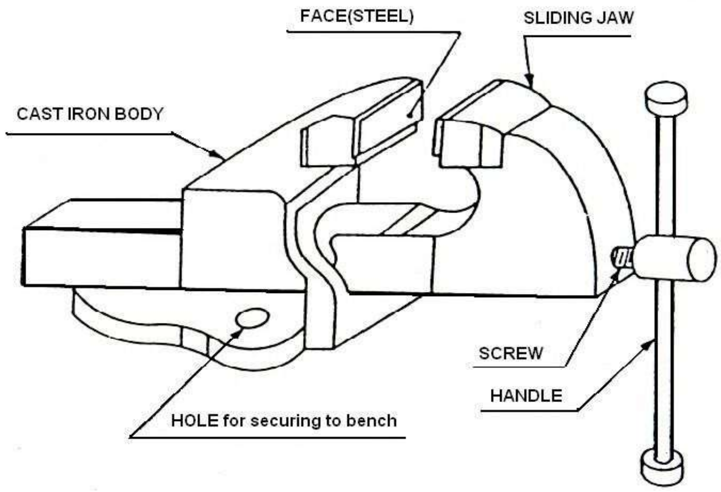



**Figure1.1**:BenchVice

It is fixed to the bench with bolts and nuts. The vice body consists of two main parts, fixed jawandmovablejaw.Whenthevicehandleisturnedinaclockwisedirection,theslidingjawforcestheworkagainst the fixed jaw. Jaw plates are made of hardened steel. Serrations on the jaws ensure a goodgrip.Jaw caps made of soft material are used to protect finished surfaces, gripped in the vice. The size ofthev iceis specified bythelengthofthejaws.

The vice body is made of cast Iron which is strong in compression, weak in tension and sofracturesundershocksandtherefore shouldneverbehammered.

### 1.2.2 V-block

V-block is rectangular or square block with a V-groove on one or both sides opposite to eachother. The angle of the 'V' is usually $90^0$. V-block with a clamp is used to hold cylindrical work securely,duringlayoutofmeasurement,formeasuringoperationsorfordrillingforthisthebarisfacedlongitudinally in the V-Groove and the screw of V-clamp is tightened. This grip the rod is firm with itsaxis paralleltotheaxisofthev-groove.

### 1.2.3 C-Clamp

Thisisusedtoholdworkagainstanangleplateorv-blockoranyothersurface,whengrippingisrequired.

ItsfixedjawisshapedlikeEnglishalphabet'C'andthemovablejawisroundinshapeanddirectlyfitted to the threaded screw at the end .The working principle of this clamp is the same as that of thebenchvice.

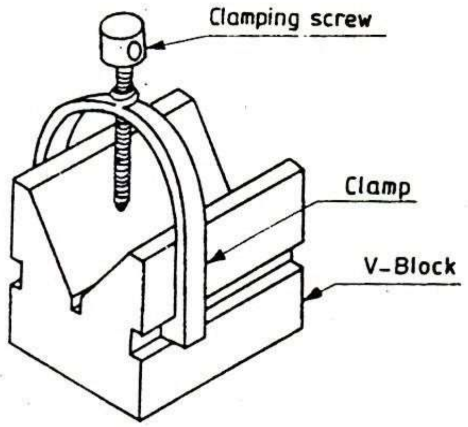



**Figure1.2**:V-block

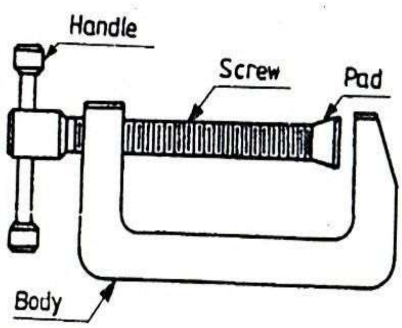



**Figure1.3**:C-clamp

**1.3 MARKINGANDMEASURINGTOOLS**

**1.3.1 Surfaceplate**

The surface plate is machined to fine limits and is used for testing the flatness of the workpiece. It is also used for marking out small box and is more precious than the marking table. The degreeof the finished depends upon whether it is designed for bench work in a fitting shop or for using in aninspection room; the surface plate is made of Cast Iron, hardened Steel or Granite stone. It is specifiedbylength,width,heightandgrade.Handlesareprovidedontwooppositesides,tocarryitwhileshiftin gfromoneplace toanother.

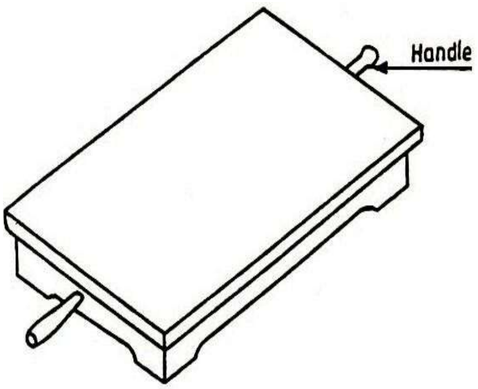



**Figure1.4**:Surfaceplate

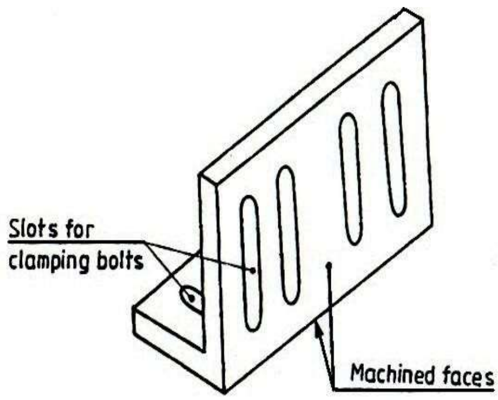


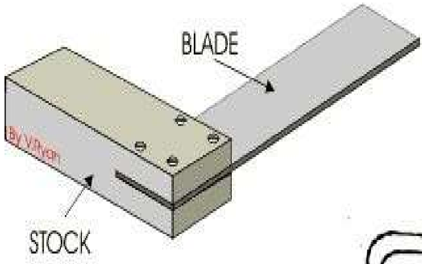

**Figure1.5**:Angleplate

**1.3.2 Trysquare**

Itismeasuringandmarkingtoolfor90$^0$angle.Inpractice,itis usedforcheckingthesquarenessof many types of small works when extreme accuracy is not required .The blade of the Try square ismade of hardened steel and the stock of cast Iron or steel. The size of the Try square is specified by thelengthofthe blade.

**1.3.3 Scriber**

A Scriber is a slender steel tool, used to scribe or mark lines on metal work pieces. It is made ofhardenedandtemperedHighCarbonSteel.TheTipofthescriberisgenerallygroundat12$^o$to15$^o$. Itisgenerallyavailableinlengths,rangingfrom125mmto250mm.Ithastwopointedendsthebentendisused formarkinglineswherethestraightendcannot reach.



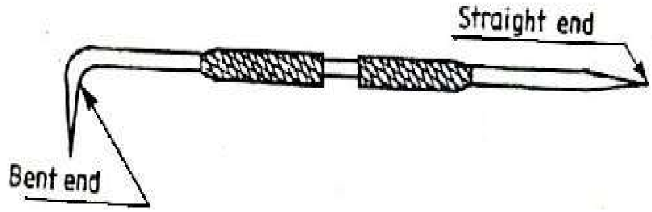




**Figure1.6**:Trysquare **Figure1.7**:Scriber

**1.3.4 OddlegCaliper**

This is also called 'Jenny Caliper' or Hermaphrodite. This is used for marking parallel liners froma finished edge and also for locating the center of round bars; it has one leg pointed like a divider andtheotherlegbentlikeacaliper.Itisspecifiedbythelengthoftheleguptothehingepoint.

**1.3.5 Divider**

It is basically similar to the calipers except that its legs are kept straight and pointed at themeasuringedge.Thisisusedformarkingcircles,arcslayingoutperpendicularlines,bysettinglines.Itismade of case hardened mild steel or hardened and tempered low carbon steel. Its size is specified bythelengthoftheleg**.**

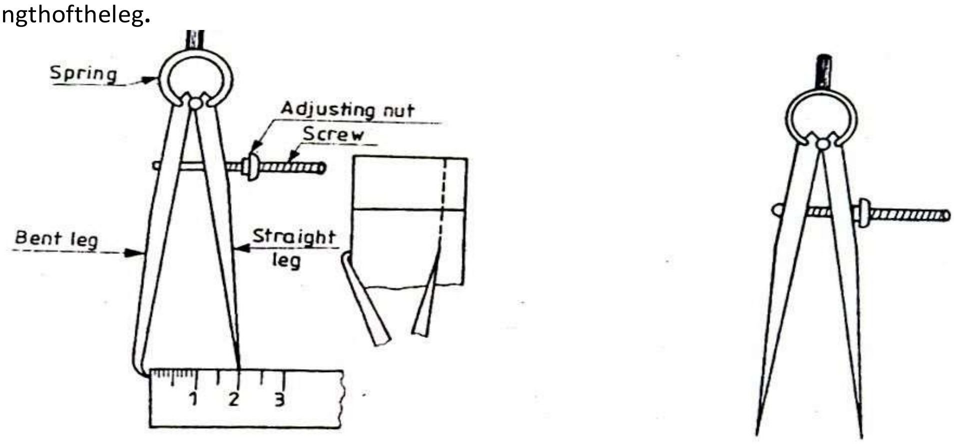



**Figure1.8**:Oddlegcaliperanddivider

**1.3.6 Trammel**

Trammelisusedfordrawinglargecirclesorarcs.

**1.3.7 Punches**

Theseareusedformakingindentationsonthescribedlines,tomakethemvisibleclearly.Theseare made of high carbon steel. A punch is specified by its length and diameter (say as 150' 12.5mm). Itconsists of a cylindrical knurled body, which is plain for some length at the top of it. At the other end, itisgroundtoapoint.Thetaperedpointofthepunchishardenedoveralengthof20to30mm.

*Dotpunch*isusedtolightlyindentalongthelayoutlines,tolocatecenterofholesandtoprovideasmallcentermarkfordividerpoint,etc.forthispurpose,thepunchisgroundtoaconicalpointhaving60°includedangle.

*Center punch* is similar to the dot punch, except that it is ground to a conical point having 90°includedangle.Itis usedtomarkthelocationoftheholes tobedrilled.

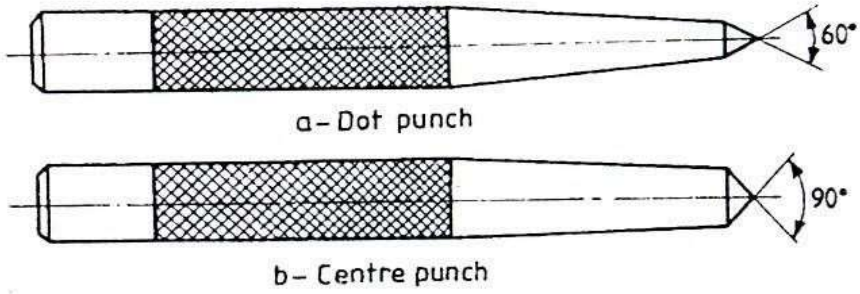


**Figure1.9**:Punches

### 1.3.8 Calipers

Theyareindirectmeasuringtoolsusedtomeasureortransferlineardimensions.Theseareusedwith the help of a steel Rule to check inside and outside measurements. These are made of Casehardenedmildsteelorhardenedandtemperedlowcarbonsteel.Whileusing,butthelegsofthecaliperare set against the surface of the work, whether inside or outside and the distance between the legs ismeasured with the help of a scale and the same can be transferred to another desired place. These arespecifiedbythelengthoftheleg.Inthecaseofoutsidecaliper,thelegsarebentinwardsandinthecaseofinsidecaliper, thelegsbent outwards.

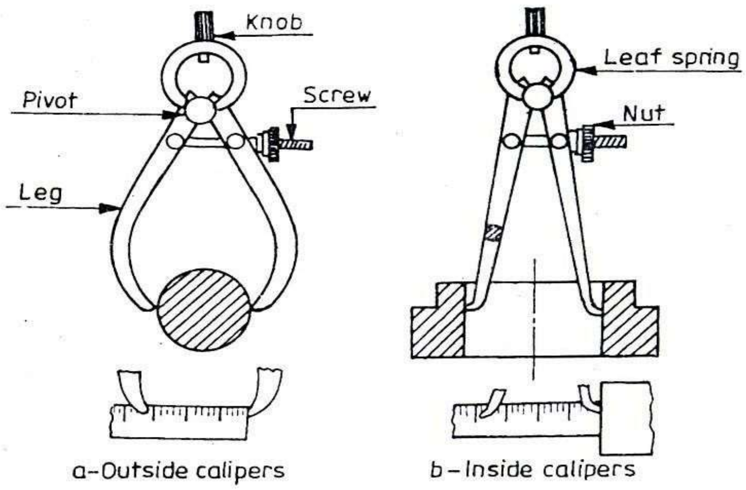


**Figure1.10**:Calipers

### 1.3.9 VernierCalipers

These are used for measuring outside as well as inside dimensions accurately. It may also beusedasadepthgauge.Ithastwojaws.Onejawisformedatoneendofitsmainscaleandtheotherjawismadepartofavernierscale.

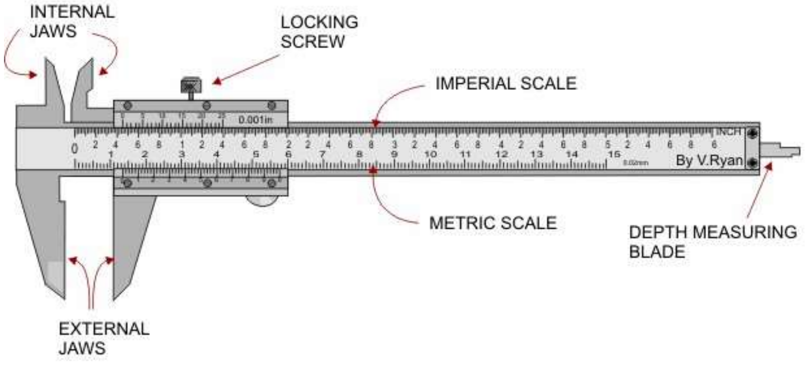


**Figure1.11**:Verniercaliper

### 1.3.10 VernierHeightGauge

TheVernierHeightgaugeclampedwithascriber.Itis usedforLayoutworkandoffsetscriberisused when it is required to take measurement from the surface, on which the gauge is standing. Theaccuracy and working principle of this gauge are the same as those of the vernier calipers. Its size isspecifiedbythemaximumheightthatcanbemeasuredbyit.ItismadeofNickel-ChromiumSteel.

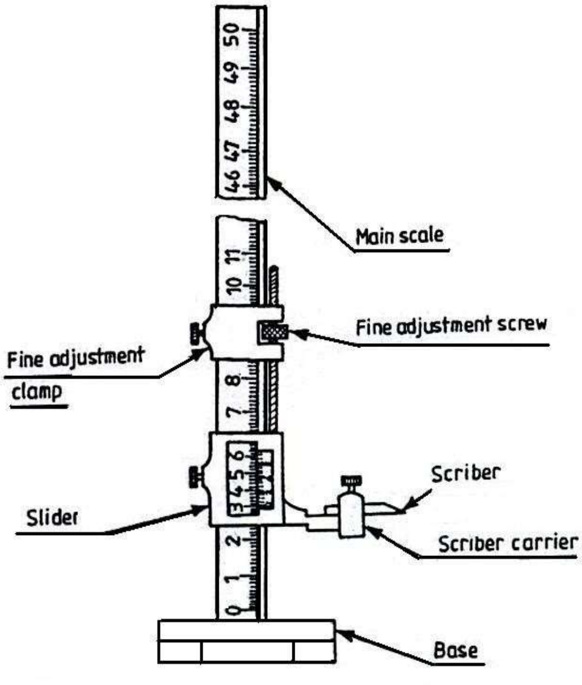



**Figure1.12**:VernierHeightgauge

## 1.4 CUTTINGTOOLS

### 1.4.1 HackSaw

The Hack Saw is used for cutting metal by hand. It consists of a frame, which holds a thin blade,firmly in position. Hacksaw blade is specified by the number of teeth for centimeter. Hacksaw bladeshaveanumberofteethrangingfrom5to15percentimeter(cm).Bladeshavinglessernumberofteethpercmareusedforcuttingsoftmaterialslikealuminum,brassandbronze.Bladeshavinglargernumberofteethpercentimeterareusedforcuttinghardmaterials likesteelandcastIron.

Hacksawbladesareclassifiedas(i)Allhardand(ii)flexibletype.TheallhardbladesaremadeofH.S.S, hardened and tempered throughout to retain their cutting edges longer. These are used to cuthardmetals.Thesebladesarehardandbrittleandcanbreakeasilybytwistingandforcingthemintothework while sawing. Flexible blades are made of H.S.S or low alloy steel but only the teeth are hardenedand the rest of the blade is soft and flexible. These are suitable for use by un-skilled or semi-skilledpersons.

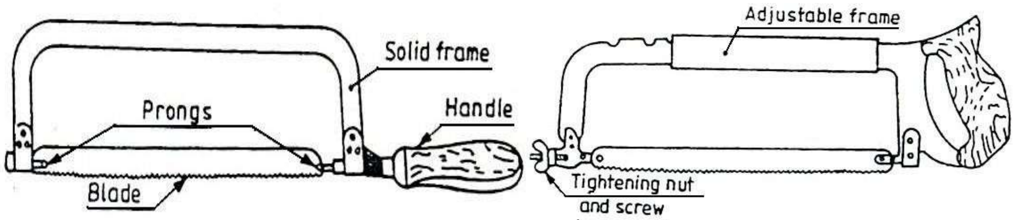



**Figure1.13:**Hacksawframewithblade

Theteethofthehacksawbladearestaggered, asshownin figureandknownasa‘setofteeth’. Thesemakeslotswiderthanthebladethickness,preventingthebladefromjamming.

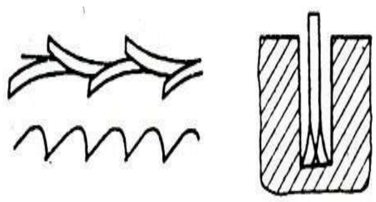


**Figure1.14:**Setofteeth

### 1.4.2 Chisels

Chisels are used for removing surplus metal or for cutting thin sheets. These tools are made from0.9% to 1.0% carbon steel of octagonal or hexagonal section. Chisels are annealed, hardened andtempered to produce a tough shank and hard cutting edge. Annealing relieves the internal stresses in ametal.Thecuttingangleofthechiselforgeneralpurpose isabout60°.

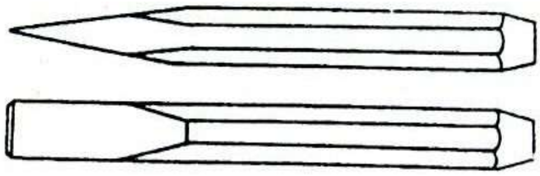


**Figure1.15:Flatchisel**

### 1.4.3 TwistDrill

Twist drills are used for making holes. These are made of High speed steel. Both straight andtapershanktwistdrillsareused.Theparallelshanktwistdrillcanbeheldinan ordinary self–centeringdrill check. The tapper shank twist drill fits into a corresponding tapered bore provided in the drillingmachinespindle.

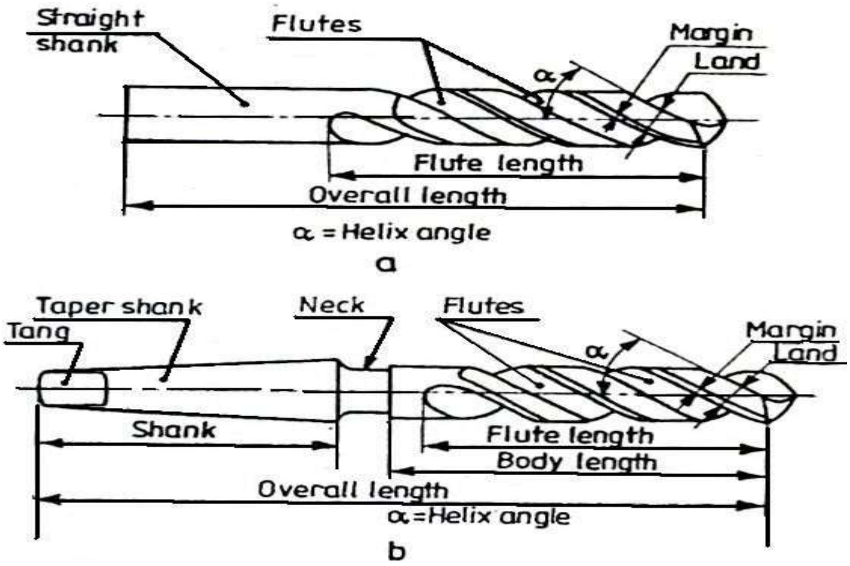



**Figure1.16:**Twistdrills

### 1.4.4 TapsandTapwrenches

A tap is a hardened and steel tool, used for cutting internal thread in a drill hole. Hand Taps areusually supplied in sets of three in each diameter and thread size. Each set consists of a tapper tap,intermediatetapandplugorbottomingtap.Tapsaremadeofhighcarbonsteelorhighspeedsteel.

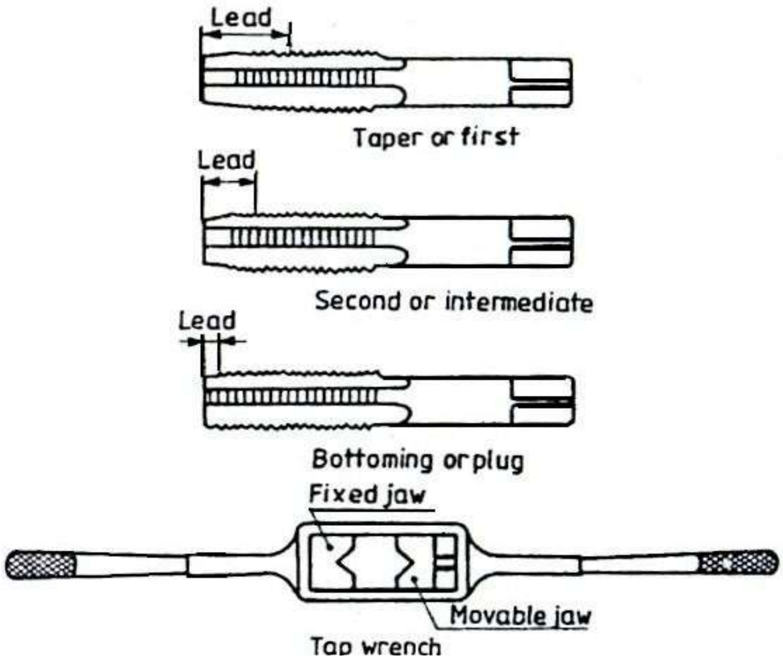


**Figure1.17:**Tapsandtapwrench

#### 1.4.5 Diesanddie-holders

Dies are the cutting tools used for making external thread. Dies are made either solid or splittype. They are fixed in a die stock for holding and adjusting the die gap. They are made of Steel or HighCarbonSteel.

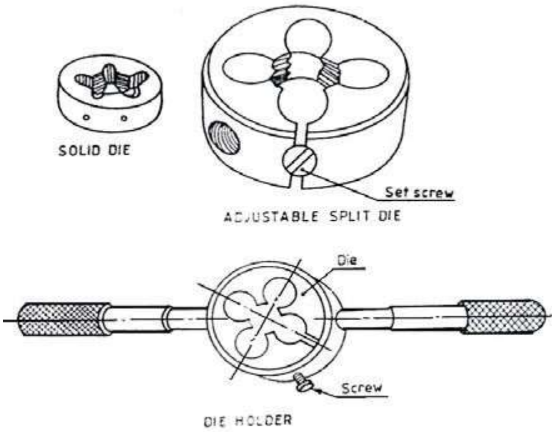


**Figure1.18:**Diesanddieholder

#### 1.4.6 BenchDrillingMachine

Holes are drilled for fastening parts with rivets, bolts or for producing internal thread. Benchdrillingmachineisthemostversatilemachineusedinafittingshopforthepurpose.Twistdrills,madeoftoolsteelorhighspeedsteelareusedwiththedrilling machinefordrillingholes.

Followingarethestagesindrillingwork

1. Selectthecorrectsizedrills,putitintothecheckandlockitfirmly
2. Adjustthespeedofthemachinetosuittheworkbychangingthebeltonthepulleys.Usehighspeedforsmall drillsandsoftmaterialsandlowspeedforlargediameterdrillsandhardmaterials.
3. Layoutofthelocationofthepoleandmarkitwithacenterpunch.
4. Holdtheworkfirmlyintheviceonthemachinetableandclampitdirectlyontothemachinetable.
5. Putonthepower,locatethepunchmarkandapplyslightpressurewiththeFeedHandle.

6. OnceDrillingiscommencedatthecorrectlocation,applyenoughpressureandcontinuedrilling.Whendrilling steelapplycuttingoil atthedrilling point.
7. Releasethepressureslightly,whenthedrillpointpiercesthelowersurfaceofthemetal.Thispreventsthedrillcatchinganddamagingtheworkordrill.
8. Oncompletionofdrillingretracethedrilloutoftheworkandput-offthepowersupply.

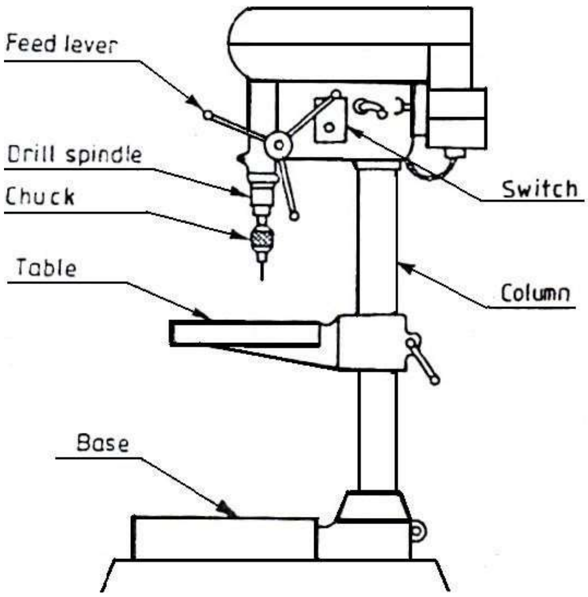



**Figure1.19:**Benchdrill

**1.5 FINISHINGTOOLS**

**1.5.1 Reamers**

Reamingisanoperationofsizingandfinishingadrilledhole,withthehelpofacuttingtoolcalledreamer having a number of cutting edges. For this, a hole is first drilled, the size of which is slightlysmaller than the finished size and then a hand reamer or machine reamer is used for finishing the holeto thecorrect size.

HandReamerismadeofHighCarbonSteelandhasleft-handspiralflutessothat,itispreventedfrom screwing into the whole during operation. The Shank end of the reamer is made straight so that itcan be held in a tap wrench. It is operated by hand, with a tap wrench fitted on the square end of thereamer and with the work piece held in the vice. The body of the reamer is given a slight tapper at itsworking end, for its easy entry into the whole during operation, it is rotated only in clock wise directionand also whileremovingitfromthe whole.

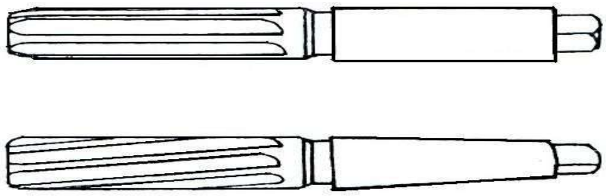


**Figure1.20:**Reamers

**1.5.2 Files**

Filing is one of the methods of removing small amounts of material from the surface of a metalpart.Afileishardenedsteeltoo,havingsmallparallelrowsofcuttingedgesorteethonitssurfaces.

On the faces, the teeth are usually diagonal to the edge. One end of the file is shaped to fit intoa wooden handle. The figure shows various parts of a hand file. The hand file is parallel in width andtapering slightly in thickness, towards the tip. It is provided with double cut teeth. On the faces, singlecutononeedgeandnoteethontheotheredge,whichisknownasasafeedge.

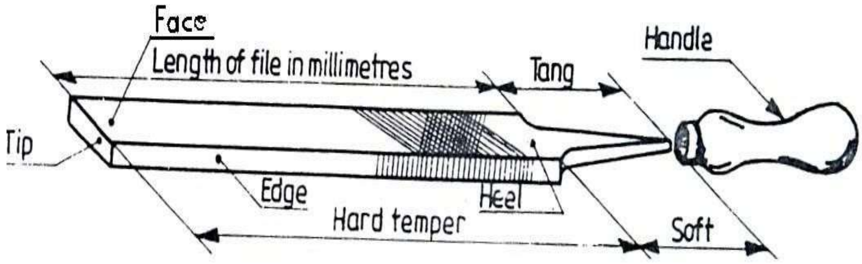



**Figure1.21**:Partsofahandfile

Filesareclassifiedaccordingtotheirshape,cuttingteethandpitchorgradeoftheteeth.Thefigureshows thevarioustypesoffilesbased ontheirshape.

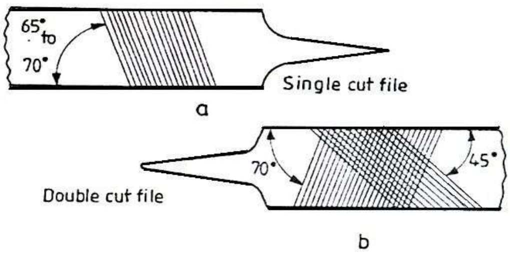
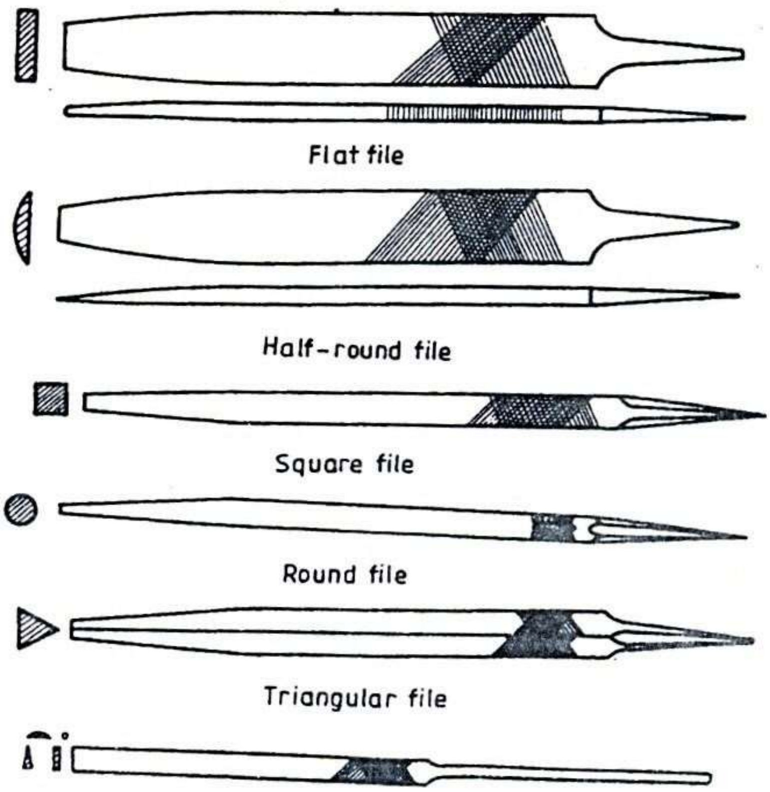



**Figure1.22:**Singleanddoublecutfiles




Needlefile

**Figure1.23:**Typesoffiles

## 1.6 MISCELLANEOUSTOOLS

### 1.6.1 Filecard

Itisametalbrush,used forcleaningthefiles,tofreethemfromfilings,cloggedin-betweenthe teeth.

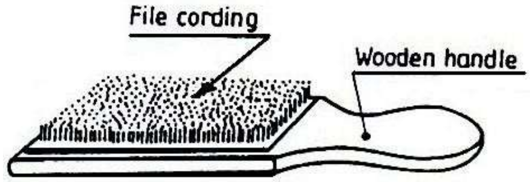



**Figure1.24:**Filecard

### 1.6.2 Spiritlevel

Itisusedtocheckthelevelingofmachines.

### 1.6.3 Ball-PeenHammer

Ball-PeenHammersarenamed,dependinguponttheirshapeandmaterialandspecifiedbytheirweight. A ball peen hammer has a flat face which is used for general work and a ball end, particularlyusedfor riveting.

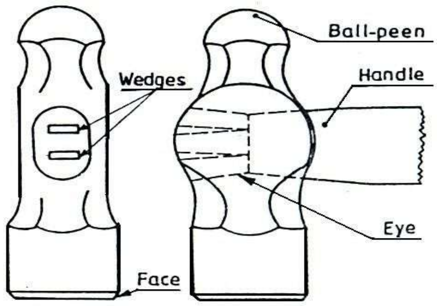



**Figure1.25:**Ballpeenhammer

### 1.6.4 Cross-PeenHammer

Itissimilartoballpeenhammer,excepttheshapeofthepeen.Thisisusedforchipping,riveting,bending andstretchingmetalsandhammeringinsidethecurvesandshoulders.

### 1.6.5 Straight-PeenHammer

Thisissimilartocrosspeenhammer,butitspeenisin-linewiththehammerhandle.Itisused forswaging,rivetinginrestrictedplacesandstretchingmetals.

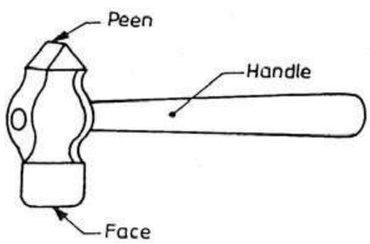



**Figure1.26:Crosspeenhammer**

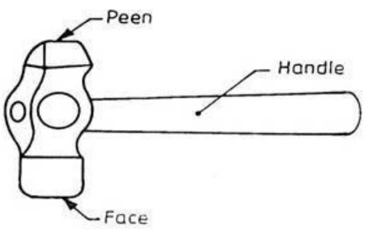



**Figure1.27:Straightpeenhammer**

### 1.6.6 Screwdriver

Ascrewdriverisdesignedtoturnscrews.Thebladeismadeofsteelandisavailableindifferentlengthsanddiameters.Thegrindingofthetiptothecorrectshapeisveryimportant.

Astarscrewdriverisspeciallydesignedtofittheheadofstarscrews.Theendofthebladeisflutedinsteadofflattened.Thescrewdriverisspecifiedbythelengthofthemetalpartfromhandletothetip.

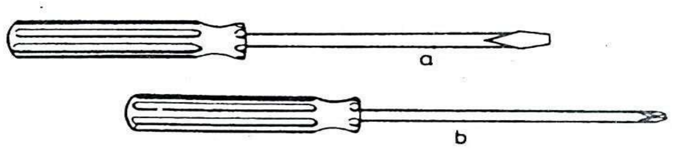



**Figure1.28:Screwdrivers**

### 1.6.7 Spanners

Aspannerorwrenchisatoolforturningnutsandbolts.Itisusuallymadeofforgedsteel.Thereare many kinds of spanners. They are named according to the application. The size of the spannerdenotesthesizeoftheboltonwhichitcanwork.

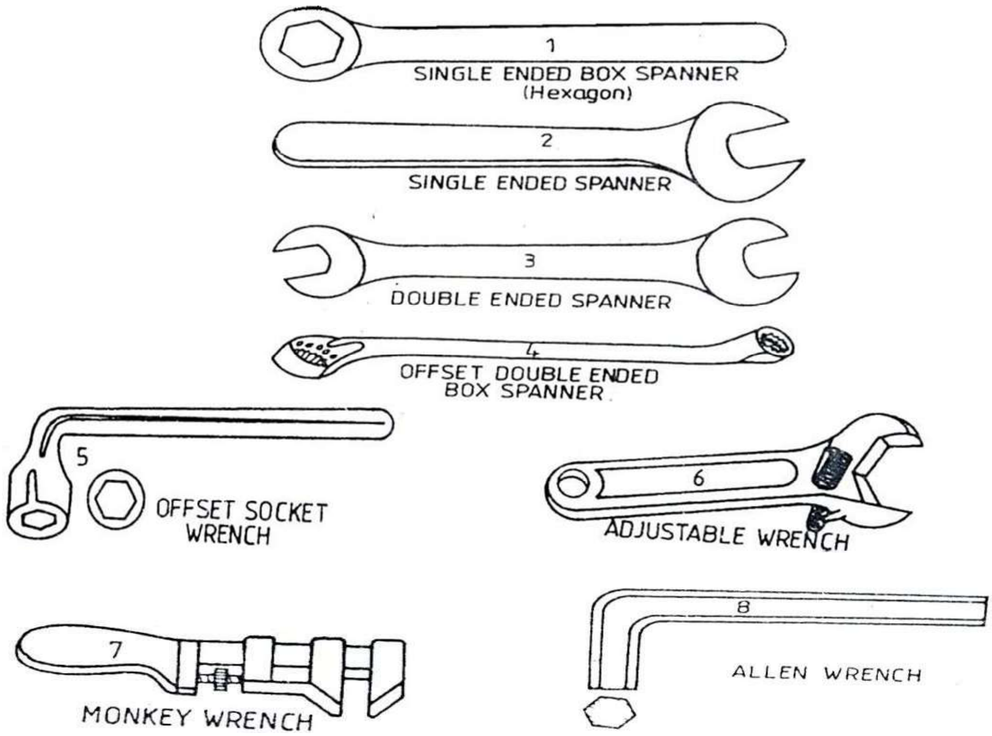



**Figure1.28:**Spanners

### 1.7 SAFEPRACTICE

Thefollowingare someofthesafeandcorrectworkpracticesinbenchworkandfittingshop,withrespecttothetools used

1. Keephandsandtoolswipedcleanandfreeofdirt,oilandgrease.Drytoolsaresafertousethanslipperytools .
2. Donotcarrysharptoolsonpockets.
3. Wearleathershoesandnotsandals.
4. Don'twearlooseclothes.
5. Donokeepworkingtoolsattheedgeofthetable.
6. Positiontheworkpiecesuchthatthecuttobemadeisclosetothevice.Thispracticepreventsspringing,sa w breakageandpersonalinjury.
7. Applyforceonlyontheforward(cutting)strokeandrelievetheforceonthereturnstrokewhilesawingand filing.
8. Donotholdtheworkpieceinhandwhilecutting.
9. Usethefilewithaproperlyfittedtighthandle.
10. Afterfiling,removetheburrsfromtheedgesofthework,topreventcutstothefingers.
11. Donotuseviceasananvil.

12. Whilesawing,keepthebladestraight;otherwiseitwillbreak
13. Donotuseafilewithouthandle.
14. Cleantheviceafteruse.

**1.8 MODELSFORPRACTICE**

Preparethemodels,asperthedimensionsandfitsshowninbelow.

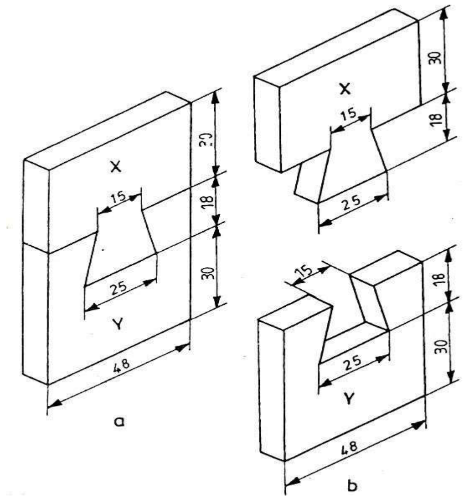



**Figure1.30:**DovetailFitting

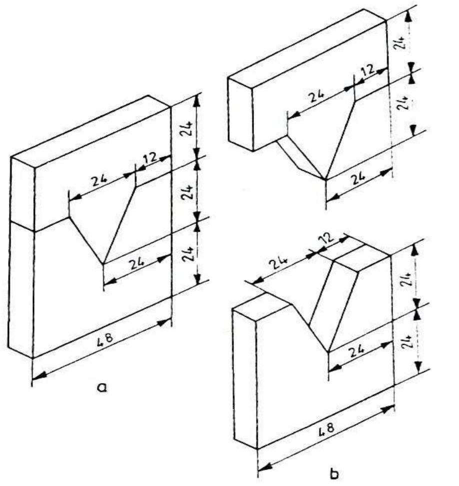



**Figure1.31:**V-fitting

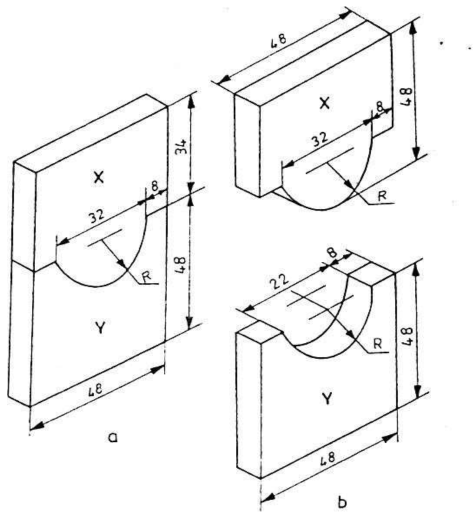



**Figure1.32:**Half-roundfitting

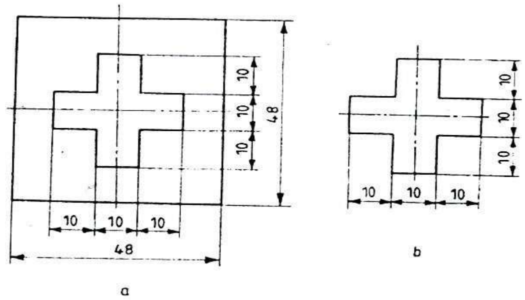



**Figure1.33:**Crossfitting

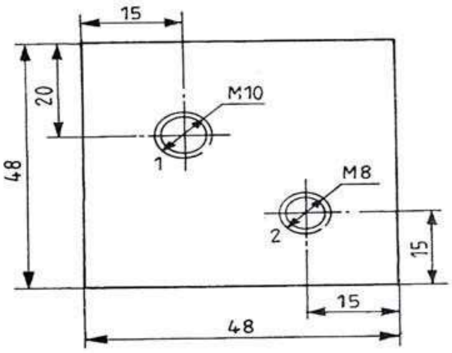



**Figure1.34:**DrillingandTapping

*Exercise1*

**SquareFiling**

**Aim**

TofilethegiventwoMildSteelpiecesintoasquareshapeof48mmsideasshowninFigureF-E1

**Toolsrequired**

Benchvice,setofFiles,Steelrule,Try-square,Verniercaliper,Vernierheightgauge,Ball-peenhammer,Scriber, Dotpunch, Surfaceplate,AngleplateandAnvil.

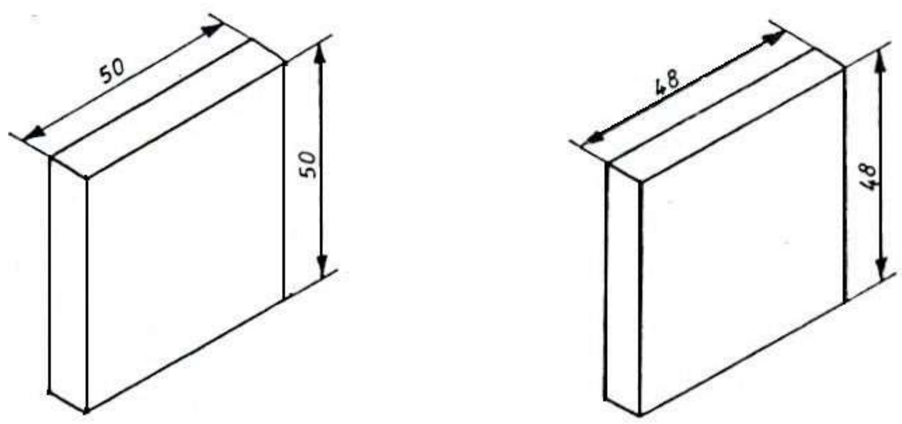
**Sequenceofoperations**

1. Thedimensionsofthegivenpiecearecheckedwiththesteelrule.
2. Thejobisfixedrigidlyinabenchviceandthetwoadjacentsidesarefiled,usingtheroughflatfilefirstandthen the smoothflatfilesuchthat,thetwosidesareatrightangle.
3. Therightangleofthetwoadjacentsidesischeckedwiththetry-square.
4. Chalkisthenappliedonthesurfaceoftheworkpiece.
5. Thegivendimensionsaremarkedbyscribingtwolines,withreferencetotheabovetwodatumsidesbyusingVer nierheight gauge,AngleplateandSurfaceplate.
6. Usingthedotpunch,dotsarepunchedalongtheabovescribedlines.
7. Thetwosidesarethenfiled,byfittingthejobinthebenchvice;followedbycheckingtheflatnessofthesurfac es.

Asthematerialremovalthroughfilingisrelativelyless,filingisdoneinsteadofsawing.

**Result**

Thesquarepiecesof48mmsideisthusobtainedbyfiling,asdiscussedabove.



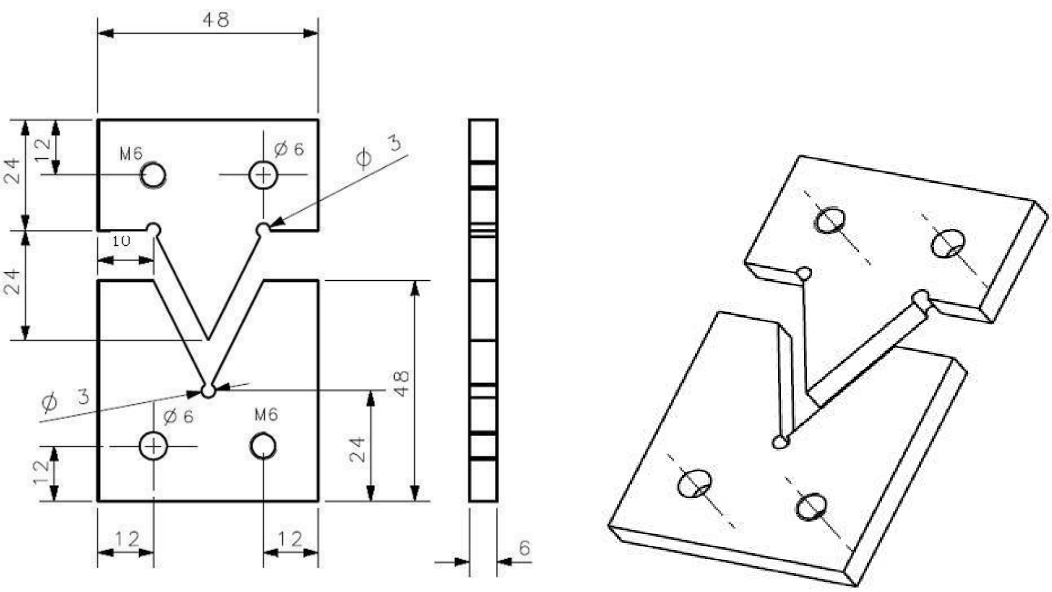

a.Rawmaterial b.Finishedjob

**FigureF-E1:**Squarefiling

*Exercise2*
**V-Fitting**

**Aim**
TomakeV-fitfromthegiventwoMSplatesanddrillingandTappingasshowninFigureF-E2
**Toolsrequired**
Bench vice, set of Files, Try-square, Scriber, Steel rule, Ball-peen hammer, Dot punch, Hacksaw, Verniercaliper, Surface plate, Angle plate, Vernier height gauge, 5mm drill bit, 3mm drill bit, M6 tap set withwrench,AnvilandDrilling machine.
**Sequenceofoperations**
1. Theburrsinthepiecesareremovedandthedimensionsarecheckedwithsteelrule.
2. MakebothpiecessurfacelevelsandrightanglesbyfixingintheVice,useFilesforremovingmaterialtoget level.
3. WiththehelpofTrysquarechecktherightanglesandsurfacelevels.
4. UsingSurfaceplateandAngleplatemarkthegiventwometalpiecesasperdrawingwithVernierheight gauge.
5. PunchthescribedlineswithdotpunchandhammerkeepingontheAnvil.Punchtopunchgive5mmgap.
6. CutexcessmaterialwherevernecessarywithHacksawframewithblade,DrillbitsandTaps.
7. Thecornersandflatsurfacesarefiledbyusingsquare/flatandtriangularfiletogetthesharpcorners.
8. Dimensionsarecheckedbyverniercaliperandmatchthetwopieces.Anydefectnoticed,arerectifiedbyfiling with asmoothfile.
9. Careistakentoseethatthepuncheddotsarenotcrossed,whichisindicatedbythehalfofthepunchdotsleft onthe pieces.

**Result**
TherequiredV-fittingisthusobtained,byfollowingthestages,asdescribedabove.




**FigureF-E2:V-Fitting**

# Chapter 2
# CARPENTRY

## 2.1 INTRODUCTION

Carpentry may be defined as the process of making wooden components. It starts from amarketable form of wood and ends with finished products. It6 deals with the building work, furniture,cabinet making. Etc. joinery, i.e., preparation of joints is one of the important operations in all wood-works.Itdealswiththespecificworkofcarpenterlikemakingdifferenttypesofjointstoformafinishedproduct.

## 2.2 TIMBER

Timber is the name given to the wood obtained from well grown trees. The trees are cut, sawninto varioussizestosuitbuilding purposes.

The word, 'grain', as applied to wood, refers to the appearance or pattern of the wood on thecut surfaces. The grain of the wood is a fibrous structure and to make it strong, the timber must be socut,that thegrainsrunparalleltothelength.

### 2.2.1 Timbersizes

Timber sold in the market is in various sizes and shapes. The following are the common shapesand sizes.

a. Log -Thetrunkofthetreewhichisfreefrombranches.
b. Balk -Thelog,sawntohaveroughlysquarecrosssection.
c. Post -Atimberpiece,roundorsquareincrosssection,havingitsdiameterorsidefrom175to300mm.
d. Plank -Asawntimberpiece,withmorethan275mminwidth,50to150mminthicknesand 2.5to6.5metersin length.
e. Board -Asawntimberpiece,below175mminwidthand30to50mminthickness.
f. Reapers - Sawntimber piecesof assorted andnon-standardsizes, which do not confirmtotheaboveshapesandsizes.

### 2.2.2 ClassificationofTimber

Wood suitable for construction and other engineering purposes is called timber. Woods ingeneralaredividedintotwo broadcategories:Soft woods andHardwoods.

*Soft woods* are obtained from conifers, kair, deodar, chir, walnut and seemal. Woods obtainedfromteak,sal,oak,shisham,beach,ashmango,neemandbabulareknownas *hardwood*,butitishighlydurable.

Another classification of woods is based on the name of the trees like teak, babul, shisham,neem, kair,chir,etc.

### 2.2.3 SeasoningofWood

A newly felled tree contains considerable moisture content. If this is not removed, the timber islikely to wrap, shrink, crack or decay. Seasoning is the art of extracting the moisture content undercontrolledconditions,atauniformrate,fromallthepartsofthetimber.Onlyseasonedwoodshouldbeusedforallcarpentryworks.Seasoningmakesthewoodresilientandlighter.Further,itensuresthatthewoodwillnotdistortafteritismadeinto anobject.

### 2.2.4 CharacteristicsofGoodTimber

Thegoodtimbermustpossessthefollowingcharacteristics

a. Itshouldhaveminimummoisturecontent,i.e.,thetimbershouldbewellseasoned.
b. Thegrainsofwoodshouldbestraightandlong.
c. Itmustretainitsstraightnessafterseasoning.
d. Itshouldproducenearmetallicsoundonhammering.
e. Itshouldbefreefromknotsorcracks.
f. Itshouldbeofuniformcolor,throughoutthepartofthewood.

g. Itshouldrespondwelltothefinishingandpolishingoperations.
h. Duringdrivingthenailsandscrew,itshouldnotspliteasily.

## 2.3 MARKINGANDMEASURINGTOOLS

Accurate marking and measurement is very essential in carpentry work, to produce parts toexact size. To transfer dimensions onto the work; the following are the marking and measuring toolsthatarerequiredin acarpentry shop.

### 2.3.1 SteelruleandSteeltape

Steel rule is a simple measuring instrument consisting of a long, thin metal strip with a markedscale of unit divisions. It is an important tool for linear measurement. *Steel tape* is used for largemeasurements,suchasmarkingonboardsandcheckingtheoveralldimensionsofthework.

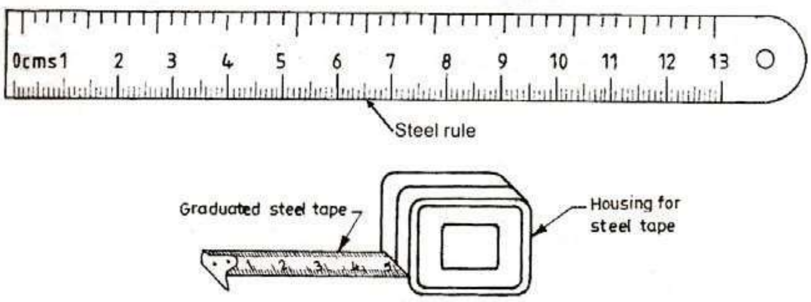
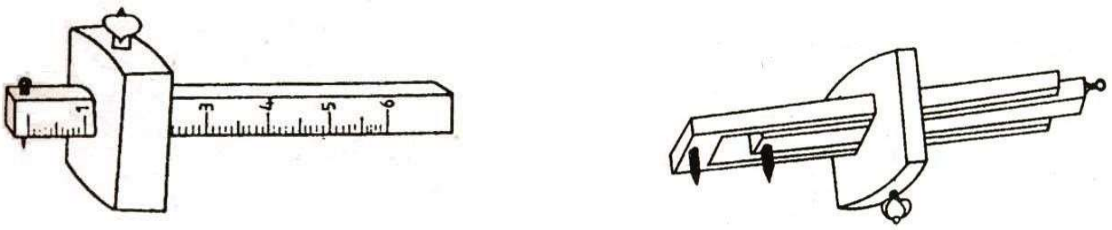



**Figure2.1:**SteelruleandSteeltape

### 2.3.2 Markinggauge

It is a tool used to mark lines parallel to the edge of a wooden piece. It consists of a squarewoodenstemwithaslidingwoodenstock(head)onit.Onthestemisfittedamarkingpin,madeofsteel.The stock is set at any desired distance from the marking point and fixed in position by a screw. Itmustbe ensured that the marking pin projects through the stem, about 3 mm and the end are sharp enoughtomakeavery fineline. A*mortisegauge*consistsoftwopins.Inthis,itispossibletoadjustthedistancebetweenthepins, todrawtwoparallellinesonthestock.



a.Markinggauge b.Mortisegauge

**Figure2.2:**Markinggauges

### 2.3.3 Try-square

Itisusedformarkingandtestingthesquarenessandstraightness ofplanedsurfaces.Itconsistsofasteelblade,fittedinacastironstock.Itisalsousedforcheckingtheplanedsurfacesforflatness.Itssizevariesfrom150to300mm,accordingtothelengthoftheblade.Itislessaccuratewhencomparedtothetry-square usedin thefitting shop.

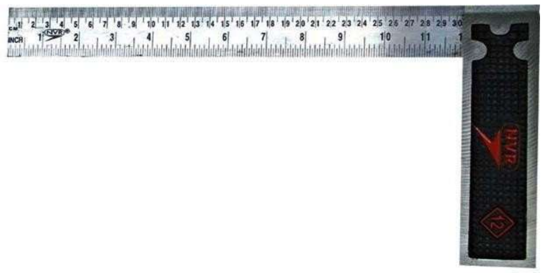


**Figure2.3:**Trysquare

### 2.3.4 Compassanddivider

Compassanddivider,areusedformarkingarcsandcirclesontheplanedsurfacesofthewood.

#### 2.3.5 Scriberormarkingknife

It is used for marking on timber. It is made of steel having one end pointed and the other endformed into a sharp cuttingedge.

#### 2.3.6 Bevel

It is used for laying-out and checking angles. The blade of the bevel is adjustable and may beheldinplaceby athumbscrew.Afteritissettothedesiredangle,itcanbeusedinmuchthesamewayas a try-square. A good way to set it to the required angle is to mark the angle on a surface and thenadjust thebladetofit theangle.

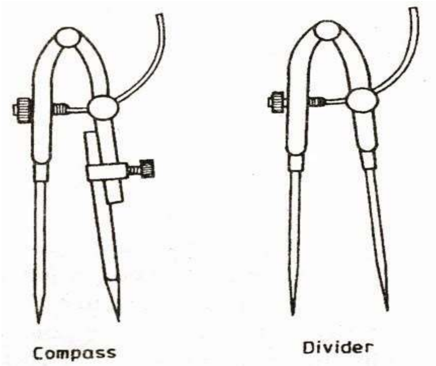



**Figure2.4:**CompassandDivider

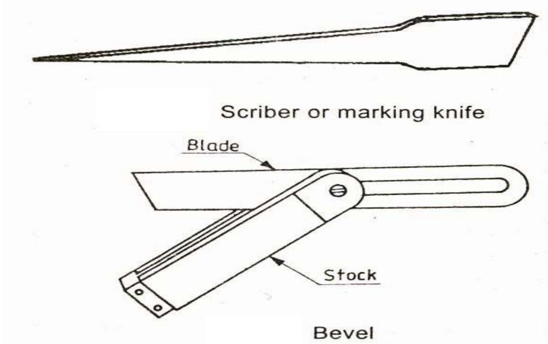



**Figure2.5:**ScriberandBevel

### 2.4 HOLDINGTOOLS

#### 2.4.1 Carpenter'svice

Figure 2.6 shows the carpenter's bench vice, used as a work holding device in a carpenter shop.Itsonejawisfixedtothesideofthetablewhiletheotherismovablebymeansofascrewandahandle.TheCarpenter'svice jaws arelinedwithhard wooden' faces.

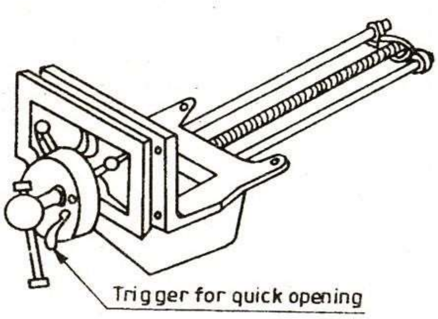



**Figure2.6:**Carpentersvice

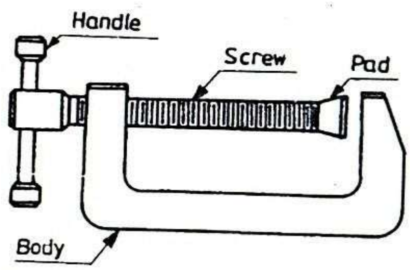



**Figure2.7:**C-clamp

#### 2.4.2 C-clamp

Figure2.7showsaC-clamp,whichisusedforholdingsmallworks.

#### 2.4.3 Barcramp

Figure2.8showsabarcramp.ItismadeofsteelbarofT-section,withmalleableironfittingsandasteelscrew.Itis usedforholdingwideworkssuchasframesortops.

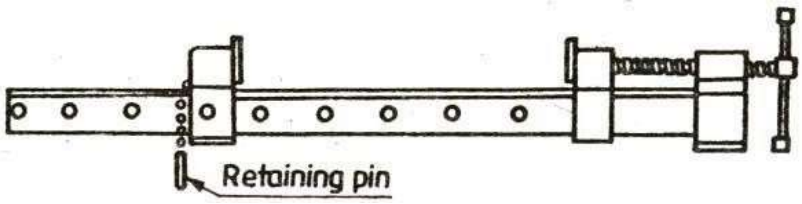



**Figure2.8:**barcramp

**2.5 PLANINGTOOLS**

Planing is the operation used to produce flat surfaces on wood. A plane is a hand tool used forthis purpose.Thecuttingbladeused inaplaneisverysimilartoachisel.Thebladeofaplaneis fittedinawoodenormetallicblock,atanangle.

**2.5.1 Jackplane**

It is the most commonly used general purpose plane. It is about 35 cm long. The cutting iron(blade) should have a cutting edge of slight curvature. It is used for quick removal of material on roughworkandisalsoused inobliqueplanning.

**2.5.2 Smoothingplane**

It is used for finishing work and hence, the blade should have a straight cutting edge. It is about20to25cmlong.Being short,itcanfolloweventheslightdepressionsinthestock,betterthanthejackplane.It is usedafter usingthejack plane.

**2.5.3 Rebateplane**

It is used for making a rebate. A rebate is a recess along the edge of a piece of wood, which isgenerallyused forpositioningglassin framesanddoors.

**2.5.4 Ploughplane**

It is used to cut grooves, which are used to fix panels in a door. Figure 2.9 shows the varioustypesofplanesmentionedabove.

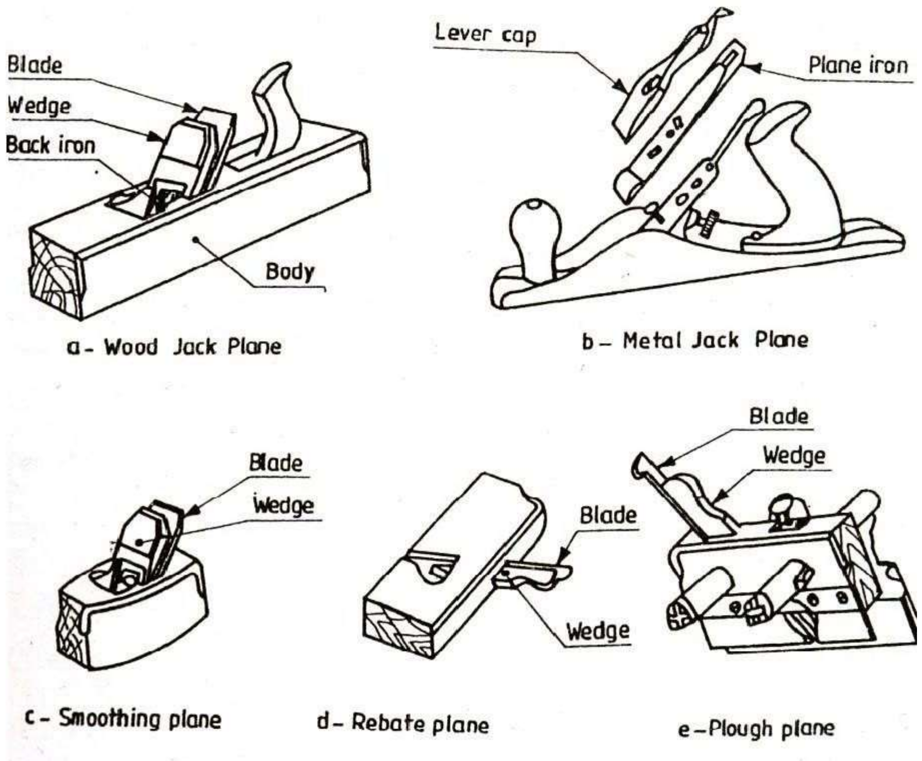



**Figure2.9:**Typesofplanes

**2.6 CUTTINGTOOLS**

**2.6.1 Saws**

Asawisusedtocutwoodintopieces.Therearedifferenttypesofsaws,designedtosuitdifferentpurposes.Asaw isspecifiedbythelengthofitstoothed edge.

**2.6.1.1 Cross-cutorhandsaw**

Itisusedtocutacrossthegrainsofthestock.Theteetharesosetthatthesawkerfwillbewiderthanthebla dethickness.Thisallowsthebladetomovefreelyinthecut,withoutsticking.

#### 2.6.1.2 Ripsaw

It is used for cutting the stock along the grains. The cutting edge of this saw makes a steeperangle,i.e.,about60°whereasthatofcrosscutsawmakesanangleof45°withthesurfaceofthestock.

#### 2.6.1.3 Tenonsaw

Itis usedforcuttingthestock eitheralongoracrossthegrains.Itisusedforcuttingtenonsandinfinecabinetwork.However,itisusedforsmall andthincuts.Thebladeofthissawisverythinandsoitisstiffenedwithathickbacksteelstrip.Hence,thisissomet imescalledasback-saw.Inthis,theteethareshapedlikethoseofcross-cutsaw.

#### 2.6.1.4 Compasssaw

Ithasanarrow,longerandstrongertaperingblade,whichisusedforheavyworks(Fig.1.13).Itismostly usedinradiuscutting.Thebladeofthissawisfittedwithanopentypewoodenhandle.

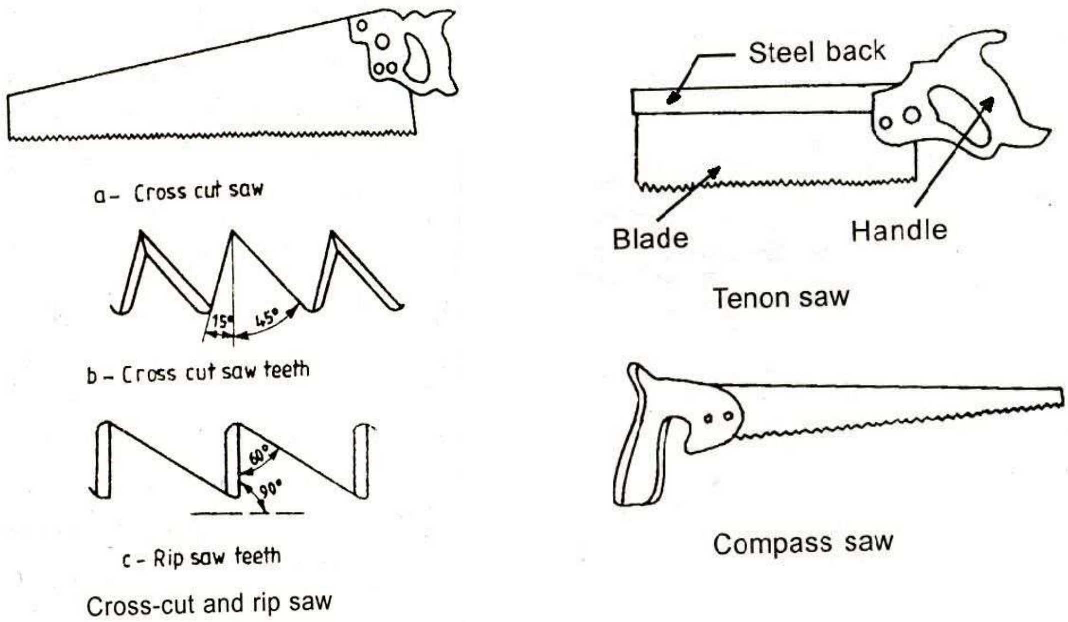



**Figure2.10:**Typesofsaws

### 2.6.2 Chisels

Chisels are used for cutting and shaping wood accurately. Wood chisels are made in variousbladewidths,rangingfrom3to50mm.Theyarealsomadeindifferentbladelengths.Mostofthewoodc hisels are made into tang type, having a steel shank which fits inside the handle. These are madeofforged steelortoolsteelblades.

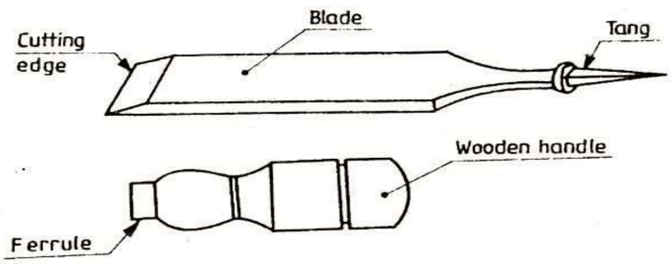



**Figure2.11:**Partsofchisel

#### 2.6.2.1 Firmerchisel

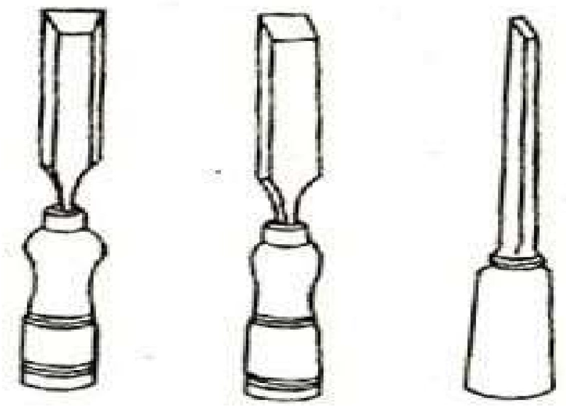
The word 'firmer' means 'stronger' and hence firmer chisel is stronger than other chisels. It is ageneralpurposechiselandisusedeitherbyhandpressureorbyamallet.Thebladeofafirmerchiselisflat,as shown inFigure2.12a.

#### 2.6.2.2 Dovetailchisel

It has a blade with a beveled back, as shown in Figure, due to which it can enter sharp comersforfinishing,as indovetailjoints.

#### 2.6.2.3 Mortisechisel

It is used for cutting mortises and chipping inside holes, etc. The cross-section of the mortise chisel isproportioned to withstand heavy blows during mortising. Further, the cross-section is made strongernearthe shank.



a.Firmer b.Dovetail c.Mortise

**Figure2.12:** Typesof chisels

## 2.7 DRILLINGANDBORINGTOOLS

### 2.7.1 Carpenter'sbrace

It is used for rotating auger bits, twist drills, etc., to produce holes in wood. In some designs,braces are made with ratchet device. With this, holes may be made in a corner where completerevolutionofthehandlecannotbemade.Thesizeofabraceisdeterminedbyitssweep.

### 2.7.2 Augerbit

Itisthemostcommontoolusedformakingholesinwood.Duringdrilling,theleadscrewofthebit guides into the wood, necessitating only moderate pressure on the brace. The helical flutes on thesurfacecarry thechipstotheoutersurface.

### 2.7.3 Handdrill

Carpenter's brace is used to make relatively large size holes; whereas hand drill is used fordrilling small holes. A straight shank drill is used with this tool. It is small, light in weight and may beconveniently used than the brace. The drill bit is clamped in the chuck at its end and is rotated by ahandleattachedtogearandpinionarrangement.

### 2.7.4 Gimlet

It has cutting edges like a twist drill. It is used for drilling large diameter holes with the handpressure.

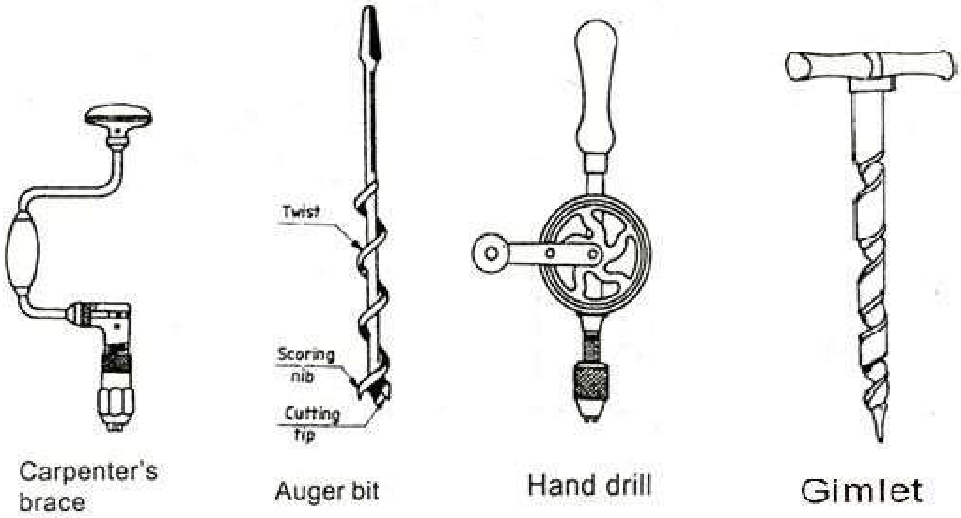



**Figure2.13:**Drillingtools

## 2.8 MISCELLANEOUSTOOLS

### 2.8.1 Mallet

It is used to drive the chisel, when considerable force is to be applied, which may be the case inmakingdeeproughcuts.Steelhammershouldnotbeusedforthepurpose,asitmaydamagethechiselhandle. Further,forbettercontrol,itisbettertoapplyaseriesoflighttapswiththemalletratherthanaheavysingle blow.

### 2.8.2 Pincer

Itismadeoftwoforgedsteelarmswithahingedjointandisusedforpulling-outsmallnailsfromwood. The inner faces of the pincer jaws are beveled and the outer faces are plain. The end of onearmhas a ball and the other has a claw. The beveled jaws and the claw are used for pulling out small nails,pinsandscrewsfromthewood.

### 2.8.3 Clawhammer

It has a striking flat face at one end and the claw at the other, as shown in figure. The face isused to drive nails into wood and for other striking purposes and the claw for extracting relatively largenailsoutofwood.Itis madeofcaststeelandweighs from0.25kgto0.75kg.

### 2.8.4 Screwdriver

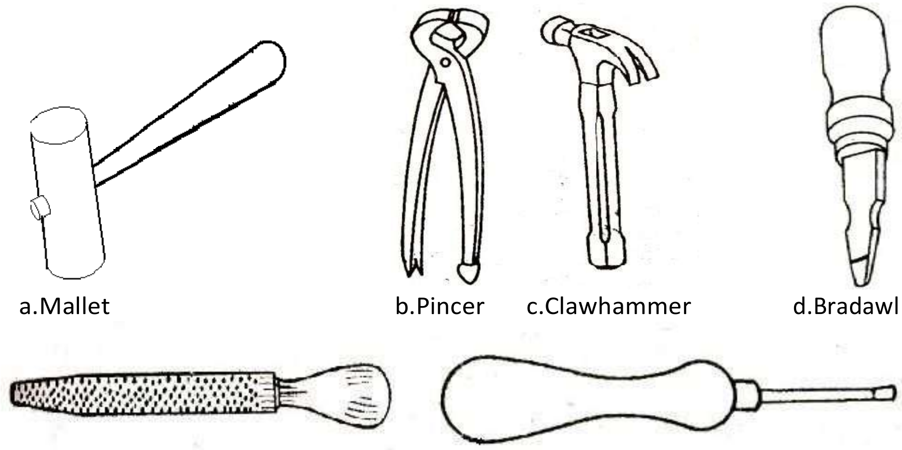
Itisusedfordrivingscrewsintowoodorunscrewingthem.Thescrewdriverofacarpenterisdifferentfro mtheothercommontypes,asshowninfigure.
Thelengthofascrewdriverisdeterminedbythelengthoftheblade.Asthelengthofthebladeincreases,thewidth andthicknessofthetip alsoincrease.

### 2.8.5 Woodraspfile

Itisafinishingtoolusedtomakethewoodsurfacesmooth,removesharpedges,finishfilletsandotherint erior surfaces.Sharpcuttingteethareprovidedonits surfaceforthepurpose.Thisfileisexclusivelyusedinwoodwork.

### 2.8.6 Bradawl

Itisahandoperatedtool,usedtoboresmallholesforstartingascreworlargenail.



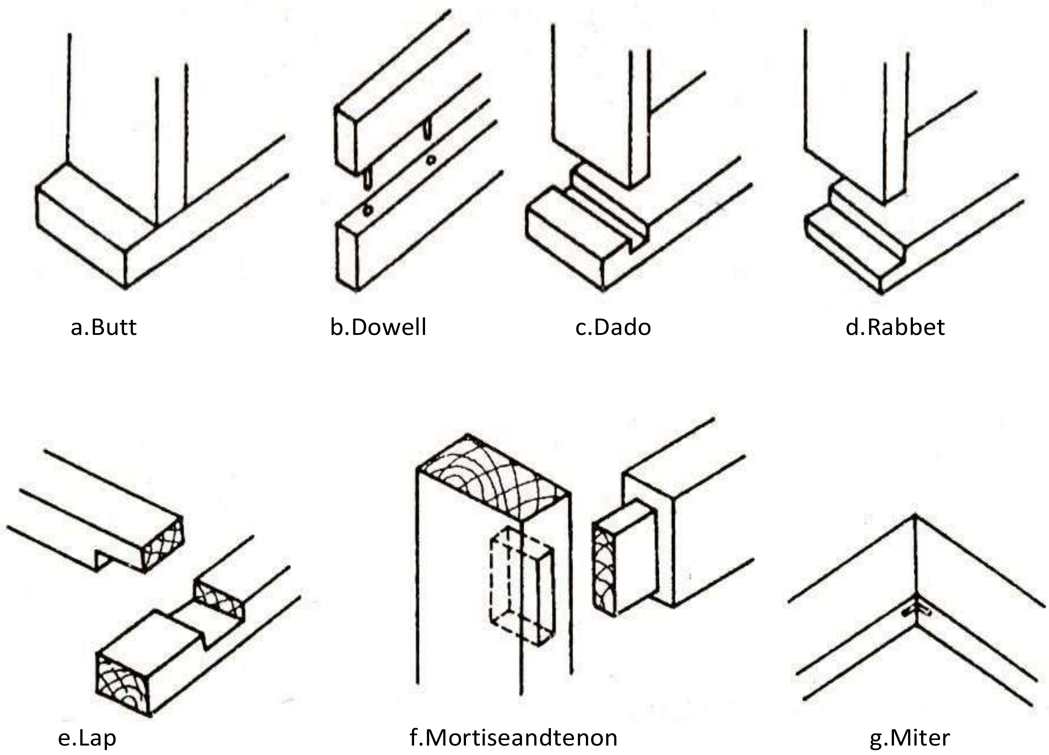
a.Mallet b.Pincer c.Clawhammer d.Bradawl

e.Woodraspfile f.Screwdriver

**Figure2.14:**Miscellaneoustools

**2.9 WOODJOINTS**

There are many kinds of joints used to connect wood stock. Each joint has a definite use andrequires lay in-out, cutting them together. The strength of the joint depends upon amount of contactarea.Ifaparticularjointdoes nothavemuchcontactarea,thenitmustbereinforcedwithnails,screwsordowels.Thefigure 2.15showssomecommonly usedwoodjoints.



a.Butt b.Dowell c.Dado d.Rabbet

e.Lap f.Mortiseandtenon g.Miter

**Figure2.15:**Commonwoodjoints

**2.9.1 Lapjoints**

Inlapjoints,anequalamountofwoodisremovedfromeachpiece,as showninfigure2.16.Lapjoints are easy to layout, using a try-square and a marking gauge. Follow the procedure suggested forsawingandremovingthewastestock.Ifthejointisfoundtobetootight,itisbettertoreducethewidthof the mating piece, instead of trimming the shoulder of the joint. This type of joint is used for smallboxestolargepiecesoffurniture.

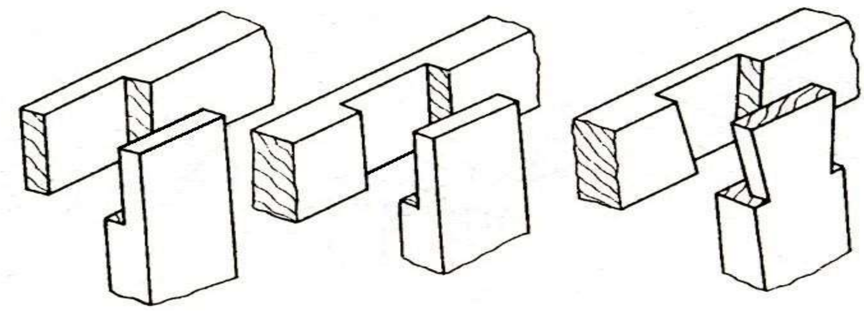


**Figure2.16:**Lapjoints

### 2.9.2 MortiseandTenonJoints

Itisusedintheconstructionofqualityfurniture.Itresultsinastrongjointandrequiresconsiderableskillt omakeit.Thefollowingarethestagesinvolvedinthework.

a. Markthemortiseandtenonlayouts.
b. Cutthemortisefirstbydrillingseriesofholeswithinthelayoutline,chiselingoutthewastestockand trimmingthecornersand sides.
c. Preparethetenonbycuttingandchiseling.
d. Checkthetenonsizeagainstthemortisethathasbeenpreparedandadjustitifnecessary.

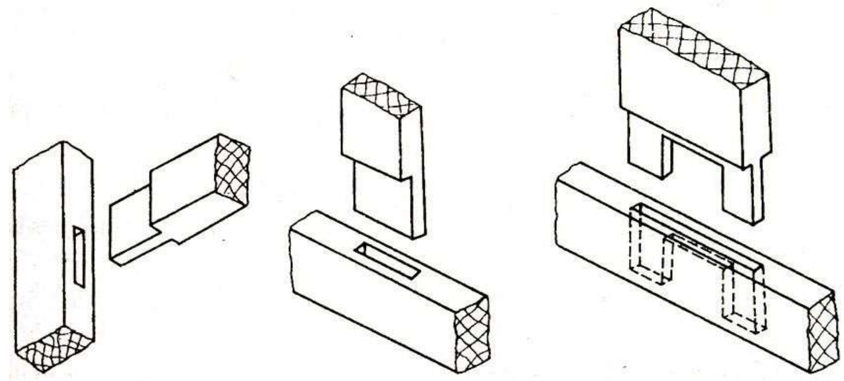


**Figure2.17:**MortiseandTenonjoints

### 2.9.3 Bridlejoint

Thisisthereverseofmortiseandtenonjointinform.Themarking-outofthejointisthesameasfor mortise and tenon joint. This joint is used where the members are of square or near square sectionand unsuitableformortiseand tenonjoint.

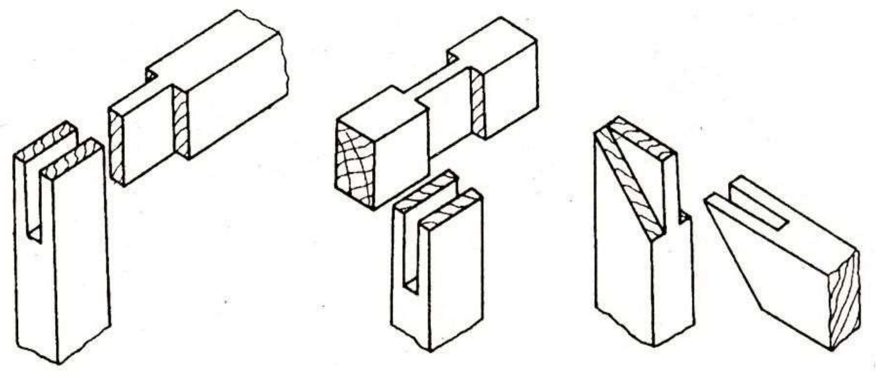


**Figure2.18:**Bridlejoint

**2.10 SAFEPRACTICE**

Thefollowingaresomeofthesafeandcorrectworkpracticesincarpentryshop,withrespecttothetools used

1. Toolsthatarenotbeingusedshouldalwaysbekeptattheirproperplaces.
2. Makesurethatyourhandsarenotinfrontofsharpedgedtoolswhileyouareusingthem.
3. Useonlysharptools.Adulltoolrequiresexcessivepressure,causingthetooltoslip.
4. Woodenpieceswithnails,shouldneverbeallowedtoremainonthefloor.
5. Becarefulwhenyouareusingyourthumbasaguideincross-cuttingandripping.
6. Testthesharpnessofthecuttingedgeofchiselonwoodorpaper,butnotonyourhand.
7. Neverchiseltowardsanypartofthebody.
8. Donotusechiselswherenailsarepresent.Donotusechiselasascrewdriver.
9. Donotuseasawwithaloosehandle.
10. Alwaysusetriangularfileforsharpeningtheteeth.
11. Donotuseasawonmetallicsubstances.
12. Donotusemallettostrikenails.
13. Donotuseplaneattheplaces,whereanailisdriveninthewood.

*Exercise1*

**T-Lapjoint**

**Aim**

TomakeaT-lapjointasshowninFigure2.19,fromthegivenreaperofsize50x35x250mm.

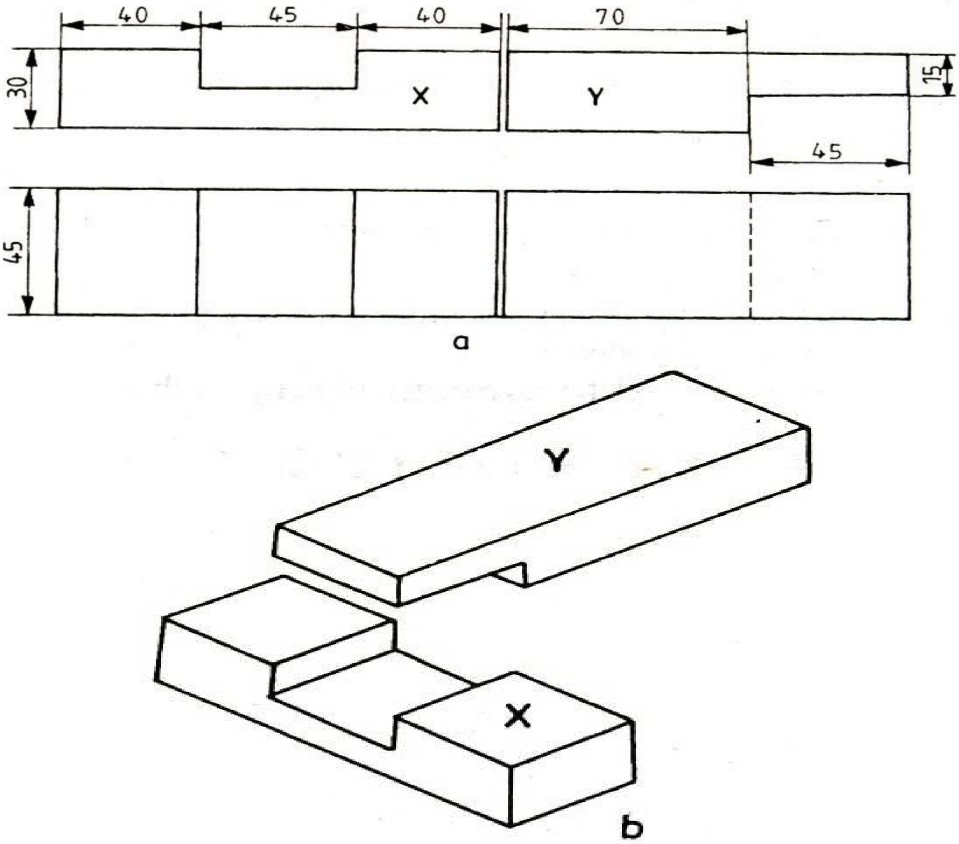
**Toolsrequired**

Carpenter'svice,steelrule,jackplane,try-square,markinggauge,25mmfirmerchisel,cross-cutsaw,tenonsaw, scriberandmallet.

**Sequenceofoperations**

1. Thegivenreaperischeckedtoensureitscorrectsize.
2. Thereaperisfirmlyclampedinthecarpenter'sviceandanytwoadjacentfacesareplanedbythejackplanea ndthetwo faces arechecked forsquarenesswiththetrysquare.
3. Marking gauge issetandlinesaredrawnat30and45mm,tomarkthethicknessandwidth ofthemodelrespectively.
4. Theexcessmaterialisfirstchiseledoutwithfirmerchiselandthenplanedtocorrectsize.
5. ThematingdimensionsofthepartsXandYarethenmarkedusingscaleandmarkinggauge
6. Usingthecross-cutsaw,theportionstoberemovedarecutinboththepieces,followedbychiselingandalsothe parts XandYareseparatedbycross-cutting,usingthetenonsaw
7. Theendsofboththepartsarechiseledtotheexactlengths.
8. Afinefinishingisgiventotheparts,ifrequiredsothat,properfittingisobtained.
9. Thepartsarefittedtoobtainaslightlytightjoint.

**Result** TheT-Lapjointisthusmadebyfollowingtheabovesequenceofoperations.




**FigureC-E1:**T-lapjoint

*Exercise2*

**Dovetaillapjoint**

**Aim**

TomakeadovetaillapjointasshowninFigure2.20,fromthegivenreaperofsize50x35 x250mm.

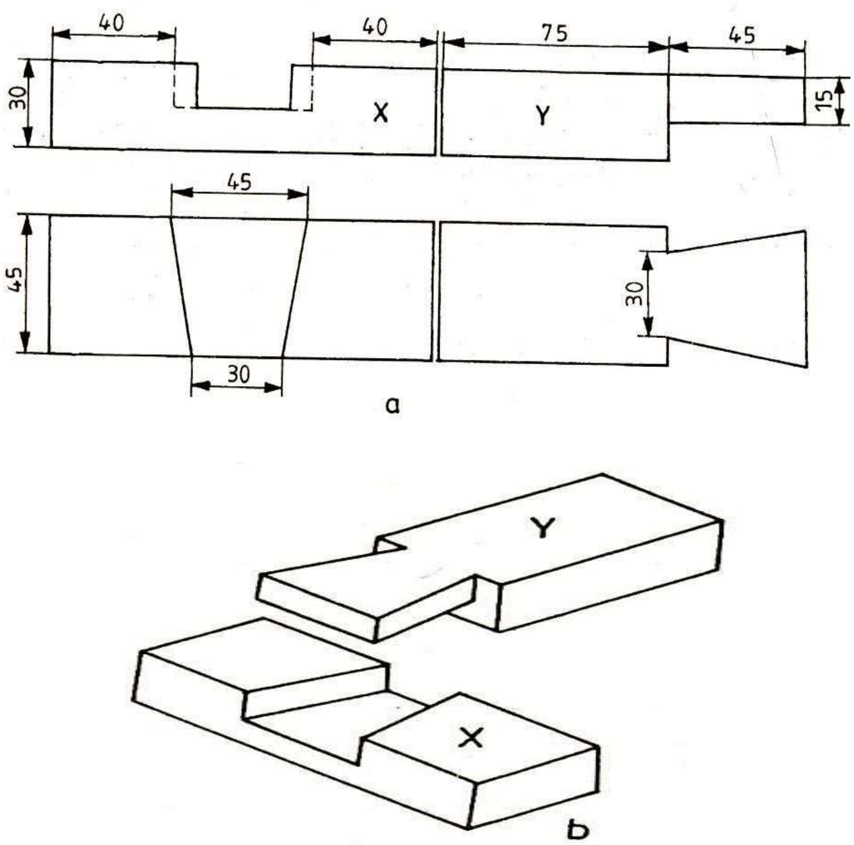
**Toolsrequired**

Carpenter'svice,steelrule,jackplane,try-square,markinggauge,25mmfirmerchisel,cross-cutsaw,tenonsaw, scriberandmallet.

**Sequenceofoperations**

1. Thegivenreaperischeckedtoensureitscorrectsize.
2. Thereaperisfirmlyclampedinthecarpenter'sviceandanytwoadjacentfacesareplanedbythejackplanea ndthetwo faces arechecked forsquarenesswiththetrysquare.
3. Marking gauge is set and lines are drawn at 30 anc145 mm, to mark the thickness and width of themodelrespectively.
4. Theexcessmaterialisfirstchiseledoutwithfirmerchiselandthenplanedtocorrectsize.
5. ThematingdimensionsofthepartsXandYarethenmarkedusingscaleandmarkinggauge.
6. Usingthecross-cutsaw,theportionstoberemovedarecutinboththepieces,followedbychiselingandalso theparts XandYareseparatedbycrosscutting, usingthetenonsaw.
7. Theendsofboththepartsarechiseledtoexactlengths.
8. Afinefinishingisgiventotheparts,ifrequiredsothat,properfittingisobtained.
9. Thepartsarefittedtoobtainaslightlytightjoint.

**Result** Thedovetaillapjointisthusmadebyfollowingtheabovesequenceofoperations.




**FigureC-E2:**Dovetaillapjoint

*Exercise3*

**MortiseandTenonjoint**

**Aim**

Tomakeamortiseandtenonjointasshowninfig.1.34b,fromthegivenreaperofsize50x35x250mm.

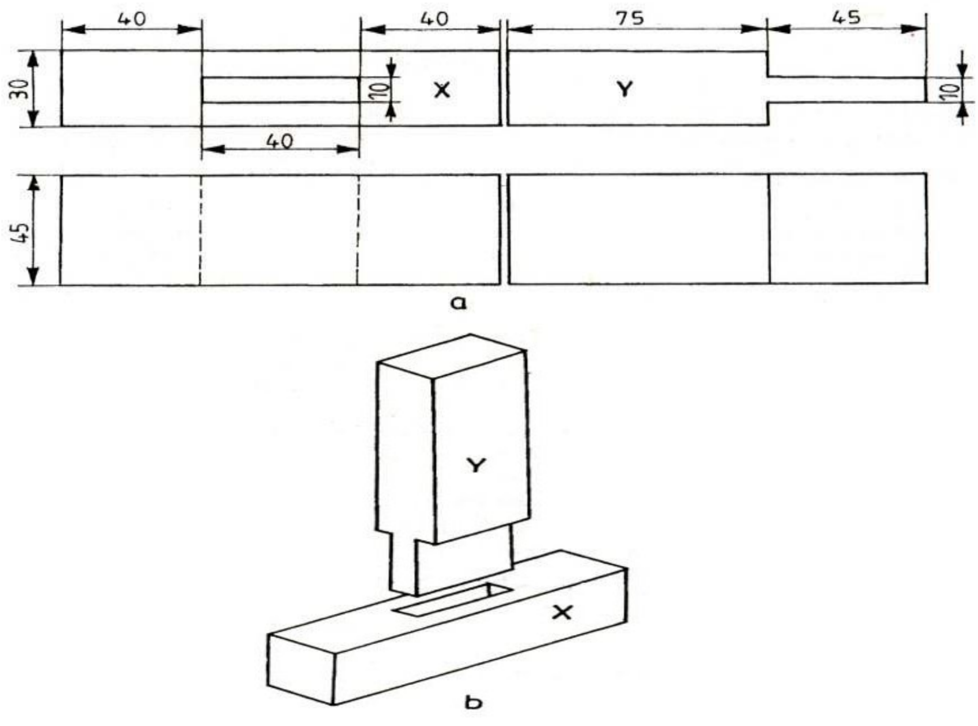
**Toolsrequired**

Carpenter'svice,steelrule,jackplane,try-square,markinggauge,25111mfirmerchisel,6mmmortisechisel,cross-cutsaw,tenonsaw,scriberand mallet.

**Sequenceofoperations**

1. Thegivenreaperischeckedtoensureitscorrectsize.
2. Thereaperisfirmlyclampedinthecarpenter'sviceandoneofitsfacesareplanedbythejackplaneand checkedfor straightness.
3. Theadjacentfaceisthenplanedandthefacesarecheckedforsquarenesswiththetry-square.
4. Marking gauge is set and lines are drawn at 30 and 45 mm, to mark the thickness and width of themodelrespectively.
5. Theexcessmaterialisfirstchiseledoutwiththefirmerchiselandthenplanedtocorrectsize.
6. ThematingdimensionsofthepartsXandYarethenmarkedusingthescaleandmarkinggauge.
7. Usingthecross-cutsaw,theportionstoberemovedinpartY(tenon)iscut,followedbychiseling.
8. ThematerialtoberemovedinpartX(mortise)iscarriedoutbyusingthemortiseand firmerchisels.
9. ThepartsXandYareseparatedbycross-cuttingwiththetenonsaw
10. Theendsofboththepartsarechiseledtoexactlengths.
11. Finishchiselingisdonewhereverneededsothat,thepartscanbefittedtoobtainaneartightjoint.

**Result** Themortiseandtenonjointisthusmadebyfollowingtheabovesequenceofoperations.




**FigureC-E3:**MortiseandTenonjoint

Chapter 3

# WELDING

## 3.1 INTRODUCTION

Welding is the process of joining similar metals by the application of heat, with or withoutapplication of pressure or filler metal, in such a way that the joint is equivalent in composition andcharacteristics of the metals joined. In the beginning, welding was mainly used for repairing all kinds ofworn or damaged parts. Now, it is extensively used in manufacturing industry, construction industry(construction of ships, tanks, locomotives and automobiles) and maintenance work, replacing rivetingand bolting,to agreater extent.

Thevariousweldingprocessesare:

1. Electricarcwelding,
2. Gaswelding
3. Thermalwelding
4. ElectricalResistanceweldingand
5. Frictionwelding

However,onlyelectricarcweldingprocessisdiscussedinthesubjectpointofview.

## 3.2 ELECTRICARCWELDING

Arcweldingis theweldingprocess,inwhichheatis generatedbyanelectricarcstruckbetweenan electrode and the work piece. Electric arc is luminous electrical discharge between two electrodesthroughionizedgas.

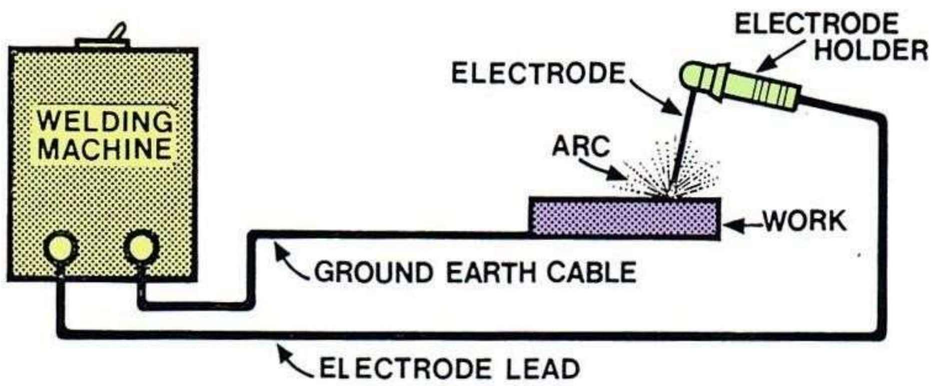



**Figure3.1:**Arcweldingsetup.

**Anyarcweldingmethodisbasedonanelectriccircuitconsistingofthefollowingparts:**

a. Powersupply(ACorDC);
b. Weldingelectrode;
c. Workpiece;
d. Weldingleads(electriccables)connectingtheelectrodeandworkpiecetothepowersupply.

Electricarcbetweentheelectrodeandworkpiececlosestheelectriccircuit.Thearctemperaturemayreach10000°F(5500°C),whichissufficientforfusiontheworkpieceedgesandjoiningthem.Whenalongjointisrequiredthearcismovedalongthejointline.Thefrontedgeoftheweldpoolmeltstheweldedsurfaceswhentheraredgeoftheweldpoolsolidifiesformingthejoint.

Transformers, motor generators and rectifiers' sets are used as arc welding machines. Thesemachinessupplyhighelectriccurrentsatlowvoltageandanelectrodeisusedtoproducethenecessaryarc. The electrode serves as the filler rod and the arc melts the surface so that, the metals to be joinedareactuallyfixedtogether.

Sizes of welding machines are rated according to their approximate amperage capacity at 60%duty cycle, such as 150,200,250,300,400,500 and 600 amperes. This amperage is the rated currentoutput attheworking terminal.

**3.2.1 Transformers**

The transformers type of welding machine produces A.C current and is considered to be the leastexpensive. It takes power directly from power supply line and transforms it to the voltage requiredforwelding.Transformersareavailableinsinglephaseandthreephasesinthemarket.

**3.2.2 Motorgenerators**

TheseareD.Cgeneratorssets,inwhichelectricmotorandalternatorare mountedon thesameshaft to produce D.C power as pert the requirement for welding. These are designed to produce D.Ccurrent in either straight or reversed polarity. The polarity selected for welding depends upon the kindofelectrodeused andthematerialtobewelded.

**3.2.3 Rectifiers**

Theseareessentiallytransformers,containinganelectricaldevicewhichchangesA.CintoD.Cbyvirtue ofwhichtheoperatorcanusebothtypesofpower(A.CorD.C,butonlyoneatatime).Inadditiontotheweldingm achine,certainaccessoriesareneededforcarryingouttheweldingwork.

**3.2.4 Weldingcables**

Twoweldingcablesarerequired,onefrommachinetotheelectrodeholderandtheother,fromthe machine to the ground clamp. Flexible cables are usually preferred because of the case of usingandcoilingthecables.Cablesarespecifiedbytheircurrentcarryingcapacity,say300A,400A,etc.

**3.2.5 Electrodes**

Filler rods are used in arc welding are called electrodes. These are made of metallic wire calledcore wire, having approximately the same composition as the metal to be welded. These are coateduniformly with a protective coating called flux. While fluxing an electrode; about 20mm of length is leftat one end for holding it with the electrode holder. It helps in transmitting full current from electrodeholder to the front end of the electrode coating. Flux acts as an insulator of electricity. Figure.4 showsthevariouspartsof an electrode.

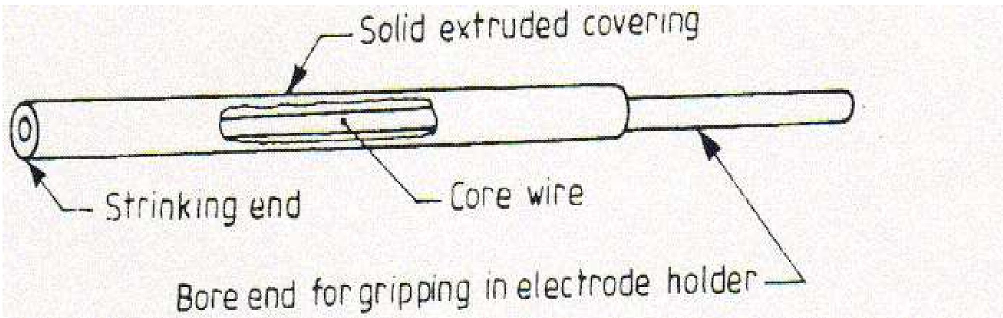



**Figure3.2:**Partsofanelectrode

In general, electrodes are classified into five main groups; mild steel, carbon steel, special alloysteel, cast iron and non-ferrous. The greatest range of arc welding is done with electrodes in the mildsteelgroup.

Various constituents like titanium oxide, potassium oxide, cellulose, iron or manganese, Ferro-silicates, carbonates, gums, clays, asbestos, etc., are used as coatings on electrodes. While welding, thecoatingorfluxvaporizesandprovidesagaseousshieldtopreventatmosphericattack.

Thesize of electrode ismeasuredanddesignated bythediameter ofthecore wireinSWGandlength,apartfromthebrandandcodenames;indicatingthepurposeforwhichtherearemostsuitable.**Electrodesmaybeclassifiedonthebasisofthickness ofthecoatedflux.As**

1. Dustcoatedorlightcoated
2. Semiormediumcoatedand
3. Heavilycoatedorshielded

Electrodesarealsoclassifiedonthebasisofmaterials,as

1. Metallicand
2. Non-metallicorcarbon

Metallicarcelectrodesarefurthersub-dividedinto

1. Ferrousmetalarcelectrode(mildsteel,low/medium/highcarbonsteel,castiron,stainlesssteel,etc)
2. Non-ferrousmetalarcelectrodes(copper,brass,bronze,aluminum,etc).

Incaseofnon-metallicarcelectrodes,mainlycarbonandgraphiteareusedtomaketheelectrodes.

### 3.3 WELDINGTOOLS

#### 3.3.1 Electrodeholder

The electrode holder is connected to the end of the welding cable and holds the electrode. Itshould be light, strong and easy to handle and should not become hot while in operation. Figure showsone type of electrode holder. The jaws of the holder are insulated, offering protection from electricshock.

**Figure3.3:**Electrodeholder

**Figure3.4:**Groundclamp

#### 3.3.2 Groundclamp

It is connected to the end of the ground cable and is clamped to the work or welding table tocompletetheelectriccircuit.Itshouldbestronganddurableandgivealowresistanceconnection.

#### 3.3.3 Wirebrushandchippinghammer

Awirebrushisusedforcleaningandpreparingtheworkforwelding.Achippinghammerisusedforremovingslagformationonwelds.Oneendoftheheadissharpenedlikeacoldchiselandtheother,to a blunt, round point. It is generally made of tool steel. Molten metal dispersed around the weldingheads, in the form of small drops, is known as spatter. When a flux coated electrode is used in weldingprocess, then a layer of flux material is formed over the welding bead which contains the impurities ofweld material. This layer is known as slag. Removing the spatter and slag formed on and around thewelding beadson themetal surface is knownaschipping.

**Figure3.5:**Wirebrush

**Figure3.6:**Chippinghammer

#### 3.3.4 Weldingtableandcabin

It is made of steel plate and pipes. It is used for positioning the parts to be welded properly.Weldingcabinismade-upbyanysuitablethermalresistancematerial,whichcanisolatethesurroundingbytheheatandlightemittedduringtheweldingprocess.Asuitabledraughtshouldalsobeprovidedforexhausting thegas producedduring welding.

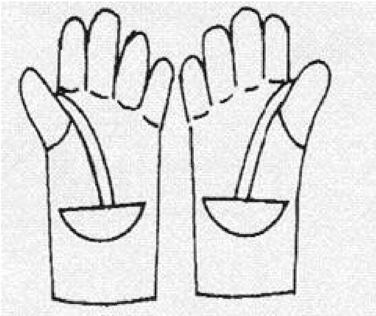
#### 3.3.5 Faceshield

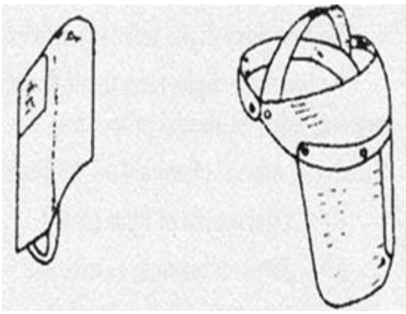
A face shield is used to protect the eyes and face from the rays of the arc and from spatter orflyingparticlesofhotmetal. Itis availableeitherinhandorhelmettype.Thehandtypeisconvenienttouse wherever the work can be done with one hand. The helmet type though not comfortable to wear,leavesbothhandsfreeforthework.

Shieldsaremadeoflightweightnon-reflectingfiberandfittedwithdarkglassestofilterouttheharmful raysofthearc.Insomedesigns,acoverglassisfittedinfrontofthedarklenstoprotectitfromspatter.

### 3.3.6 Handgloves

Theseareusedtoprotectthehandsfromelectricshocksandhotspatters





Hand-heldtype Helmettype

**Figure3.7:**Handgloves **Figure3.8:**Faceshield

## 3.4 TECHNIQUESOFWELDING

### 3.4.1 Preparationofwork

Before welding, the work pieces must be thoroughly cleaned of rust, scale and other foreignmaterial. The piece for metal generally welded without beveling the edges, however, thick work pieceshouldbebeveledorveedouttoensureadequatepenetrationandfusionofallpartsoftheweld.But,ineithercase,thepartstobeweldedmustbeseparatedslightlytoallowbetterpenetrationoftheweld.

Beforecommencingtheweldingprocess,thefollowingmustbeconsidered

a) Ensurethattheweldingcablesareconnectedtoproperpowersource.
b) Settheelectrode,asperthethicknessoftheplatetobewelded.
c) Settheweldingcurrent,asperthesizeoftheelectrodetobeused.

Table3.1ElectrodecurrentVselectrodesizeVsplatethickness.

| Platethickness,mm | Electrodesize,mm | Electrodecurrentrange,amp |
|---|---|---|
| 1.6 | 1.6 | 40-60 |
| 2.5 | 2.5 | 50-80 |
| 4.0 | 3.2 | 90-130 |
| 6.0 | 4.0 | 120-170 |
| 8.0 | 5.0 | 180-270 |
| 25.0 | 6.0 | 300-400 |

**NOTE:**Whilemakingbutt weldsinthinmetal, itisabetterpractice totack-weldthepiecesintervalstoholdthemproperlywhilewelding.

### 3.4.2 Strikinganarc

Thefollowingarethestagesandmethodsofstrikinganarcandrunningabead

a) Selectanelectrodeofsuitablekindandsizefortheworkandsettheweldingcurrentatapropervalue.
b) Fastenthegroundclamptoeithertheworkorweldingtable.
c) Startorstrikethearcbyeitherofthefollowingmethods

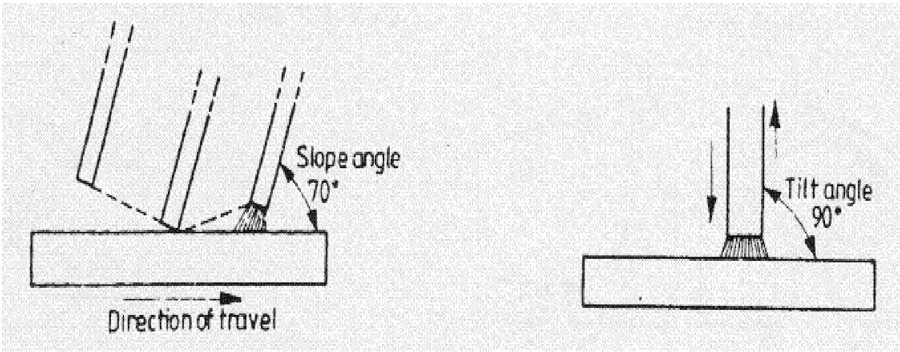
**Strikeandwithdraw**

Inthismethodthearcisstartedbymovingtheendoftheelectrodeontotheworkwithaslowsweeping motion,similartostrikingamatch.

**Touchandwithdraw**

In this method, the arc is started by keeping the electrode perpendicular to the work andtouchingorbouncingitlightlyonthework.Thismethodispreferredasitfacilitatesrestartingthe momentarily broken arc quickly.If the electrode sticks to the work, quickly bend it back and forth,pulling at the same time. Make sure to keep the shield in front of the face, when the electrode isfreedfromsticking.

d) As soon as the arc is struck, move the electrode along, slowly from left to right, keeping at 15º to25ºfromverticaland inthedirectionofwelding.




Strikeandwithdraw Touchandwithdraw

**Figure3.9:**strikinganarc

### 3.4.3 Weaving

A steady, uniform motion of the electrode produces a satisfactory bead. However, a slightweaving or oscillating motion is preferred, as this keeps the metal molten a little longer and allows thegas to escape, bringing the slag to the surface. Weaving alsoproduces a wider bead with betterpenetration.

### 3.5 TYPESOFJOINTS

Welds are made at the junction of the various pieces that make up the weldment. The junctionsof parts, or joints, are defined as the location where two or more numbers are to be joined. Parts beingjoined to produce the weldment may be in the form of rolled plate, sheet, pipes, castings, forgings, orbillets.Thefivebasictypesofjointsarelistedbelow.

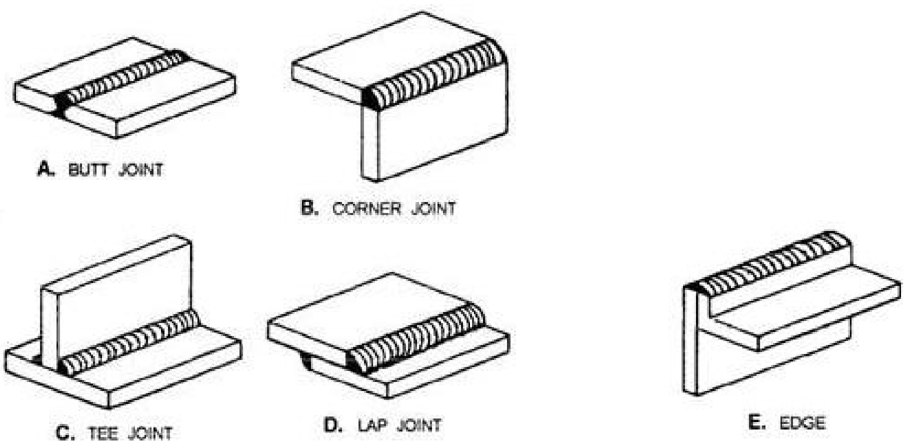



**Figure3.10:**Typesofweldingjoints.

Abuttjointisusedtojointwomembersalignedinthesameplane(fig.3.10,viewA).Thisjointisfrequently usedinplate,sheetmetal,andpipework.Ajointofthistypemaybeeithersquareorgrooved.

Corner and tee joints are used to join two members located at right angles to each other (fig.3.10, views B and C). In cross section, the corner joint forms an L-shape, and the tee joint has the shapeoftheletterT.Variousjointdesignsofbothtypeshaveusesinmanytypesofmetalstructures.

A lap joint, as the name implies, is made by lapping one piece of metal over another (fig. 3.10,viewD).Thisisoneofthestrongesttypesofjointsavailable;however,formaximumjointefficiency,youshould overlap the metals a minimum of three times the thickness of the thinnest member you arejoining.Lapjointsarecommonlyusedwithtorchbrazingandspotweldingapplications.

An edge joint is used to join the edges of two or more members lying in the same plane. In mostcases, one of the members is flanged, as shown in figure 3.10, view E. While this type of joint has someapplications in plate work, it is more frequently used in sheet metal work. An edge joint should only beusedforjoiningmetals 1/4inchorlessinthicknessthatarenotsubjectedtoheavyloads.

**3.6 WELDINGPOSITIONS**

Depending upon the location of the welding joints, appropriate position of the electrode andhandmovementis selected.Thefigureshows differentweldingpositions.

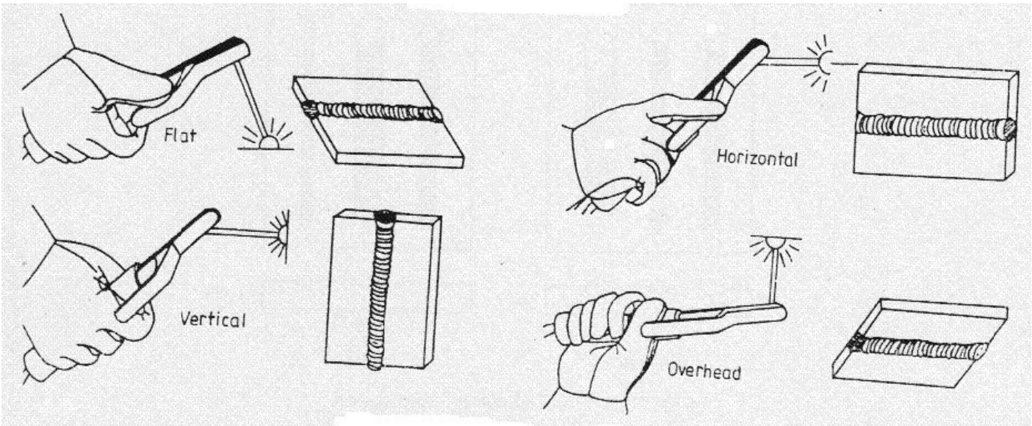



**Figure3.11:**Weldingpositions

**3.6.1 Flatpositionwelding**

Inthisposition,theweldingisperformedfromtheuppersideofthejoint,andthefaceoftheweldis approximately horizontal. Flat welding is the preferred term; however, the same position is sometimescalled downhand.

**3.6.2 Horizontalpositionwelding**

In this position, welding is performed on the upper side of an approximately horizontal surfaceand againstan approximately verticalsurface.

**3.6.3 Verticalpositionwelding**

Inthisposition,theaxisoftheweldisapproximatelyverticalasshowninfigure.

**3.6.4 Overheadpositionwelding**

Inthisweldingposition,theweldingisperformedfromtheundersideofajoint.

**3.7 ADVANTAGES&DISADVANTAGESOFARCWELDINGAdvantages**

1. Weldingprocessissimple.
2. Equipmentisportableandthecostisfairlylow.
3. Alltheengineeringmetalscanbewelded because oftheavailabilityofawide varietyofelectrodes.

**Disadvantages**

1. Mechanizedweldingisnotpossiblebecauseoflimitedlengthoftheelectrode.
2. Numberofelectrodesmayhavetobeusedwhileweldinglongjoints.
3. Adefect(slaginclusionorinsufficientpenetration)mayoccurattheplacewhereweldingisrestartedwith afreshelectrode.

**3.8 SAFEPRACTICE**

Alwaysweldinawellventilatedplace.Fumesgivenofffromweldingareunpleasantandinsomecasesmaybeinjurious,particularlyfromgalvanizedorzinccoatedparts.

1. Donotweldaroundcombustibleorinflammablematerials,wheresparksmaycauseafire.
2. Neverweld containers,whichhavebeenusedforstoringgasoline,oilor similarmaterials,withoutfirsthavingthemthoroughlycleaned.
3. Checktheweldingmachinetomakesurethatitisproperlygroundedandthatallleadsproperlyinsulated.
4. Neverlookatthearcwiththenakedeye.Thearccanburnyoureyesseverely.Alwaysuseafaceshieldwhile welding.
5. Preventweldingcablesfromcomingincontactwithhotmetal,water,oil,orgrease.Avoiddraggingthecables around sharpcorners.
6. Ensureproperinsulationofthecablesandcheckforopenings.
7. Alwayswearthesafetyhandgloves,apronandleathershoes.
8. Alwaysturnoffthemachinewhenleavingthework.
9. Applyeyedropsafterweldingisoverfortheday,torelievethestrainontheeyes.
10. Whilewelding,standondryfootingandkeepthebodyinsulatedfromtheelectrode,anyotherpartsoftheelectrodeholder andthework.

*Exercise1*

**SingleV-Buttjoint**

**Aim**

Tomakeasinglev-buttjoint,usingthegivenmildsteelpiecesofandbyarcwelding.

**Materialused**

Twomildsteelpiecesof100X40X6mm.

**Toolsandequipmentused**

Arc welding machine, Mild steel electrodes, Electrode holder, Ground clamp, flat nose Tong, Face shield,Apron,Handgloves,MetallicworkTable,Benchvice,Roughflatfile,Trysquare,Steelrule,Wirebrush,Ballpeenhammer,Chippinghammer,ChiselandGrindingmachine.

**Sketch**

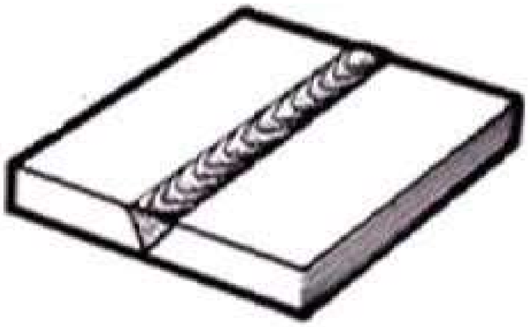


**Figure3.12:**Single-Vbuttjoint

**Operationstobecarriedout**

1. Cleaningtheworkpieces
2. tackwelding
3. fullwelding
4. cooling
5. chipping
6. finishing

**Procedure**

1. Take the twomild steel piecesof given dimensionsand clean the surfaces thoroughlyfromrust, dustparticles,oiland grease.
2. Removethesharpcornersandburrsbyfilingorgrinding.
3. Oneedgeofeachpieceisbeveled,toanangle30˚.
4. The two piecesare positioned on the welding tablesuchthat, they areseparatedslightly for betterpenetrationoftheweld.
5. Theelectrodeisfittedintotheelectrodeholderandtheweldingcurrentissettoapropervalue.
6. Thegroundclampisfastenedtotheweldingtable.ThemachineisswitchedON
7. Wearingtheapron,handgloves,usingthefaceshield,thearcisstruckandtheworkpiecesaretack-weldedattheendsandholdingthetwopiecestogether;firstrunoftheweldisdonetofilltherootgap.
8. Secondrunoftheweldingisdonewithproperweavingandwithuniformmovement. Duringtheprocess of welding, the electrode is kept at angle of 15˚ to 25˚ from vertical and in the direction ofwelding.
9. Theslagformationontheweldisremovedbychippinghammer.
10. Filingisdonetoremovespattersaroundtheweld.

**Result** Thesinglev-buttjointisthusmade,usingthetoolsandequipmentasmentionedabove.

*Exercise2*

**Double-Lapjoint**

**Aim**

Tomakeadoublelapjoint,usingthegivenmildsteelpiecesandbyarcwelding.

**Materialused**

Two**mildsteel**piecesof100X40X6mm.

**Toolsandequipmentused**

Arc welding machine, Mild steel electrodes, Electrode holder, Ground clamp, flat nose Tong, Face shield,Apron,Handgloves,MetallicworkTable,Benchvice,Roughflatfile,Trysquare,Steelrule,Wirebrush,Ballpeenhammer,Chippinghammer,ChiselandGrindingmachine.

**Sketch**

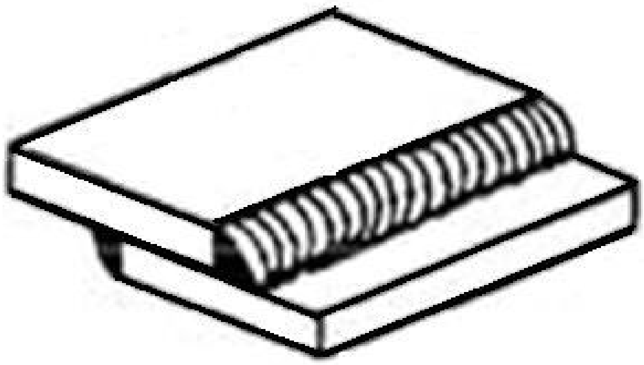


**Figure3.13:**Doublelapjoint

**Operationstobecarriedout**

1. Cleaningtheworkpieces
2. tackwelding
3. fullwelding
4. cooling
5. chipping
6. finishing

**Procedure**

1. Takethetwomildsteelpiecesofgivendimensionsandcleanthesurfacesthoroughlyfromrust,dustparticles,oiland grease.
2. Removethesharpcornersandburrsbyfilingorgrindingandpreparetheworkpieces.
3. Theworkpiecesarepositionedontheweldingtable,toformalapjointwiththerequiredoverlapping.
4. Theelectrodeisfittedintotheelectrodeholderandtheweldingcurrentissettoapropervalue.
5. Thegroundclampisfastenedtotheweldingtable.
6. Wearingtheapron,handgloves,usingthefaceshieldandholdingtheoverlappedpiecesthearcisstruckandtheworkpiecesaretack-weldedattheendsofboththesides
7. Thealignmentofthelapjointischeckedandthetack-weldedpiecesarereset,ifrequired.
8. Weldingisthencarriedoutthroughoutthelengthofthelapjoint,onboththesides.
9. Removetheslag,spattersandcleanthejoint.

**Result** Thedoublelapjointisthusmade,usingthetoolsandequipmentasmentionedabove.

*Exercise3*

**Cornerjoint**

**Aim**

Tomakeacornerjoint,usingthegivenmildsteelpiecesandbyarcwelding.

**Materialused**

Two**mildsteel**piecesof100X40X6mm.

**Toolsandequipmentused**

Arc welding machine, Mild steel electrodes, Electrode holder, Ground clamp, flat nose Tong, Face shield,Apron,Handgloves,MetallicworkTable,Benchvice,Roughflatfile,Trysquare,Steelrule,Wirebrush,Ballpeenhammer,Chippinghammer,ChiselandGrindingmachine.

**Sketch**

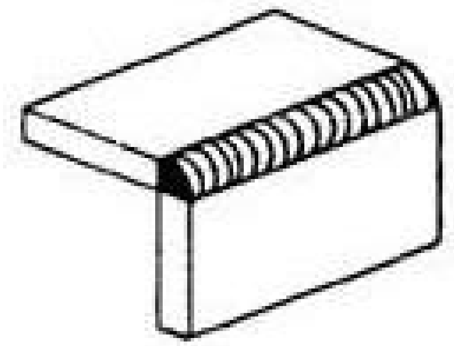


**Figure3.14:**Cornerjoint

**Operationstobecarriedout**

1. Cleaningtheworkpieces
2. tackwelding
3. fullwelding
4. cooling
5. chipping
6. finishing

**Procedure**

1. Take the twomild steel piecesof given dimensionsand clean the surfaces thoroughlyfromrust, dustparticles,oiland grease.
2. Removethesharpcornersandburrsbyfilingorgrindingandpreparetheworkpieces.
3. Theworkpiecesarepositionedontheweldingtablesuchthat,theLshapeisformed.
4. Theelectrodeisfittedintotheelectrodeholderandtheweldingcurrentissettoapropervalue.
5. Thegroundclampisfastenedtotheweldingtable.
6. Wearingtheapron,handgloves,usingthefaceshieldandholdingthepiecesthearcisstruckandtheworkpieces aretack-weldedatboththeends.
7. Thealignmentofthecornerjointischeckedandthetack-weldedpiecesarereset,ifrequired.
8. Weldingisthencarriedoutthroughoutthelength.
9. Removetheslag,spattersandcleanthejoint.

**Result** TheCornerjointisthusmade,usingthetoolsandequipmentasmentionedabove.

*Exercise4*

**T-joint**

**Aim**

TomakeaT-joint,usingthegivenmildsteelpiecesandbyarcwelding.

**Materialused**

Two**mildsteel**piecesof100X40X6mm.

**Toolsandequipmentused**

Arc welding machine, Mild steel electrodes, Electrode holder, Ground clamp, flat nose Tong, Face shield,Apron,Handgloves,MetallicworkTable,Benchvice,Roughflatfile,Trysquare,Steelrule,Wirebrush,Ballpeenhammer,Chippinghammer,ChiselandGrindingmachine.

**Sketch**

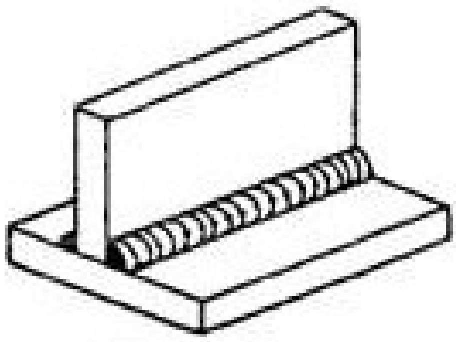


**Figure3.15:**T-joint

**Operationstobecarriedout**

1. Cleaningtheworkpieces
2. tackwelding
3. fullwelding
4. cooling
5. chipping
6. finishing

**Procedure**

1. Take the twomild steel piecesof given dimensionsand clean the surfaces thoroughlyfromrust, dustparticles,oiland grease.
2. Removethesharpcornersandburrsbyfilingorgrindingandpreparetheworkpieces.
3. Theworkpiecesarepositionedontheweldingtablesuchthat,theTshapeisformed.
4. Theelectrodeisfittedintotheelectrodeholderandtheweldingcurrentissettoapropervalue.
5. Thegroundclampisfastenedtotheweldingtable.
6. Wearingtheapron,handgloves,usingthefaceshieldandholdingthepiecesthearcisstruckandtheworkpieces aretack-weldedatboththeends.
7. ThealignmentoftheTjointischeckedandthetack-weldedpiecesarereset,ifrequired.
8. WeldingisthencarriedoutthroughoutthelengthoftheTjointasshowninthefigure.
9. Removetheslag,spattersandcleanthejoint.

**Result** TheTeejointisthusmade,usingthetoolsandequipmentasmentionedabove.

Chapter 4
# MACHINESHOP

### 4.1 INTRODUCTION

Inamachineshop,metalsarecuttoshapeondifferentmachinetools.Alatheisusedtocutandshape the metal by revolving the work against a cutting tool. The work is clamped either in a chuck,fittedon to the lathe spindle or in-between the centers. The cutting tool is fixed in a tool post, mountedon amovable carriage that is positioned on the lathe bed. The cutting tool can be fed on to the work, eitherlengthwise or cross-wise. While turning, the chuck rotates in counter-clockwise direction, when viewedfromthe tailstockend.

### 4.2 PRINCIPALPARTSOFALATHE

Figure4.1showsacenterlathe,indicatingthemainparts.Thenameisduetothefactthatworkpiecesareheld bythecenters.

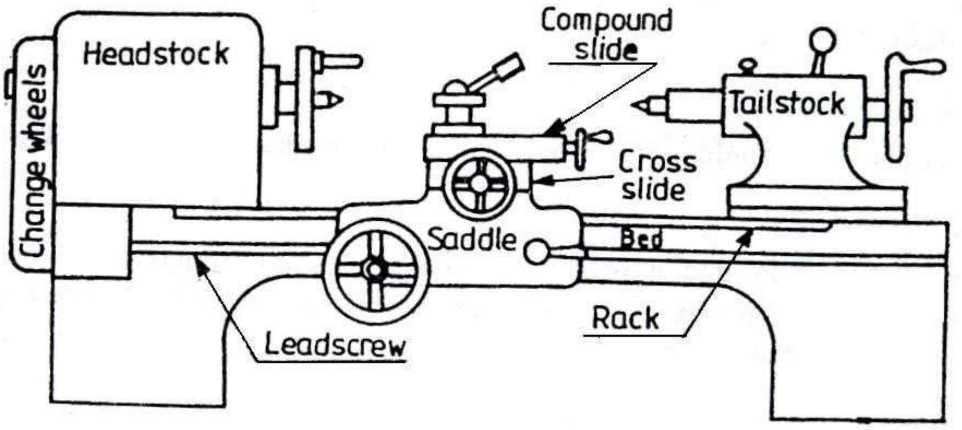



**Figure4.1:**Partsofacenterlathe

#### 4.2.1 Bed

Itisanessentialpartofalathe,whichmustbestrongandrigid.Itcarriesallpartsofthemachineandresiststhecuttingforces.Thecarriageandthetailstockmovealongtheguideways providedonthebed. It is usuallymade ofcast iron.

#### 4.2.2 Headstock

Itcontainseitheraconepulleyorgearingstoprovidethenecessaryrangeofspeedsandfeeds. Itcontainsthemainspindle,towhichtheworkisheldandrotated.

#### 4.2.3 Tailstock

Itis usedtosupporttherighthandendofalongworkpiece.Itmaybeclampedinanypositionalong the lathe bed. The tail stock spindle has an internal Morse taper to receive the dead center thatsupports the work. Drills, reamers, taps may also be fitted into the spindle, for performing operationssuchas drilling, reamingandtapping.

#### 4.2.4 CarriageorSaddle

It is used to control the movement of the cutting tool. The carriage assembly consists of thelongitudinalslide,crossslideandthecompoundslideandapron.Thecrossslidemovesacrossthelengthofthebedandperpendiculartotheaxis ofthespindle.Thismovementisusedforfacingandtoprovidethenecessary depthofcutwhileturning. Theapron,whichisboltedtothesaddle,is onthefrontofthelatheandcontainsthelongitudinal andcrossslidecontrols.

#### 4.2.5 CompoundRest

Itsupportsthetoolpost.Byswivelingthecompoundrestonthecrossslide,shorttapersmaybeturnedtoanydesiredangles.

### 4.2.6 ToolPost

Thetoolpost,holdsthetoolholderorthetool,whichmaybeadjustedtoanyworkingposition.

### 4.2.7 LeadScrew

It is a long threaded shaft, located in front of the carriage, running from the head-stock to thetailstock.Itisgearedtothespindleandcontrolsthemovementofthetool,eitherforautomaticfeedingorfor cuttingthreads.

### 4.2.8 Centers

There are two centers known as dead center and live center. The dead center is positioned inthe tail stock spindle and the live center, in the head-stock spindle. While turning between centers, thedeadcenterdoesnotrevolvewiththeworkwhilethelivecenterrevolveswiththework.

## 4.3 WORK-HOLDINGDEVICES

### 4.3.1 Threejawchuck

It is a work holding device having three jaws (self-centering) which will close or open withrespectto the chuck center or the spindle center, as shown in figure. It is used for holding regular objects likeroundbars,hexagonal rods,etc.

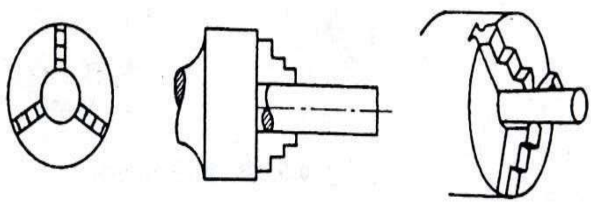


**Figure4.2:**Threejawchuck

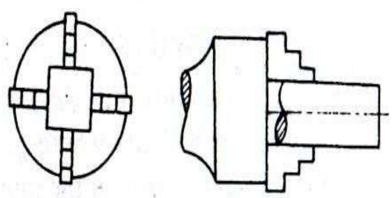


**Figure4.3:**Fourjawchuck

### 4.3.3 Faceplate

Itis aplateoflargediameter,usedforturningoperations.Certaintypes ofworkthatcannotbeheldinchucksareheldonthefaceplatewiththehelpofvarious accessories.

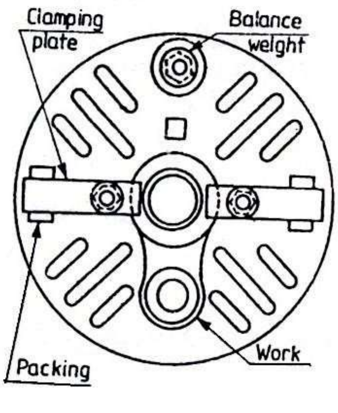



**Figure4.4:**Faceplate

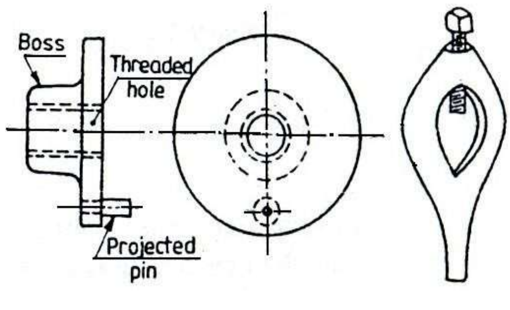



**Figure4.5:**Lathedoganddrivingplate

### 4.3.4 Lathedogsanddrivingplate

These are used to drive a work piece that is held between centers. These are provided with anopening to receive and clamp the work piece and dog tail, the tail of the dog is carried by the pinprovidedinthedrivingplatefordriving theworkpiece.

## 4.4 MEASURINGINSTRUMENTS

### 4.4.1 OutsideandinsideCalipers

Firmjointorspringcalipersareusedfortransferofdimensionswiththehelpofasteelrule.

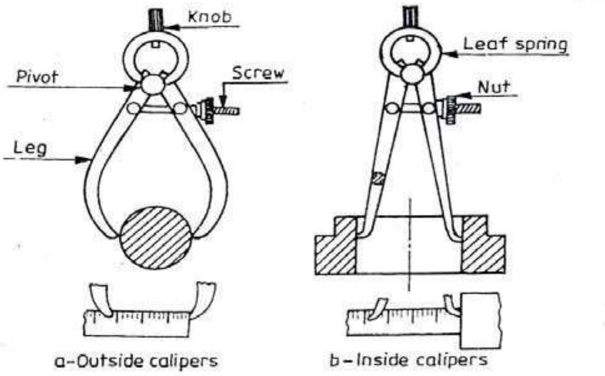



**Figure4.6:**Calipers

### 4.4.2 VernierCalipers

Verniercaliperisaversatileinstrumentwithwhichbothoutsideandinsidemeasurementsmaybemade accurately.Theseinstrumentsmayhaveprovisionfordepthmeasurementalso.

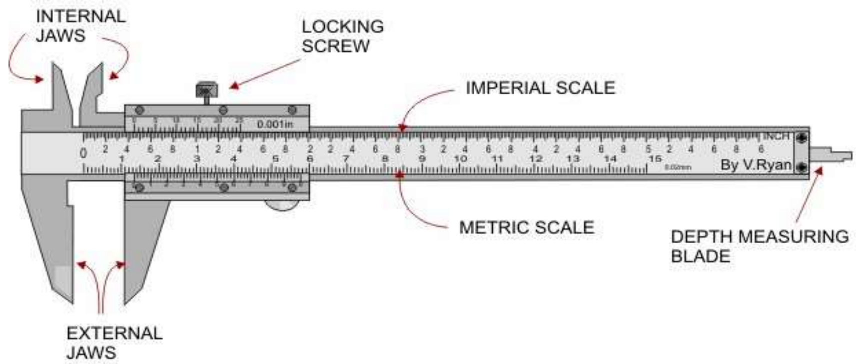



**Figure4.7:**VernierCaliper

### 4.4.3 Micrometers

Outside and inside micrometers are used for measuring components where greater accuracy isrequired.

## 4.5 CUTTINGPARAMETERS

### 4.5.1 Cuttingspeed

Itisdefinedasthespeedatwhichthematerialisremovedandisspecifiedinmetersperminute.Ti depends upon the work piece material, feed, depth of cut, type of operation and so many other cuttingconditions. It iscalculatedfromtherelation,

Spindlespeed(RPM)=cuttingspeedx1000/(πD)

WhereDistheworkpiecediameterinmm.

### 4.5.2 Feed

It is the distance traversed by the tool along the bed, during one revolution of the work. Its valuedepends uponthedepthofcut andsurfacefinishoftheworkdesired.

### 4.5.3 DepthofCut

It is the movement of the tip of the cutting tool, from the surface of the work piece andperpendicular to the lathe axis. Its value depends upon the nature of operation like rough turning orfinish turning.

## 4.6 TOOLMATERIALS

General purpose hand cutting tools are usually made from carbon steel or tool steel. The singlepointlathecuttingtoolsaremadeofhighspeedsteel(HSS).themainalloyingelementsin18-4-1HSS tools are 18 percent tungsten, 4 percent chromium and 1 percent vanadium.5 to 10 percent cobalt isalso addedtoimprovetheheatresisting propertiesofthetool.

Carbidetippedtoolsfixedintoolholders,aremostlyusedinproductionshops.

**4.7 TOOLGEOMETRY**

Asinglepointcuttingtoolusedonlathemaybeconsideredasasimplewedge.Figure4.8showsthe common turning tools used for different operations. Figure 6.9 shows the basic angles of a simpleturningtool.

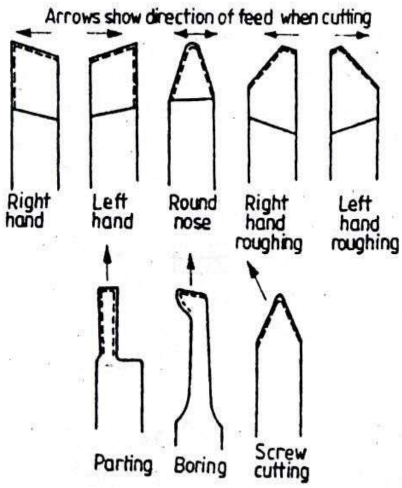



**Figure4.8:**Commonturningtools

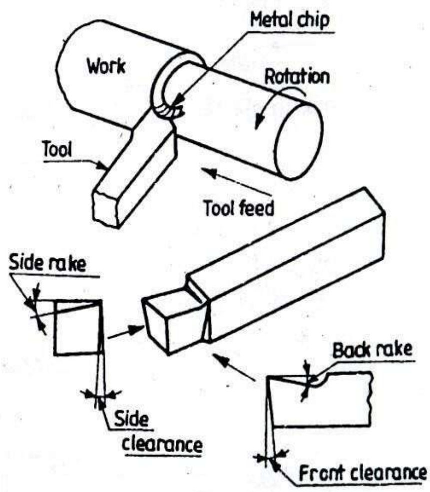



**Figure4.9:**Toolgeometry

## 4.8 LATHEOPERATIONS

### 4.8.1 Turning

Cylindricalshapes,bothexternalandinternal,areproducedbyturningoperation.Turningistheproces sinwhichthematerialisremovedbyatraversingcuttingtool,fromthesurfaceofarotatingworkpiece.Theoper ationusedformachininginternalsurfacesisoftencalledtheboringoperationinwhichahole previouslydrilled isenlarged.

For turning long work, first it should be faced and center drilled at one end and then supportedbymeans ofthe tail-stockcentre.

### 4.8.2 Boring

Boring is enlarging a hole and is used when correct size drill is not available. However, it shouldbenotedthatboringcannotmakea hole.

### 4.8.3 Facing

Facing is a machining operation, performed to make the end surface of the work piece, flat andperpendicular to the axis of rotation. For this, the work piece may be held in a chuck and rotated aboutthe lathe axis. A facing tool is fed perpendicular to the axis of the lathe. The tool is slightly inclinedtowardstheendof theworkpiece.

### 4.8.4 TaperTurning

A taper is defined as the uniform change in the diameter of a work piece, measured along itslength. It is expressed as a ratio of the difference in diameters to the length. It is also expressed indegrees ofhalftheincluded (taper) angle.

Taperturningreferstotheproductionofaconicalsurface,ontheworkpieceonalathe.

Short steep tapers may be cut on a lathe by swiveling the *compound rest* to the required angle. Here,thecuttingtoolisfedbymeansofthecompoundslidefeedhandle.Theworkpieceisrotatedinachuckorfa ceplateorbetween centers.

### 4.8.5 Drilling

Holesthatareaxiallylocatedincylindricalpartsareproducedbydrillingoperation,usingatwistdrill. For this, the work piece is rotated in a chuck or face plate. The tail stock spindle has a standardtaper.Thedrillbitis fittedintothetailstockspindledirectly orthroughdrillchuck.Thetailstockisthenmoved over the bed and clamped on it near the work. When the job rotates, the drill bit is fed into theworkby turningthe tailstock hand wheel.

### 4.8.6 Knurling

It is the process of embossing a diamond shaped regular pattern on the surface of a work pieceusingaspecialknurlingtool.Thistoolconsistsofasetofhardenedsteelrollersinaholderwiththeteethcut on their surface in a definite pattern. The tool is held rigidly on the tool post and the rollers arepressedagainst the revolving work piece to squeeze the metal against the multiple cutting edges. The purposeof knurling is to provide an effective gripping surface on a work piece to prevent it from slippingwhenoperated byhand.

### 4.8.7 Chamfering

It is the operation of beveling the extreme end of a work piece. Chamfer is provided for betterlook, to enable nut to pass freely on threaded work piece, to remove burrs and protect the end of theworkpiece frombeingdamaged.

### 4.8.8 Threading

Threading is nothing but cutting helical groove on a work piece. Threads may be cut either ontheinternalorexternalcylindricalsurfaces.Aspeciallyshapedcuttingtool,knownasthreadcuttingtool,isusedforthispurpose.Threadcuttinginalatheisperformedbytraversingthecuttingtoolatadefiniterate, inproportiontotherate atwhichtheworkrevolves.

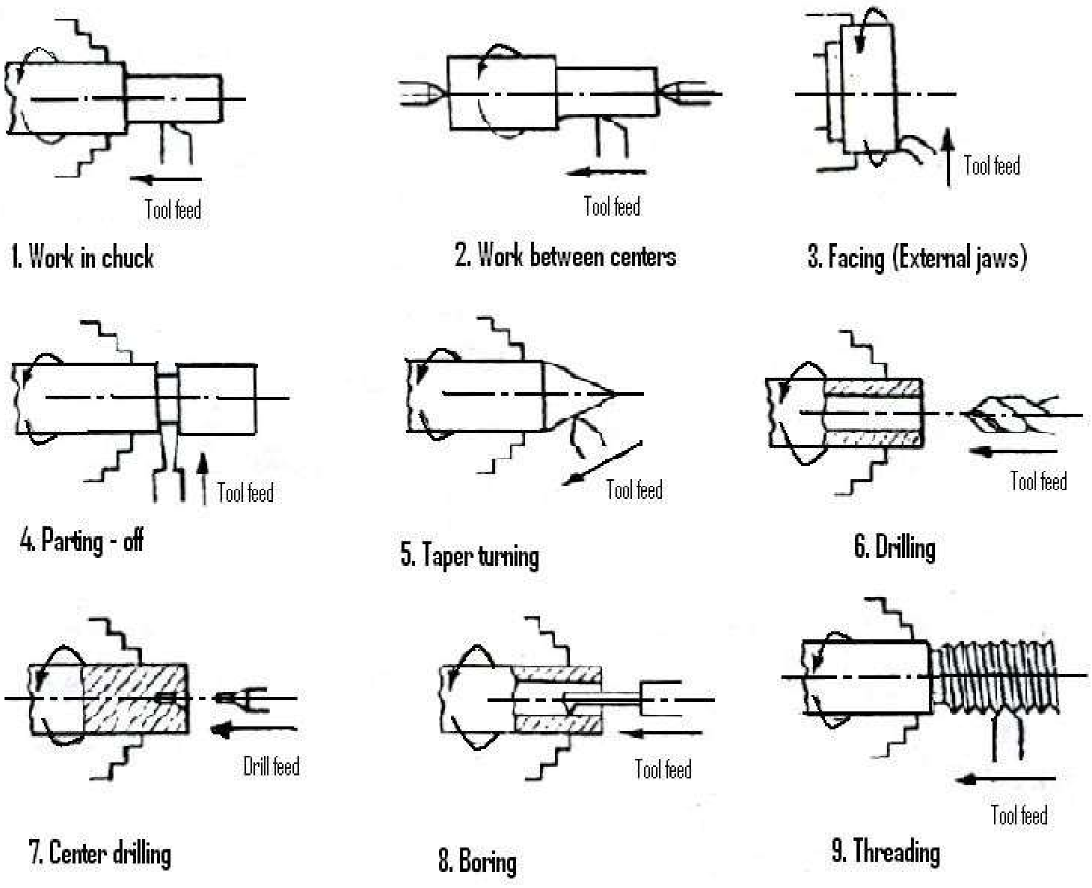



**Figure4.10:**OperationsofLathe

### 4.9 SAFETYPRECAUTIONS

1. Always wear eye protection - preferably industrial quality safety glasses with side-shields. The lathecan throw off sharp, hot metal chips at considerable speed as well as spin off spirals of metal thatcanbequite hazardous.Don'ttake chances withyoureyes.
2. Wearshortsleeveshirts,loosesleevescancatchonrotatingworkandquicklypullyourhandorarmintohar m'sway.
3. Wearshoes-preferablyleatherworkshoes-toprotectyourfeetfromsharpmetalchipsonthe shopfloorandfromtoolsandchunksofmetalthatmaygetdropped.
4. Remove wrist watches, necklaces, chains and other jewelry. Tie back long hair so it can't get caughtintherotatingwork.Thinkaboutwhathappenstoyourfaceifyourhairgetsentangled.
5. Always double check to make sure your work is securely clamped in the chuck or between centersbeforestartingthelathe.Startthelatheatlowspeedand increasethespeedgradually.
6. Get in the habit of removing the chuck key immediately after use. Some users recommend neverremoving your hand from the chuck key when it is in the chuck. The chuck key can be a lethalprojectileifthelatheis startedwiththechuckkeyinthechuck.
7. Keep your fingers clear of the rotating work and cutting tools. This sounds obvious, but I am oftentemptedtobreakawaymetalspirals astheyformat thecuttingtool.
8. Avoid reaching over the spinning chuck. For filing operations, hold the tang end of the file in yourlefthandsothatyourhandandarmarenot abovethespinningchuck.
9. Neveruseafilewithabaretang-thetangcouldbeforcedbackintoyourwristorpalm.

*Exercise1*

**Facingandplainturning**

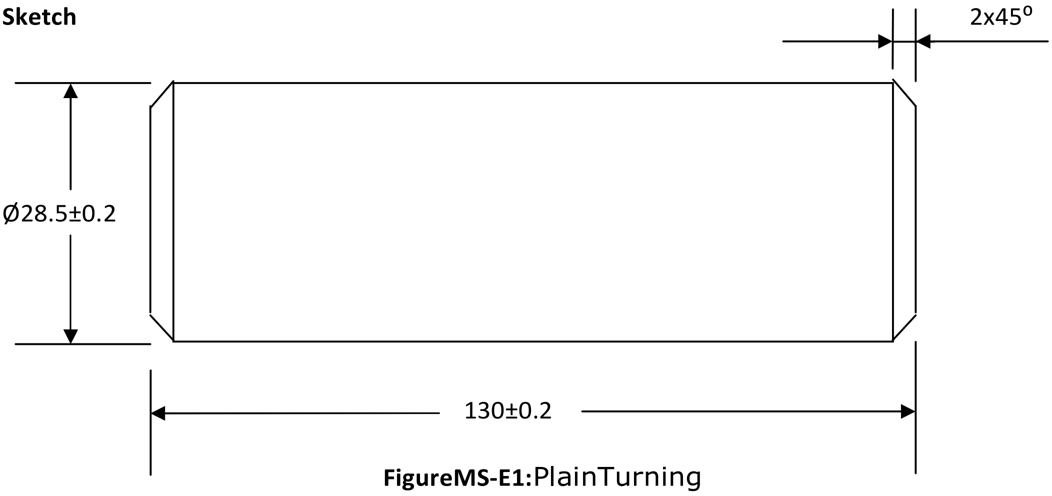
**Aim**

Toobtainrequireddiameterofacylindricalworkpiecewiththegivenlength(Fig4.11).

**Tools&Equipment**

Lathemachine.Mildsteelbar,righthandcuttingtool,boxkeyortoolpostkey,chuckkey,steelrule,outsidecalipersorverniercalipers.

**Sketch**




**FigureMS-E1:**PlainTurning

**Theory**

Facingistheoperationsoffinishingtheendsofworkto makeendsflat,smoothandtorequiredlength.Roughturningoperationisusedwhereexcessivestockistoberemovedandsurfacefinishisnotcritical.For such a operation deep cuts with coarse feed are used. During rough machining, maximum metal isremovedandverylittleoversizedimension isleft forfinishingoperation.

**Procedure**

1. Thegivenworkpieceisheldinthe3-jawchuckofthelathemachineandtightenedfirmlywithchuckkey.
2. Righthandsinglepointcuttingtoolistakentightenedfirmlywiththehelpofboxkeyinthetoolpost.
3. Machine is switched on and the tool post is swiveled and the cutting point is adjusted such that itpositioned approximately for facing operation then the tool is fed into the work piece and the toolpostisgiventhetransversemovementbyrotatingthehandwheelofthecrossslide.
4. With this facing is completed and the tool post is swiveled and cutting point is made parallel to theaxis ofwork piece.
5. Depth of cut is given by cross slide to the tool post and the side hand wheel is rotated to give thelongitudinalmovementforthetoolpostandjobisturnedtotherequiredlengthanddiameter.
6. After completion of the job it is inspected for the dimensions obtained with the help of steel ruleand outsidecaliperorverniercaliper.

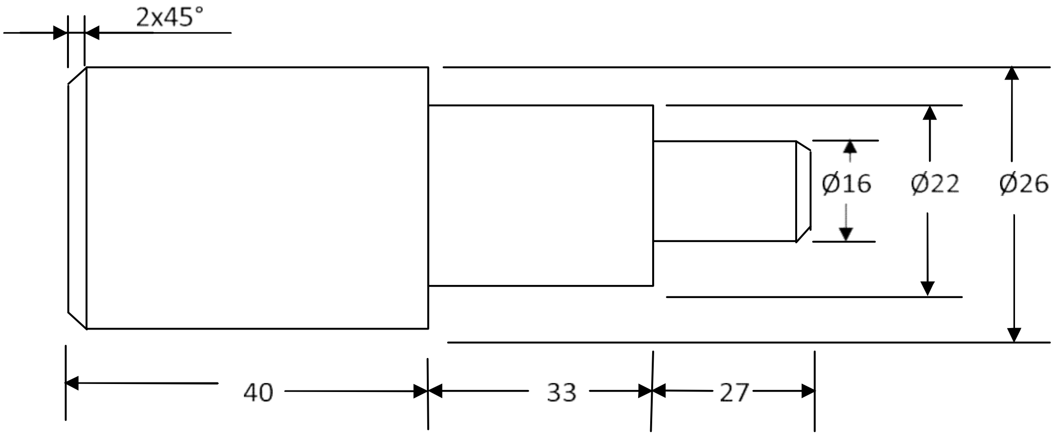
**Precautions**

1. Workpieceshouldbeheldfirmly.
2. Inroughturningoperationdonotoverfeedthetool,asitmaydamagethecuttingpointofthetool.
3. Exercise over hung of tool shouldbe avoidedasit resultsin chatter and causesroughmachinedsurface.
4. It is important to ensure that during facing operation the cutting is performed from center point totheouterdiameteroftheworkpiece.

**Result** Thejobisthusmadeaccordingtothegivendimensions.

*Exercise2*
**Stepturning**

**Aim**
Toobtainrequireddiameters(steps)onacylindricalworkpiecewiththegivenlengths.
**Tools&Equipment**
Lathemachine.Mildsteelbar,righthandcuttingtool,boxkeyortoolpostkey,chuckkey,steelrule,outsidecalipersorverniercalipers.
**Theory**
Step turning is the operation of creating various cylindrical cross sections on a metal blank. Rough turningoperation is used where excessive stock is to be removed and surface finish is not critical. For such aoperationdeepcutswithcoarsefeedareused.Duringroughmachiningmaximummetalisremovedandverylittleoversizedimensionisleft forfinishingoperation.
**Sketch**




**FigureMS-E2:**StepTurning

**Procedure**
1. Thegivenworkpieceisheldinthe3-jawchuckofthelathemachineandtightenedfirmlywithchuckkey.
2. Right hand single point cutting tool is taken tightened firmly with the help of box key in the toolpost.
3. Machine is switched on and the tool post is swiveled and the cutting point is adjusted such that itpositioned approximately for facing operation then the tool is fed into the work piece and the toolpostisgiventhetransversemovementbyrotatingthehandwheelofthecross slide.
4. Withthisfacing iscompletedandthetoolpost isswiveledandcuttingpointismadeparalleltotheaxis ofworkpiece.
5. Depth of cut is given by cross slide to the tool post and the side hand wheel is rotated to give thelongitudinal movement for the tool post and job is turned to the required length and diametersaccordingtothesketchshown infigure.
6. After completion of the job it is inspected for the dimensions obtained with the help of steel ruleand outsidecaliperorverniercaliper.

**Precautions**
1. Workpieceshouldbeheldfirmly.
2. Inroughturningoperationdonotoverfeedthetool,asitmaydamagethecuttingpointofthetool.
3. Exerciseoverhungoftoolshouldbeavoidedasitresultsinchatterandcausesroughmachinedsurface.
4. Itisimportanttoensurethatduringfacingoperationthecuttingisperformedfromcenterpointtotheouterdiameteroftheworkpiece.

**Result** Thejobisthusmadeaccordingtothegivendimensions.

*Exercise3*

**Shoulderturning**

**Aim**

Toobtainrequireddiametersonacylindricalworkpiecewiththegivendimensions.

**Tools&Equipment**

Lathemachine,Mildsteelbar,righthandcuttingtool,boxkeyortoolpostkey,chuckkey,steelrule,outsidecalipersorverniercalipers.

**Sketch**

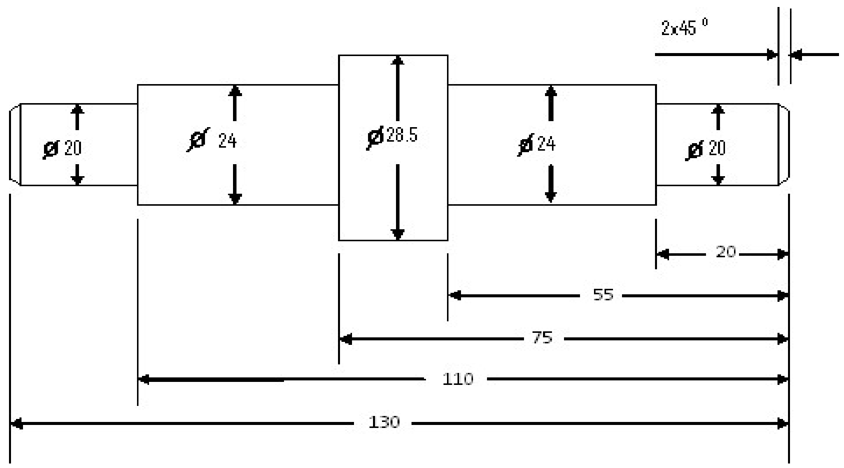



**Figure4.13:**ShoulderTurning

**Procedure**

1. Thegivenworkpieceisheldinthe3-jawchuckofthelathemachineandtightenedfirmlywithchuckkey.
2. Righthandsinglepointcuttingtoolistakentightenedfirmlywiththehelpofboxkeyinthetoolpost.
3. Machine is switched on and the tool post is swiveled and the cutting point is adjusted such that itpositioned approximately for facing operation then the tool is fed into the work piece and the toolpostisgiventhetransversemovementbyrotatingthehandwheelofthecrossslide.
4. With this facing is completed and the tool post is swiveled and cutting point is made parallel to theaxis ofwork piece.
5. Depth of cut is given by cross slide to the tool post and the side hand wheel is rotated to give thelongitudinalmovementforthetoolpostandjobisturnedtotherequiredlengthanddiameters.
6. After completion of the job it is inspected for the dimensions obtained with the help of steel ruleand outsidecaliperorverniercaliper.

**Precautions**

1. Workpieceshouldbeheldfirmly.
2. Inroughturningoperationdonotoverfeedthetool,asitmaydamagethecuttingpointofthetool.
3. Exercise over hung of tool shouldbe avoidedasit resultsin chatter and causesroughmachinedsurface.
4. It is important to ensure that during facing operation the cutting is performed from center point totheouterdiameteroftheworkpiece.

**Result** Thejobisthusmadeaccordingtothegivendimensions.