TURNER

NSQF LEVEL - 5

2nd Semester

TRADE THEORY

SECTOR: Production & Manufacturing

Directorate General of Training

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

NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI

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FOREWORD

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

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Turner Trade Theory 2nd Semester NSQF Level - 5 in Production & Manufacturing Sector under Semester Pattern.** The NSQF Level - 5 Trade Practical will help the trainees to get an International equivalency Standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

RAJESH AGGARWAL
Director General/ Addl.Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

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

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

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The Instructor guide enable 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 supplement in improving the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

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

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

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

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

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

ACKNOWLEDGEMENT

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

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

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

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

INTRODUCTION

TRADE THEORY

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

The Trade Theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indication 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 atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

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

Module 1	Taper Turning	100 Hrs
Module 2	Eccentric Turning	50 Hrs
Module 3	Thread cutting	175 Hrs
Module 4	Other forms of thread	150 Hrs
Module 5	Special job & Maintenance	50 Hrs
	Total	525 Hrs

TRADE PRACTICAL

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

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

The skill training in the computer lab is planned through a series of practical exercises centerd 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 a below average traninee. However the Development Team accept that there can be some scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Recognise, understand typical turning operations like Form turning, taper turning, boring etc.,**
- **Draw and organise work to make Morse Taper plug, Taper sleeves, executing complex job involving face plate, angle plate etc.,**
- **Execute turning of crackshaft, turning of long shaft using lathe attachments such as revolving steady, roller steady etc.,**
- **Perform eccentric boring, stepped boring within 50 micron accuracy level and use of inside micrometer, telescopic gauges etc for bore measurement.**
- **Execute metric and British standard thread cutting, multi start thread cutting, making use of change wheel calculation, and checking of threads.**
- **Understand the use and applications of all types of lathe attachments.**

SYLLABUS

Second Semester **Duration: Six Month**

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
27.	Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components. *[Different component of machine: - Form tool, Compound slide, tail stock offset, taper turning attachment. Different machine parameters- Feed, speed, depth of cut.]*	49. Make taper turning by form tool and compound slide swiveling. (25 hrs.)	Taper – different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of taper. Taper turning by swiveling compound slide, its calculation.
28-29	-do-	50. Male and female taper turning by taper turning attachment,offsetting tail stock. (22 hrs.) 51. Matching by Prussian Blue. (2 hrs.) 52. Checking taper by bevel protector and sine bar. (1 hrs.) 53. Make MT3 lathe dead centre and check with female part. (Proof machining) (25 hrs.)	Bevel protector & Vernier bevel protractorits function & reading Method of taper angle measurement. Sine bar-types and use. Slip gauges-types, uses and selection.
30.	Set the different machining parameter & tools to prepare job by performing different boring operations. *[Different machine parameter- Feed, speed & depth of cut; Different boring operation – Plain, stepped & eccentric]*	54. Turning and boring practice on CI (preferable) or steel. (23 hrs.) 55. Tip brazing on shank. (2 hrs.)	Method of brazing solder, flux used for tip tools. Basic process of soldering, welding and brazing.

31-32	-do-	56. Eccentric marking practice. (2 hrs.) 57. Perform eccentric turning. (18 hrs.) 58. Use of Vernier height Gauge and Vblock.(1 hrs.) 59. Perform eccentric boring. (18 hrs.) 60. Make a simple eccentric with dia. of 22mm and throw/ offset of 5mm.(11 hrs.)	Vernier height gauge, function, description & uses, templates-its function and construction. Screw thread-definition, purpose & it's different elements. Driving plate and lathe carrier and their usage. Fundamentals of thread cutting on lathe. Combination set-square head. Center head, protractor head-its function construction and uses.
33-35	Set the different machining parameters to produce different threaded components applying method/ technique and test for proper assembly of the components. *[Different thread: - BSW, Metric, Square, ACME, Buttress.]*	61. Screw thread cutting (B.S.W) external (including angular approach method) R/H & L/H, checking of thread by using screw thread gauge and thread plug gauge. (16 hrs.) 62. Screw thread cutting (B.S.W) internal R/H & L/H, checking of thread by using screw thread gauge and thread ring gauge. (18 hrs.) 63. Fitting of male & female threaded components (BSW) (2 hrs.) 64. Prepare stud with nut (standard size).(14 hrs.)	Different types of screw thread- their forms and elements. Application of each type of thread. Drive train. Chain gear formula calculation. Different methods of forming threads. Calculation involved in finding core dia., gear train (simple gearing) calculation. Calculations involving driver-driven, lead screw pitch and thread to be cut.
36-37	-do-	65. Grinding of "V" tools for threading of Metric 60 degree threads and check with gauge. (3 hrs.) 66. Screw thread cutting (External) metric thread- tool grinding.(15 hrs.) 67. Screw thread (Internal) metric & threading tool grinding. (16 hrs.) 68. Fitting of male and female thread components (Metric) (2 hrs.) 69. Make hexagonal bolt and nut (metric) and assemble. (14 hrs.)	Thread chasing dial function, construction and use. Calculation involving pitch related to ISO profile. Conventional chart for different profiles, metric, B.A., With worth, pipe etc. Calculation involving gear ratios and gearing (Simple & compound gearing). Screw thread micrometer and its use.
38.	-do-	70. Cutting metric threads on inch lead screw and inch threads on Metric Lead Screw. (25 hrs.)	Calculation involving gear ratios metric threads cutting on inch L/ S Lathe and vice-versa.

39.	-do-	71. Practice of negative rake tool on nonferrous metal and thread cutting along with fitting with ferrous metal.(25 hrs.)	Tool life, negative top rake-its application and performance with respect to positive top rake
40-41	-do-	72. Cutting Square thread (External) (16 hrs.) 73. Cutting Square thread (Internal). (18 hrs.) 74. Fitting of male and female Square threaded components. (2 hrs.) 75. Tool grinding for Square thread (both External & Internal). (2 hrs.) 76. Make square thread for screw jack (standard) for minimum 100mm length bar. (12 hrs.)	Calculation involving tool Thickness, core dia., pitch proportion, depth of cut etc. of sq.thread.
42-43	-do-	77. Acme threads cutting (male & female) & tool grinding. (16 hrs.) 78. Fitting of male and female threaded components (14 hrs.) 79. Cut Acme thread over 25 mm dia rod and within length of 100mm.(20 hrs.)	Calculation involved – depth, core dia., pitch proportion etc. of Acme thread. Calculation involved depth, core dia., pitch proportion, use of buttress thread.
44-45	-do-	80. Buttress threads cutting (male & female) & tool grinding. (26 hrs.) 81. Fitting of male & female threaded components. (2 hrs.) 82. Make carpentry vice lead screw (22 hrs.)	Buttress thread cutting (male & female) & tool grinding
46.	Set the different machining parameter & lathe accessories to produce components applying techniques and rules and check the accuracy. *[Different machining parameters: - Speed, feed & depth of cut; Different lathe accessories: - Driving Plate, Steady rest, dog carrier and different centres.]*	83. Make job using different lathe accessories viz., driving plate, steady rest, dog carrier and different centres. (15 hrs.) 84. Make test mandrel (L=200mm) and counter bore at the end. (10 hrs.)	Different lathe accessories, their use and care.

47.	Plan and perform basic maintenance of lathe & grinding machine and examine their functionality.	85. Balancing, mounting & dressing of grinding wheel (Pedestal). (5 hrs.) 86. Periodical lubrication procedure on lathe. (10 hrs.) 87. Preventive maintenance of lathe. (10 hrs.)	Lubricant-function, types, sources of lubricant. Method of lubrication. Dial test indicator use for parallelism and concentricity etc. in respect of lathe work Grinding wheel abrasive, grit, grade, bond etc.
48-49		**In-plant training / Project work** 1. Drill extension socket 2. conical brush 3. V-belt pulley 4. Tail Stock Centre (MT – 3) 5. Taper ring gauge 6. Sprocket 7. Socket spanner	
50-51		Revision	
52.		Examination	

Different methods of expressing tapers

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

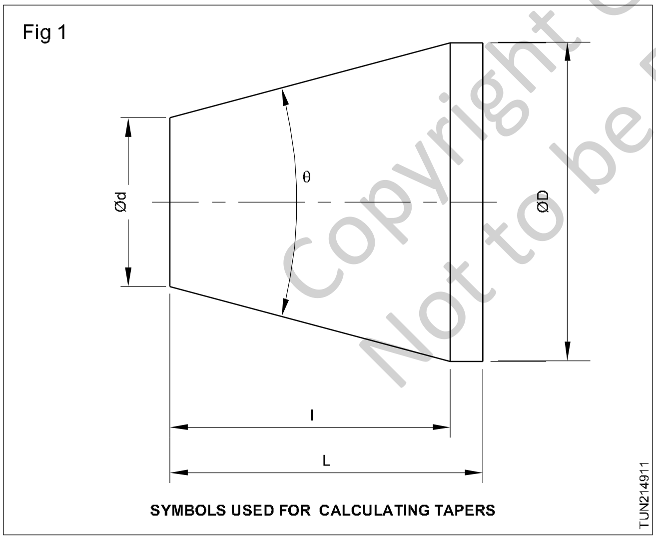
Tapers are used for:

- 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)

Big diameter (D)

Small diameter (d)



Length of the taper (l)

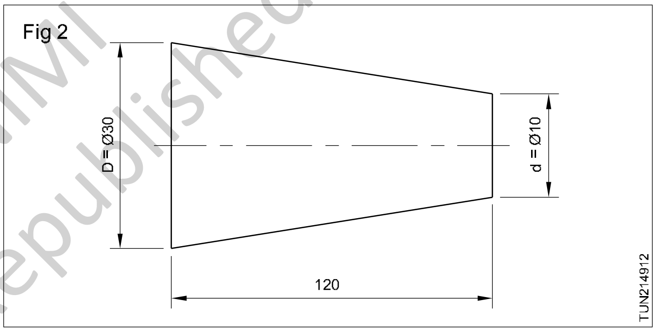
Angle of taper (θ)

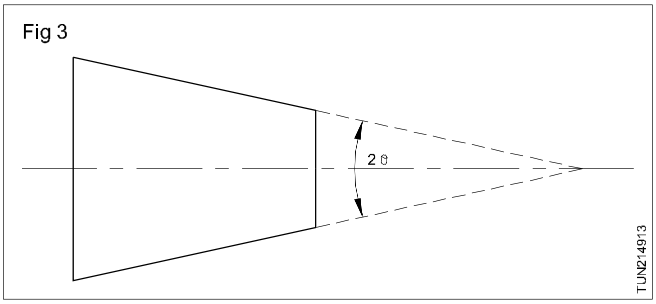
Total length of the job (L)

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)
- 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)
- 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)





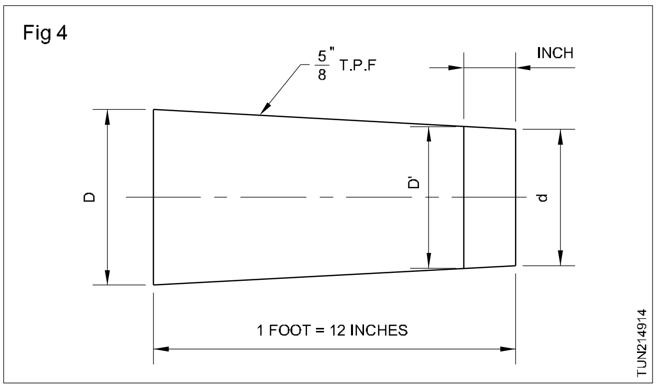


Fig 5

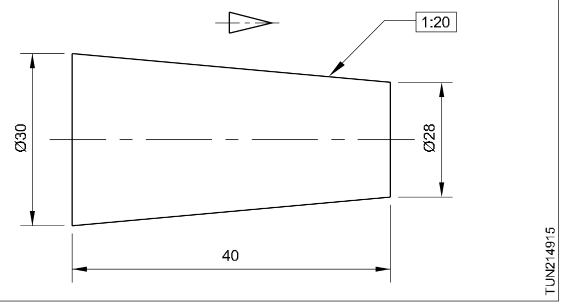
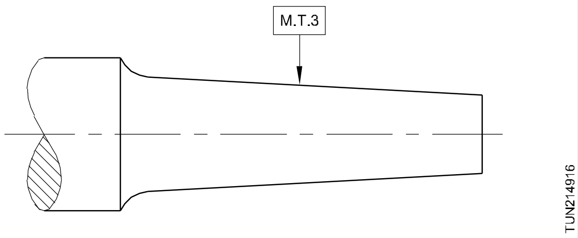


Fig 6



Conversion

The relationship between the elements of a taper are:

$$\tan\theta = \frac{D-d}{2L}$$

$$\tan\theta = \frac{TPF}{24}$$

$$\tan\theta = \frac{ratio}{2}$$

Classification of tapers

Tapers are classified into the following:

- Self-holding tapers (Figs 7 & 7a)

Self-holding tapers have a low taper angle, limited to a maximum of 10°. They will not have any locking devices for holding the components assembled.

Fig 7

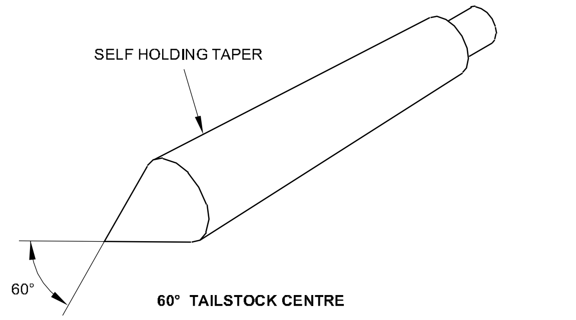
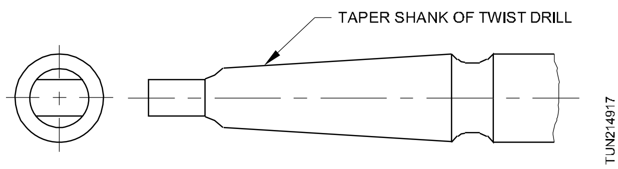


Fig 7a

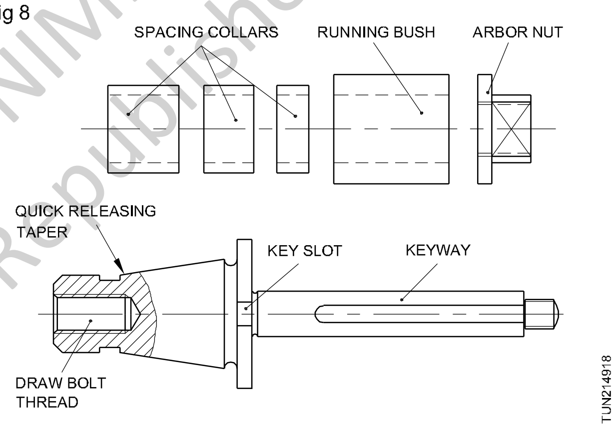


Examples

Taper shank of drills, reamers and sleeves.

- Quick releasing tapers (Fig 8)

Fig 8



Quick releasing tapers have higher taper angles and they require locking devices for holding.

Example

Arbor of a milling machine.

Different Standard tapers and their uses

Objectives: At the end of this lesson you shall be able to
- **name the standard tapers in use in engineering**
- **state the speciality of each standard taper**
- **list out their specific applications in engineering.**

The different standard tapers and their uses

The following are the common standard tapers in use.
Morse taper (MT)

Brown & Sharpe taper (BS)

Jarno taper (JT)

Metric taper

Pin taper

Morse taper

It is the most commonly used standard taper in the industry. It is a self-holding taper. This taper is usually used in bores of spindle noses of lathes and drilling machines, shanks of drills, reamers, centres, etc. The Morse taper is denoted by the letters MT. They are available from MTO to MT7. The numbers MTO to MT4 are commonly used on taper shanks of twist drills, reamers and lathe centres. The included angle of Morse taper is approximately 3° and the taper per foot is 5/8". A chart showing the angles and TPF of different Morse taper numbers in detail may be referred to for specific use.

Brown and Sharpe taper

Both quick-releasing and self-holding tapers are available in Brown and Sharpe tapers. The taper used in the arbors of milling machines is the quick-releasing Brown and Sharpe taper having a taper of 3 1/2" T.P.F.

Brown and Sharpe self-holding tapers are available from BS1 to BS18. The taper per foot is 1/2" except BS 10. BS10 has a taper of 0.5161" taper per foot.

Jarno taper

Jarno tapers are also used on the external taper of the lathe spindle nose where chuck or face plate is mounted. They are available from No.I to No.20. The amount of taper per foot is 0.6". The dimensions of this taper will be found as follows.

$$\text{Big diameter} = \frac{\text{Number}}{8}$$

$$\text{Small diameter} = \frac{\text{Number}}{10}$$

$$\text{Length of taper} = \frac{\text{Number}}{2}$$

Jarno taper is mostly used in die-sinking machines.

Metric taper

It is available as both self-holding and quick-releasing tapers. A self-holding metric taper has an included angle of 2° 51' 51". The commonly used self-holding metric tapers are expressed in numbers, and they are 4, 6, 80, 100, 120,160 and 200. These numbers indicate the highest diameter of the taper shank up to which the gauge or mating part is to match.

Quick-releasing metric tapers are used as the external tapers of lathe spindle noses. Metric tapers are expressed by numbers which represent the big diameter of the taper in millimetres. The equivalent quick (self) releasing taper in metric also has a taper of 7/24 and the available sizes are 30, 40, 45, 50.

A 7/24 taper of No.30 will have a maximum diameter of 31.75 mm at the larger end and No.60 will have 107.950 mm. All other sizes fall within this range.

Standard pin taper

It is used in taper pins. It is a self-holding taper. It is available both in Metric and British systems. The amount of taper is 1:50 in the Metric system and 1:48 (1/4" TPF) in the British system.

A taper pin is used to assemble parts which must be held and positioned for accurate, quick and easy assembly. It also permits to transmit the drive.

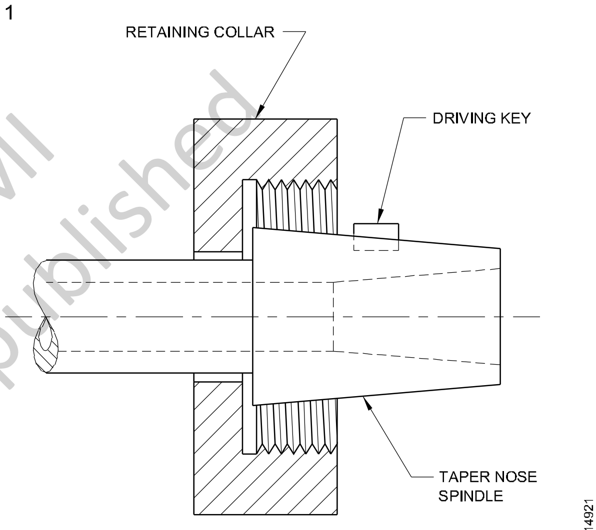
Uses of standard tapers

Tapers are used for:

- self-alignment/location of components in an assembly
- assembling and dismantling parts easily
- transmitting drive through assembly.

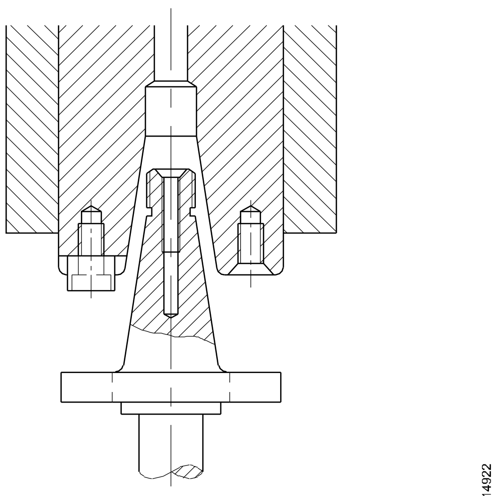
Tapers have a variety of applications in engineering assembly work.(Figs 1,2 & 3)

Fig 1



LATHE-TAPER NOSE SPINDLE

Fig 2



MILLING MACHINE SPINDLE

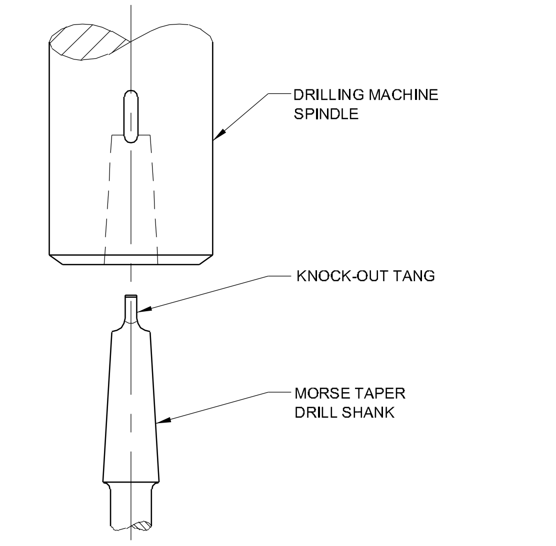
Tapers used in other assembly work

A variety of tapers are used in engineering assembly work. The most common ones are:

- pin taper

- key and keyway taper.

Fig 3

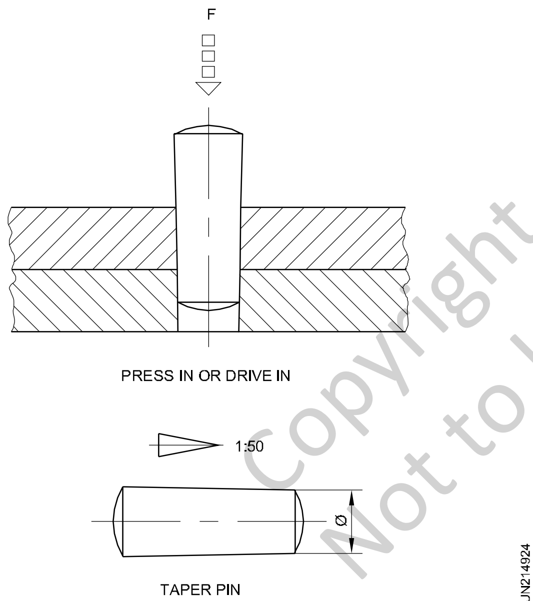


DRILLING MACHINE SPINDLE AND DRILL WITH TAPER SHANK

Pin taper

This is the taper used for taper pins used in assembly. (Fig 4)

Fig 4



The taper is 1:50.

The diameter of taper pins is specified by the small diameter.

Taper pins help in assembling and dismantling of components without disturbing the location.

Key and keyway tapers

This taper is 1:100. This taper is used on keys and keyways. (Figs 5 & 6)

For further information about the tapers used for special application refer to: IS:3458-1981

Fig 5

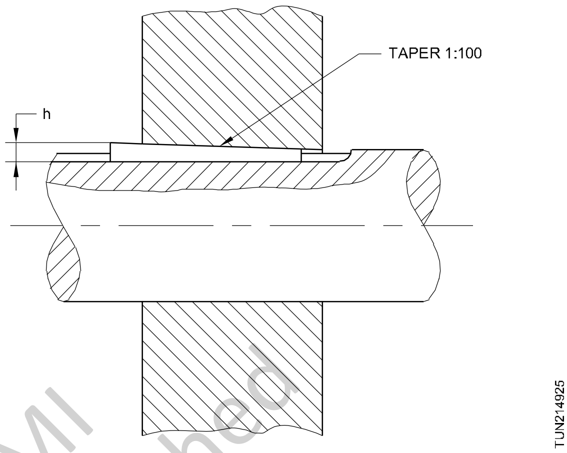
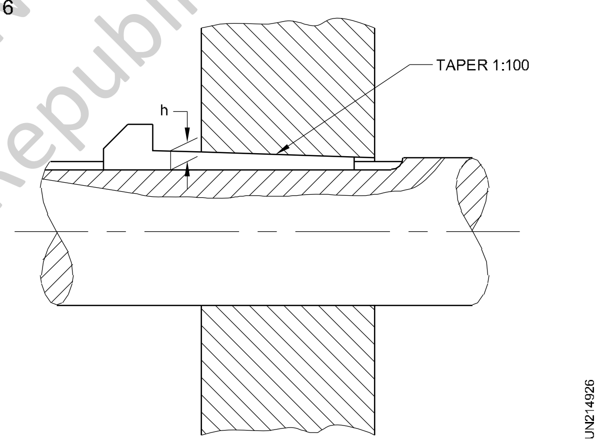


Fig 6



Methods of turning taper on Lathe and important dimensions of taper

Objectives: At the end of this lesson you shall be able to
- **point out the taper turning methods on a lathe**
- **state the features of each method**
- **list out the important dimension of taper.**

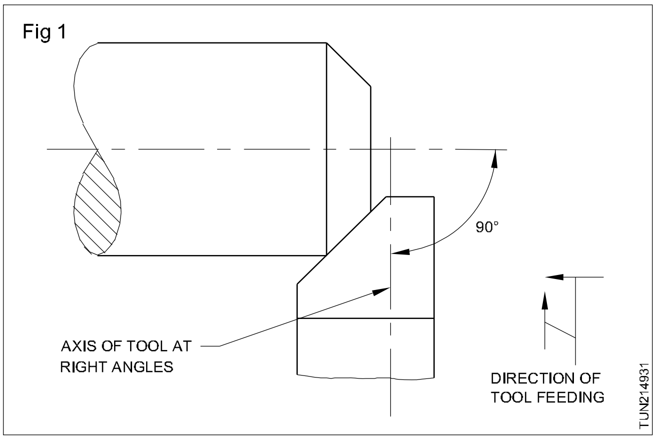
Methods of turning taper on a lathe

The different methods of taper turning on a lathe are:

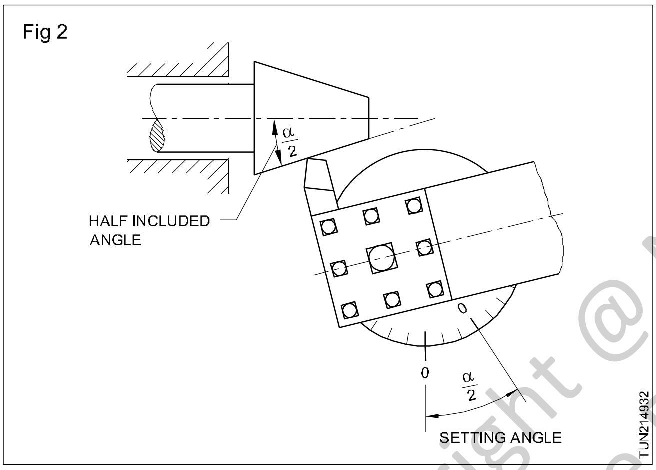
- form tool method
- swivelling compound slide method
- tailstock offset method
- taper turning attachment method.

Form tool method (Fig 1)

This method is used in mass production for producing a small length of taper where accuracy is not the criterion. The form tool should be set at right angles to the axis of the work. The carriage should be locked while turning taper by this method.



Swivelling Compound slide method (Fig 2)



In this method the top slide of the compound rest is swivelled to half the included angle of the taper, and the taper is turned.

The amount of taper for setting the angle is found by the formula

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

where

D= larger taper diameter

d= smaller taper diameter

l = length of taper

$\frac{\alpha}{2}$ = 1/2 included angle in degrees.

Advantages

Both internal and external taper can be produced.

Steep taper can be produced.

Easy setting of the compound slide.

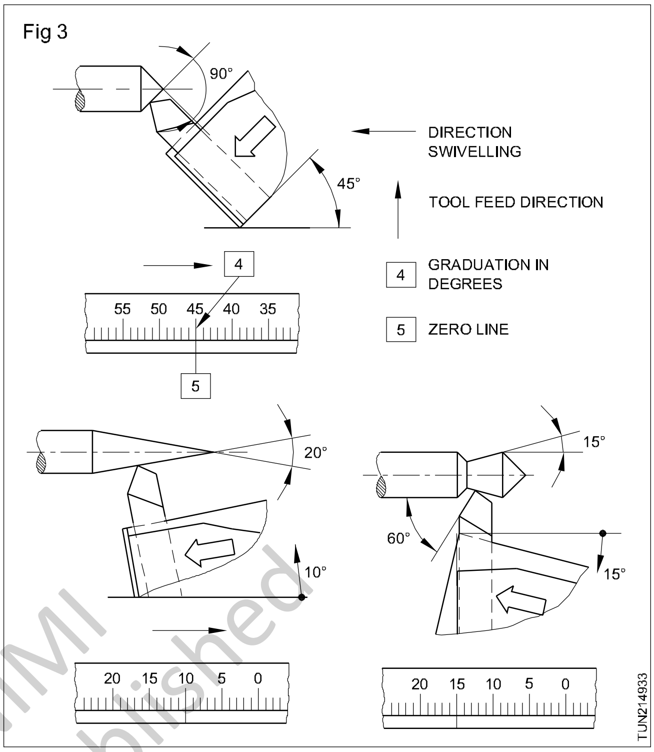
Disadvantages

Only hand feed can be given.

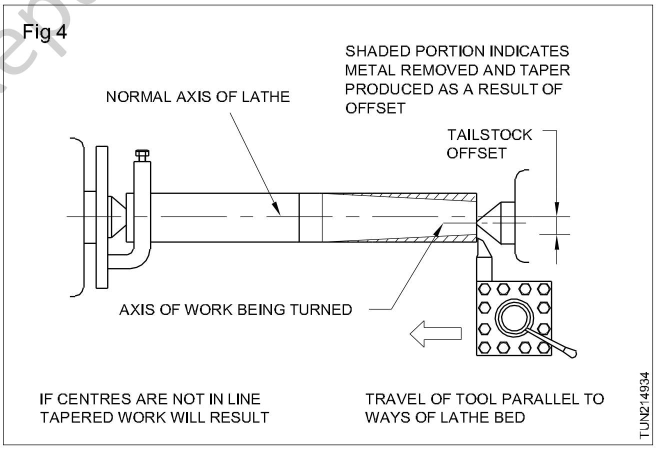
Threads on taper portion cannot be produced.

Taper length is limited to the movement of the top slide.

- Fig.3 shows the settings of a top slide for turning different taper angles.



Tailstock offset method (Fig 4)



In this method the job is held at an angle and the tool moves parallel to the axis. The body of the tailstock is shifted on its base to an amount corresponding to the angle of taper.

The taper can be turned between centres only and this method is not suitable for producing steep tapers. The amount of offset is found by the formula:

$$\text{Offset} = \frac{(D - d) x L}{2l}$$

where

D = big dia. of taper

d = small dia. of taper

l = taper length

L = total length of job.

Advantages

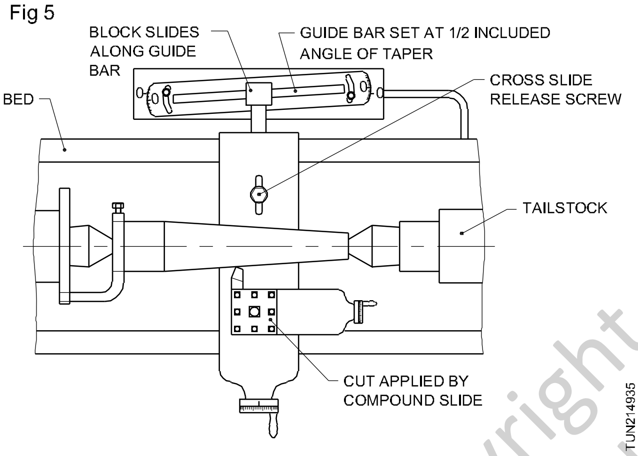
- Power feed can be given.
- Good surface finish can be obtained.
- Maximum length of the taper can be produced.
- External thread on taper portion can be produced.
- Duplicate tapers can be produced.

Disadvantages

- Only external taper can be turned.
- Accurate setting of the offset is difficult.
- Taper turning is possible when work is held between centres only.
- Damages the centre drilled holes of the work.
- The alignment of the lathe centres will be disturbed.
- Steep tapers cannot be turned.

Taper turning by attachment (Fig 5)

Fig 5



This attachment is provided on a few modern lathes. Here the job is held parallel to the axis and the tool moves at an angle. The movement of the tool is guided by the attachment.

Advantages

- Both internal and external tapers can be produced.
- Threads on both internal and external taper portions can be cut.
- Power feed can be given.
- Lengthy taper can be produced.
- Good surface finish is obtained.
- The alignment of the lathe centres is not disturbed.
- It is most suitable for producing duplicate tapers because the change in length of the job does not affect the taper.
- The job can be held either in chuck or in between centres.

Disadvantage

- Only limited taper angles can be turned.

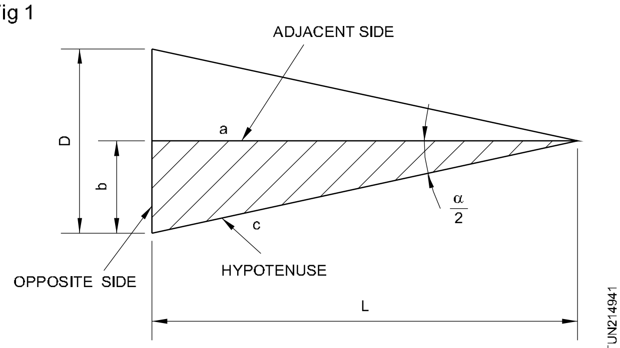
Calculation of the compound slide swivel angle

Objectives: At the end of this lesson you shall be able to
- **derive a formula to determine the swivel angle**
- **solve problems involving taper calculation**
- **refer to tables and determine the value of the angle for the arrived result**
- **determine the depth of cut to reduce the taper length.**

Derivation of the formula

For convenience a tapered job whose small diameter is zero is taken (Fig 1) to illustrate as to how the formula can be derived.

Fig 1

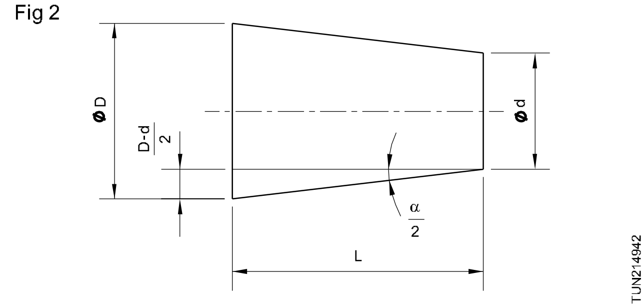


The taper is divided into two right angled triangles by the centre line. By referring to the shaded right angled triangle in figure 1, the side (b) shown against the half included angle of taper a/2, is termed as the opposite side. The side (a) is termed as the adjacent side and side (c) is termed as 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 2, 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 2



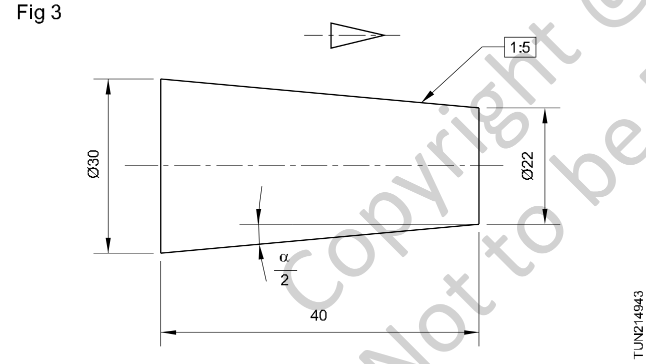
D = 30 mm d = 22 mm & l = 40 mm

Now the formula becomes

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

For example, referring to Fig.3 we have

Fig 3



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

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

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 3.

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

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

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 3), 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 $5^{o}45'$.

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"

$$\text{Tan}\ \alpha/2 = \frac{\frac{5''}{8}}{2 \times 12} = \frac{5}{8 \times 24} = 0.0260$$

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

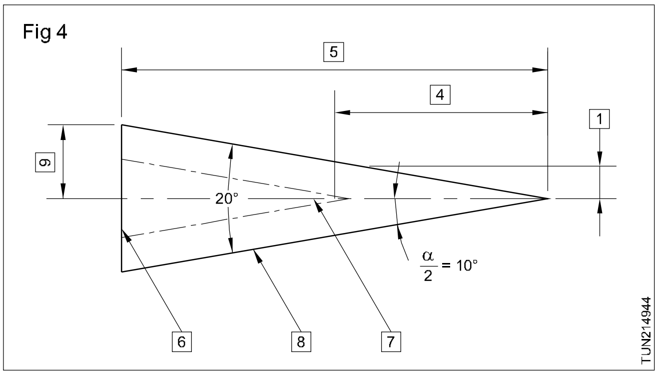
The formula is Tan of half included

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

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. 4)

Referring to Fig.4, [9] is the radius at the bigger end, (also the diference 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 4 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 $20^o/2$

=2mm x tan 10^o

=2 x 0.1763

=0.3526mm

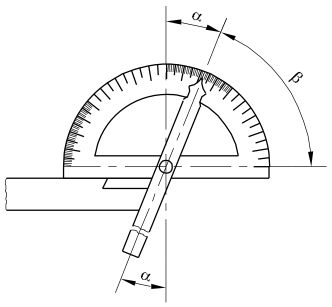
Hence a depth of cut of 0.35 mm is to be given in order to reduce the taper length by 2 mm, the taper included angle remaining the same 20°.

Bevel protractor and Vernier bevel protractor

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

Bevel protractor (Fig 1) : The bevel protractor is a direct angular measuring instrument, and has graduation marked from 0° to 180°. This instrument can measure angles within an accuracy of ±1°.

Fig 1



BEVEL PROTRACTOR

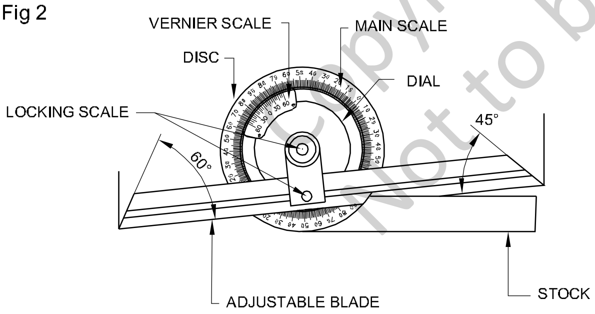
TUN215011

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

Parts of a Vernier Bevel Protractor

The following are the parts of a vernier bevel protractor. (Fig 2)

Fig 2



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Stock

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

Disc

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

Dial

It is pivoted to the disc and can be rotated through 360°. The vernier scale of the instrument is attached to the dial. The dial is locked to the disc while reading the measurement.

Blade

This is the other contacting surface of the instrument that contacts the work during measurement, preferably the inclined surfaces. 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 alloy steel, properly heat-treated and highly finished. A magnifying glass is sometimes fitted for clear reading of the graduations.

Uses of a vernier bevel protractor

Fig 3

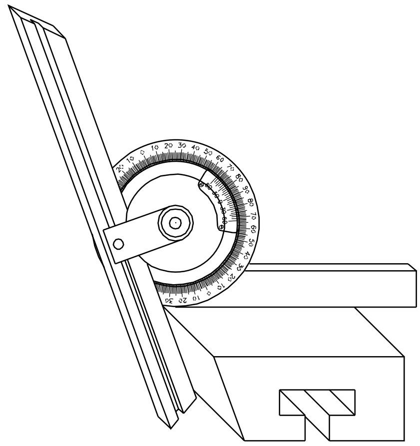

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Fig 4

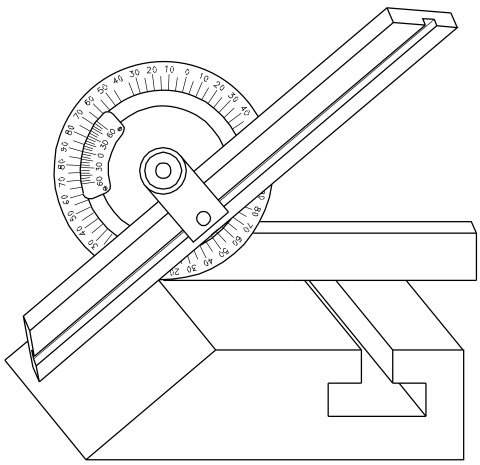

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Fig 5

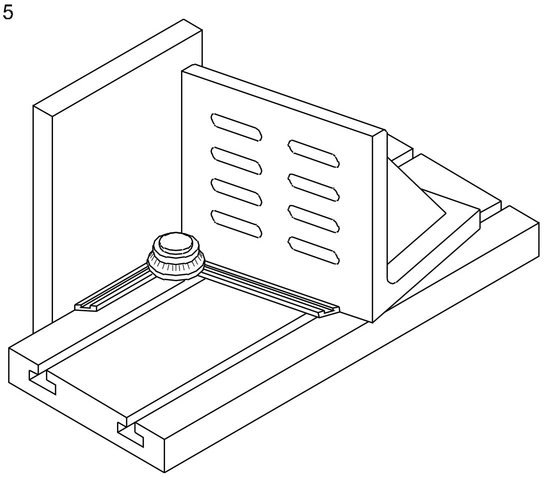
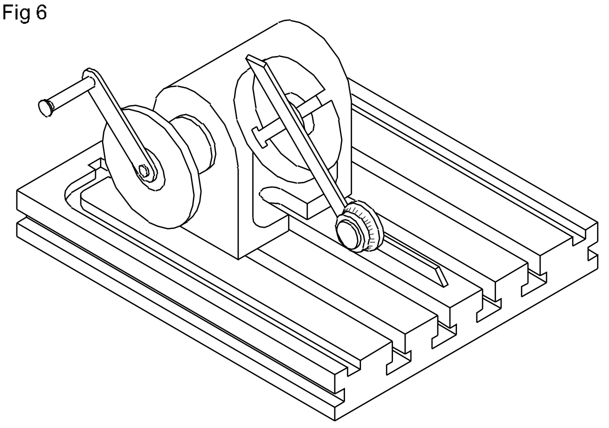


Fig 6



The vernier bevel protractor is used to measure acute angles, i.e. less than 90° (Fig 3), obtuse angles i.e more than 90° (Fig 4) for setting work-holding devices to angles on machine tools, work tables etc. (Figs 5 & 6)

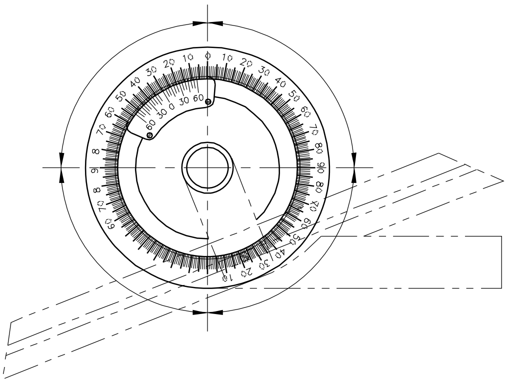
Graduations on vernier bevel protractor

Objectives: At the end of this lesson you shall 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

For purposes of taking angular measurements, the full circumference of the disc is graduated in degrees.The 360° are equally divided and marked in four quardrants, from 0 degree to 90 degrees, 90 degrees to 0 degree, 0 to 90 degrees and 90 degrees to 0 degrees. Every tenth division is marked longer and numbered. Each division represents 1 degree. The graduations on the disc are known as the main scale divisions. On the dial, 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)

$$= \frac{23^o}{12} = 1\frac{11^o}{12} = 1^o55'$$

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 1)

Hence, the least count is

2 MSD – 1 VSD

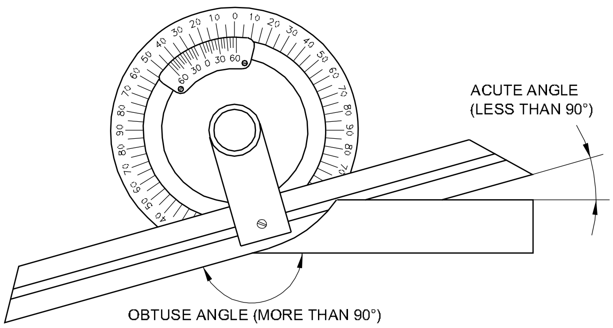
i.e. the least count $= 2^o - 1\frac{11^o}{12}, 2 - 1^o55'$

$$= \frac{1^o}{12}$$

$$= 5'$$

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 dial assist to achieve this. (Fig 2)

Fig 2

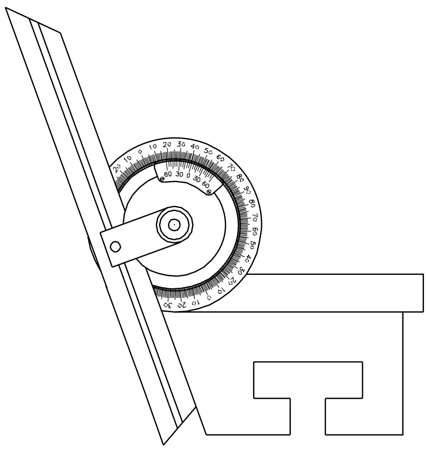


Reading of vernier bevel protractor

Objectives: At the end of this lesson you shall 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)

Fig 1



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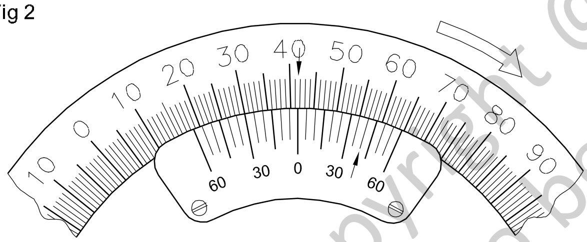
First read the number of whole degrees between zero of the main scale and zero of the vernier scale. (Fig 1)

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)

Fig 2



TUN215032

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

Example: 8 x 5' = 40'

Sum up both readings to get the measurements. = 41° 40'

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

For obtuse angle set up (Fig 3)

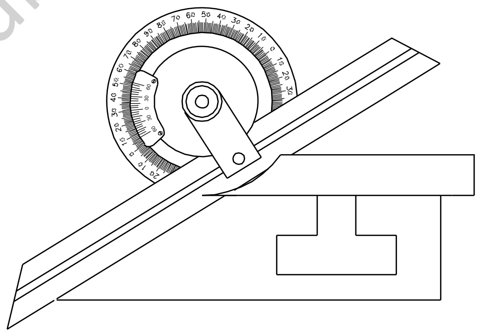
The vernier scale reading is taken on the left side as indicated by the arrow. The reading value is subtracted from 180° to get the obtuse angle value.

Reading 22° 30'

Measurement

180° — 22° 30'=157° 30'

Fig 3



TUN215033

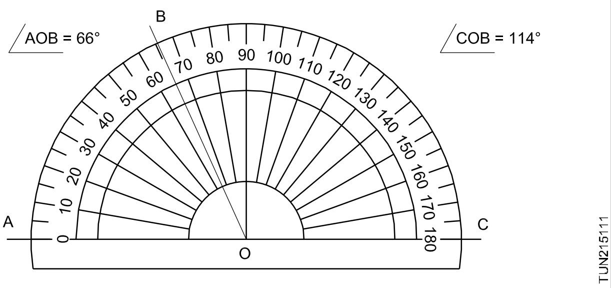
Method of taper angle measurement

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°	
Subdivisions	1 degree or 1°	= 60 mts or	60'
	1 min or 1'	= 60 secs or	60"

Measuring angles with vernier bevel protractor

Objective: At the end of this lesson you shall be able to
- **state the methods of measuring angles with a vernier bevel protractor.**

A vernier bevel protractor setting depends on the type of the angle to be measured. It can be set in different ways for measuring and checking angles. (Figs 1 to 6)

Before measuring, check that the measuring surfaces (the blade and the stock of the protractor) are not damaged.

Clean the measuring faces of the protractor and the workpiece. Use a soft clean cloth.

While measuring, loosen the vernier scale locking screw.

Loosen the blade locking screw, adjust the blade to suit the workpiece, tighten the blade screw and place the protractor on the work-surface.

Adjust the protractor so that the inner surface of the blade and the base are in contact with the workpiece.

Make sure that the protractor is perpendicular to the surface being measured.

The protractor must be adjusted so that the blade and base are in full contact with the surfaces being measured. (There should not be any gap between the blade, base and the workpiece surfaces).

Lock the vernier locking nut and carefully remove the vernier bevel protractor.

Take the reading.

> **When you have finished measuring, clean the protractor using a soft cloth and put it in its case.**
>
> **Do not leave the protractor in any place from where it could fall, or be otherwise damaged.**

Fig 1

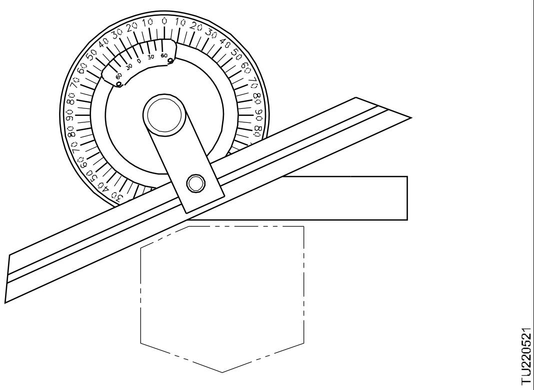


Fig 2

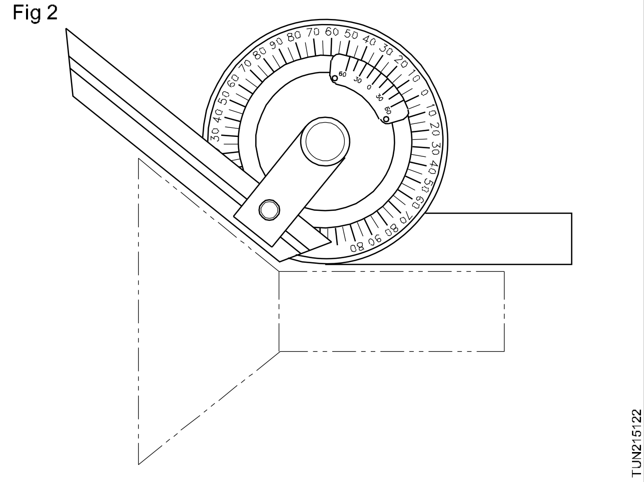


Fig 5

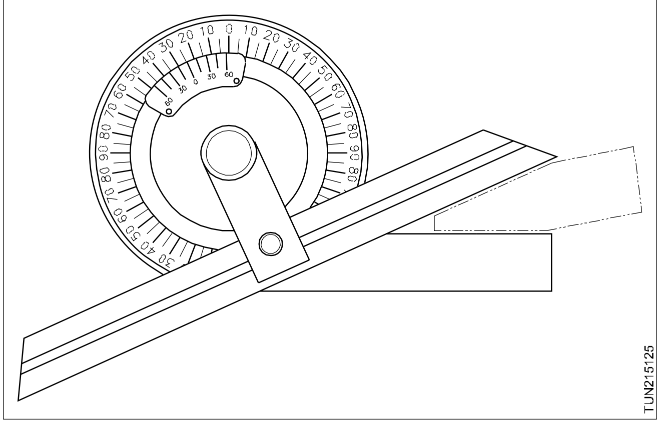


Fig 3

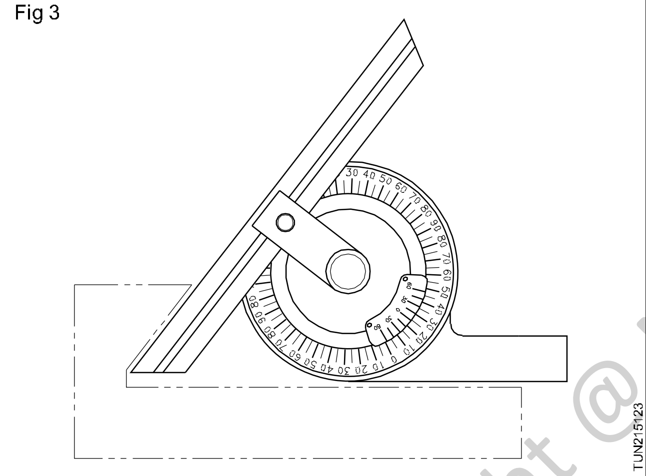


Fig 6

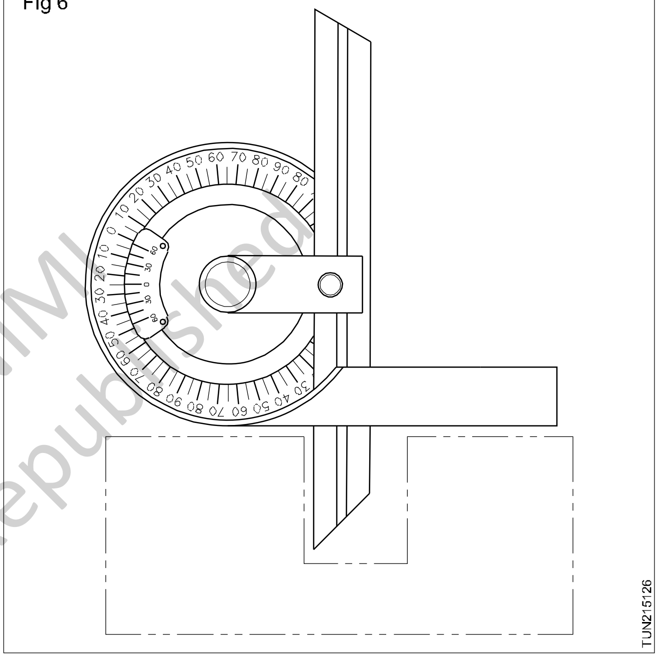


Fig 4

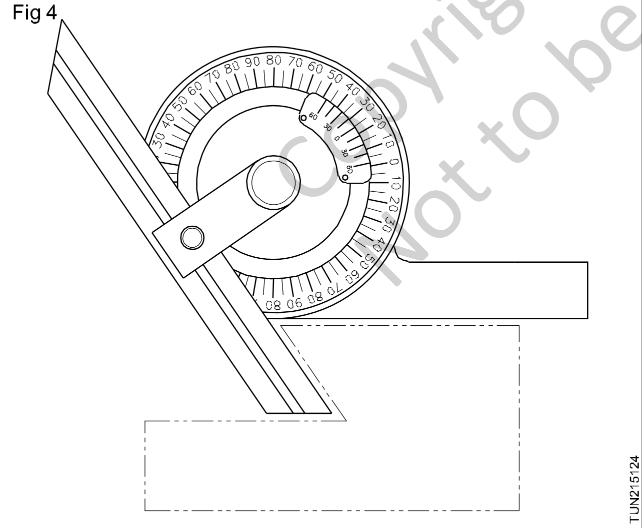
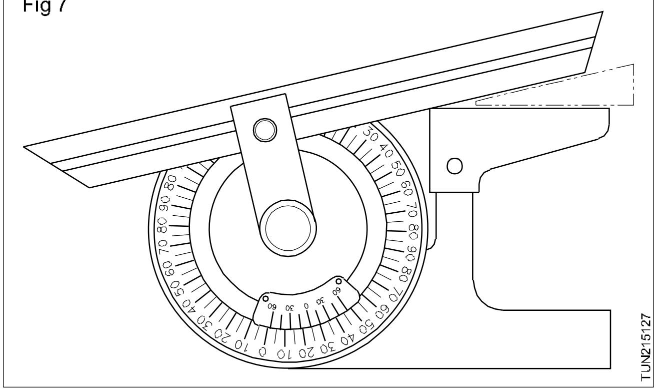


Fig 7



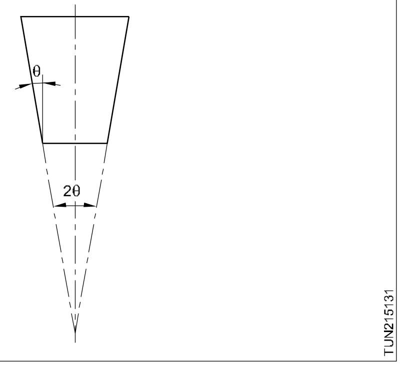
Measuring angle of tapered (external) components

Objectives: At the end of this lesson you shall be able to
- **name the features of a taper which can be measured using precision rollers and slip gauges**
- **state the formula for measuring the angle of the taper**
- **calculate the angle of the taper.**

A method used for checking the dimensions of the tapered components is by using precision rollers or balls along with the slip gauges. Using this method the following elements of the tapers can be checked.

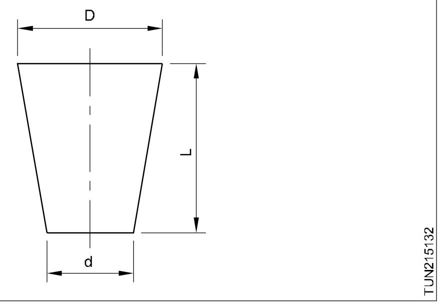
- Angle of the taper (Fig 1)

Fig 1



- Small end diameter (Fig 2)
- Large end diameter (Fig 2)

Fig 2

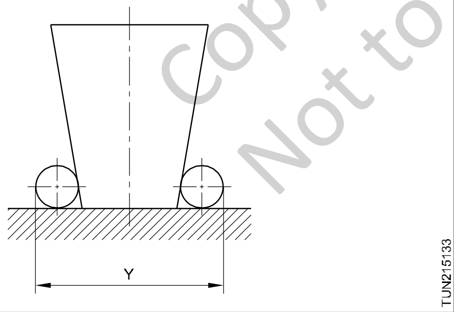


Checking the angle of the taper

For determining this angle two measurements are taken. i.e. X and Y.

The measurement Y is taken by placing the component against a datum surface like the surface plate or the marking table. Two precision rollers are then placed at the smaller end resting on the datum surface and contacting the workpiece. (Fig 3)

Fig 3



Measurement 'X' is taken by lifting and placing the rollers on both sides with the help of two sets of slip packs having the same size.

The measurement is then taken with a micrometer over the rollers. (Fig 4)

For computing the taper angle the following trigonometrical ratio is applied. (Fig 5a)

$$\text{Tan}\,\theta = \frac{BC}{AB} = \frac{a}{c}$$

From the two measurements taken and the height of the slip packs the ratio is established by subtracting the measurement 'Y' from 'X' and dividing it by two. This corresponds to the distance AB. (Fig 5b)

The length AC corresponds to the size of the slip pack used on one side.

$$AB = \frac{x - y}{2}$$

Then the tangent of the taper angle is

$$\text{Tan}\theta = \frac{AB}{AC} = \frac{\frac{x-y}{2}}{H} = \frac{x-y}{2H}$$

Where X is the measurement over the rollers placed on the slip gauge height, Y is the measurement over the rollers at the smaller end and H is the slip gauge height.

The included angle of the taper will be double the above angle.

Fig 4

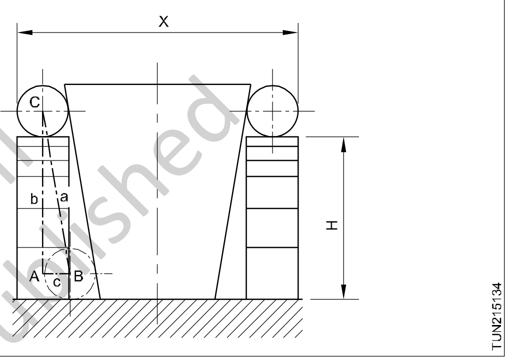
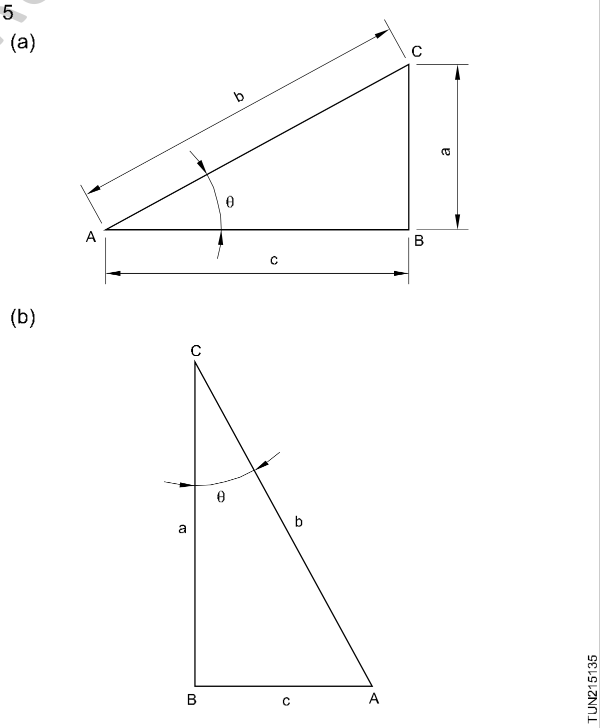


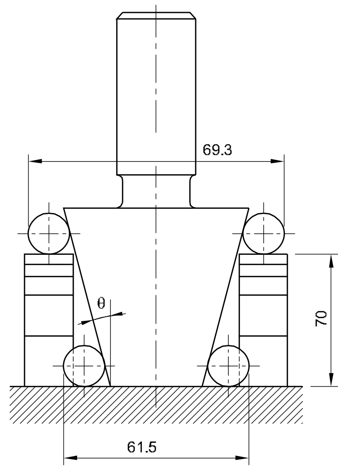
Fig 5



Example

Calculate the included angle of the tapered component shown in Fig 6.

Fig 6



TUN215136

The measurement

X = 69.3 MM

X = 69.3 MM

Y = 61.5 MM

Height = 70 MM

$\tan\theta = (69.3)-(61.5)/2X70$

$= 7.8/2X70$

$$= \frac{3.9}{70} = \frac{0.39}{7} = 0.0557$$

Referring to the log table under Natural Tangents we find θ = 3° 11.'

HENCE INCLUDED ANGLE OF THE TAPER

2θ = 3° 11'X 2 = 6° 22'

2θ = 6° 22'.

Determining diameters of tapered components

Objectives: At the end of this lesson you shall be able to
- **calculate the small diameter of a tapered component**
- **calculate the large diameter of a tapered component.**

Diameters at any position of tapered components can be determined when the angle of taper is known.

For inspection of tapered components for dimensional quality the following diameters are measured.

Small end diameter d (Fig 1)

Large end diameter D (Fig 1)

Fig 1

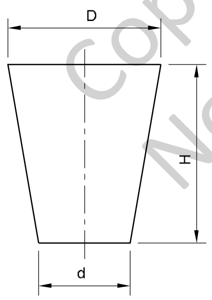


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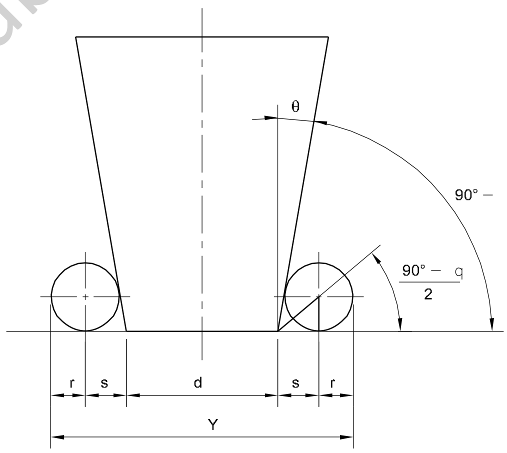
Fig 2



TUN215142

Determining small end diameter (Fig 2)

The small diameter 'd' is = Y – 2 (S + r).

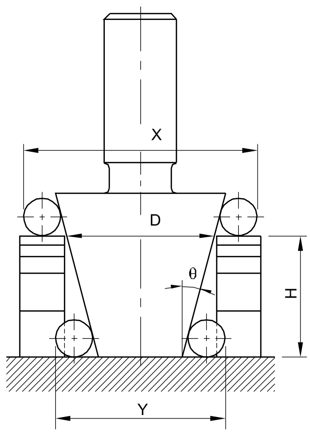
Y - is the diameter over the two precision rollers.

r - is the radius of the roller.

S - is the distance from the centre of the roller to the end of the component.

Calculating S (Fig 3)

Fig 3



TUN215143

$$\tan\left\{\frac{90-\theta}{2}\right\} = \frac{r}{s}$$

$$s = \frac{r}{\tan\left\{\frac{90-\theta}{2}\right\}}$$

$$d = Y - 2\left[\frac{r}{\tan\left\{\frac{90-\theta}{2}\right\}} + r\right]$$

$$= Y - 2r\left[\cot\left\{\frac{90-\theta}{2}\right\} + 1\right]$$

Example

θ = 3° 11"

Y = 61.5 mm

r = (radius of roller) 6 mm

$$\text{Then } d = 61.5 - 12\left[\cot\left\{\frac{90 - 3^o 11'}{2}\right\}\right] + 1$$

= 61.5 – 12 (1.0570 + 1)

= 61.5 – 12 x 2.0570

= 61.5 – 24.6840 = 36.3160 mm

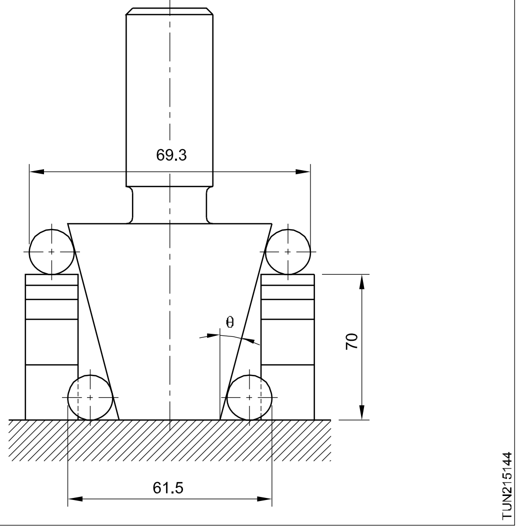
Determining the large diameter of taper at any desired heigh (H for example)

The formula is derived by taking into consideration the measurement over the rollers placed at a known height 'H', the diameter of the roller and the angle of taper. The diameter 'D' at larger end at height 'H'.

= X – 2 (s + r)

Example (Fig 4)

Fig 4



θ = 3° 11'

X = 69.3 mm

H = 70 mm

r = (radius of the roller) 6 mm

Then the diameter of the taper at height H from the small end. = 69.3 – 12 (1+1.0570)

= 69.3 – 24.6840 = 44.6160 mm

The length of the taper can be directly measured by using a vernier height gauge. Then the largest diameter of the taper is determined by computing the known values.

If 'M' is the maximum diameter of the taper, 'T' is the minimum diameter of the taper and L is the tapered length

then M = T + 2L x Tan θ.

Sine bar - Types - Uses

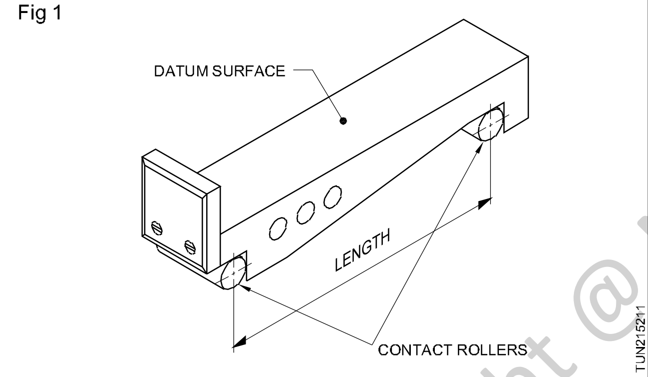
Objectives: At the end of this lesson you shall be able to
- **state the different uses of a sine bar**
- **state the features of a sine bar**
- **specify the sizes of a sine bar**
- **state the principle of a sine bar.**

A sine bar is a precision instrument meant for setting work to machine angular surfaces, to determine the angles of tapered jobs by calculation.

Features

The sine bar is a rectangular bar made of stabilized chromium steel. (Fig 1)

Fig 1



The surfaces are accurately finished by grinding and lapping.

Two precision rollers of the same diameters are mounted on either end of the bar. The centre line of the rollers is parallel to the top face of the sine bar.

There are holes drilled across the bar. This helps in reducing the weight, and also facilitates clamping the sine bar to the angle plates, with bolts and nuts.

The length of the sine bar is the distance between the centres of the rollers. The commonly available sizes are 100 mm, 200 mm, 250 mm and 500 mm. A sine bar is specified by its length.

Uses

Sine bars are used when high degree of accuracy is needed during

- the checking of parallelism (Fig 2)
- the marking out (Fig 3)
- the setting up of components for machining angular surfaces. (Fig 4)

The principle of a sine bar

The principle of a sine bar is based on the trigonometrical function of sine of an angle.

Fig 2

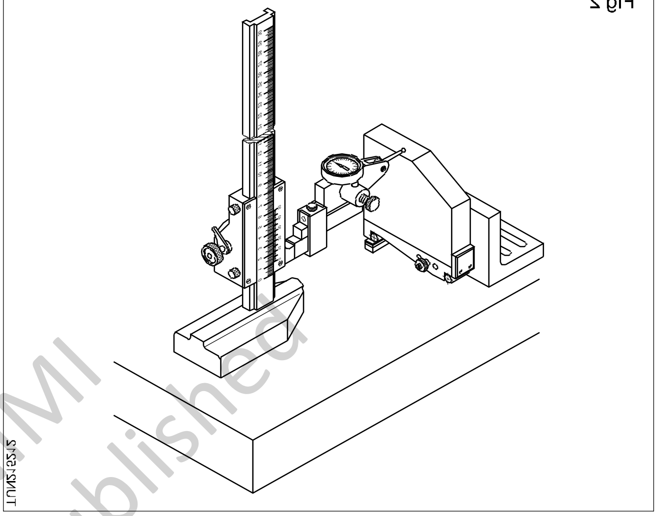
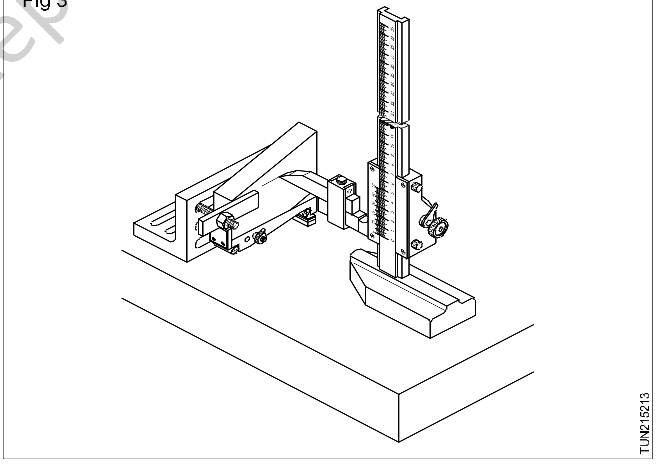


Fig 3



In a right angled triangle the function known as sine of an angle is the relationship existing between the hypotenuse and the side opposite to the angle. (Fig 5)

It may be noted that for setting the sine bar to different angles, slip gauges are used.

A surface plate or marking table provides the datum surface for the set up.

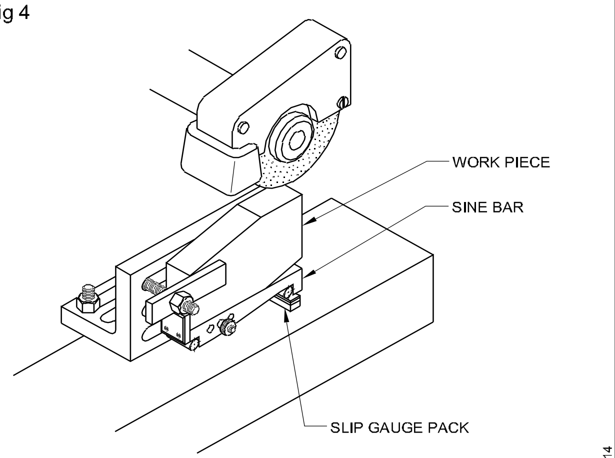
The sine bar, the slip gauges and the datum surface upon which they are set form the sides of a right angle triangle. (Fig 6)

The sine bar forms the hypotenuse (c) and the slip gauge stack forms the side opposite to the angle θ (a).

$$\text{Sine of the angle } \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$$

$$\text{Sine } \theta = \frac{a}{c}$$

Fig 4



ANGULAR SURFACE OF THE WORKPIECE SET FOR FURTHER MACHINING (GRINDING)

Fig 5

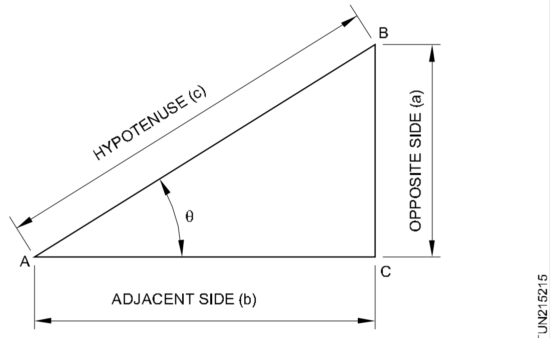
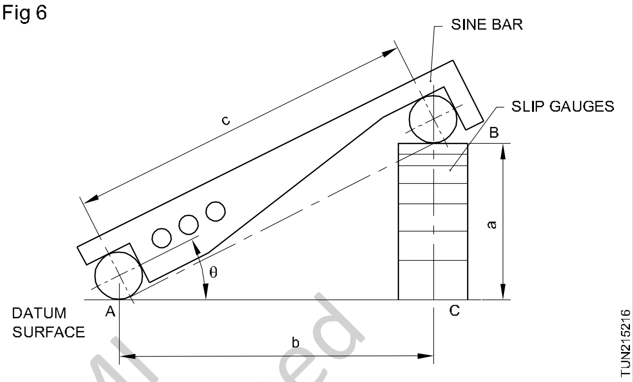


Fig 6



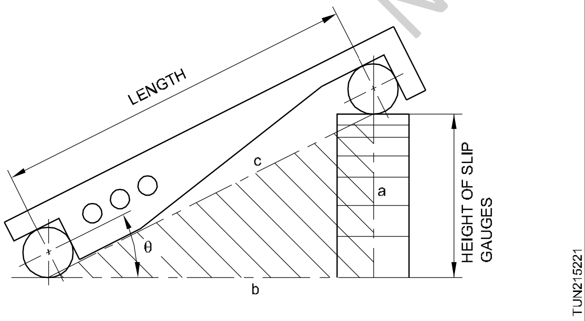
Determining taper angle using sine bar and slip gauges

Objectives: At the end of this lesson you shall be able to
- **check the correctness of the known angle of the work**
- **calculate the height of slip gauges to build up the height for a given angle.**

A sine bar provides a simple means of checking angles to a high degree of accuracy.

The use of a sine bar is based on the trigonometrical function. The sine bar forms the hypotenuse of that triangle and the slip gauge height forms the opposite side of the angle. (Fig1)

Fig 1

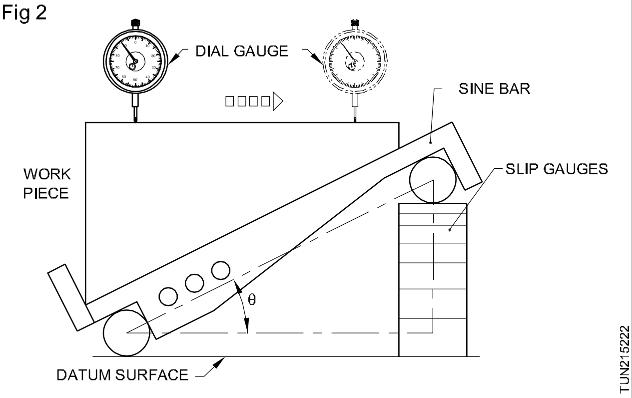


Checking the correctness of a known angle

For this purpose first choose the correct slip gauge combination for the angle to be checked.

The component to be checked should be mounted on the sine bar after placing the selected slip gauges under one roller, with the other roller resting on the datum surface. (Fig 2)

Fig 2



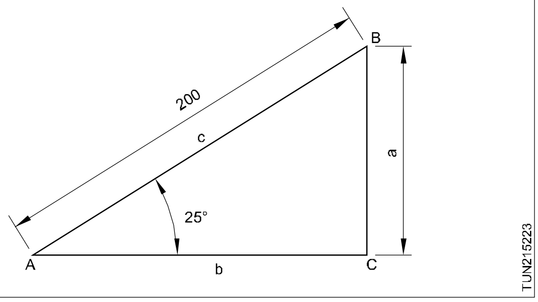
A dial test indicator is mounted on a suitable stand or vernier height gauge. (Fig 2) The dial test indicator is then set in first position as shown in the figure, and the dial is set to zero. Move the dial indicator to the other end of the component (second position). If there is any difference then the angle is incorrect. The height of the slip gauge pack can be adjusted until the dial test indicator reads the same reading at both ends. The actual angle can then be calculated and the deviation, if any, will be the error.

Method of calculating the slip gauge height

Example

To determine the height of slip gauges for an angle of 25° using a sine bar of 200 mm long. (Fig 3)

Fig 3



$$\text{Sine } \theta = \frac{a}{c}$$

$\theta = 25°$

$a = C \text{ sine } q$

$= 200 \times 0.4226$

$= 84.52$ mm.

The height of the slip gauge required is 84.52 mm.

Note

The value of Sine θ can be seen from mathematical tables. (Natural Sine)

Use always accurate tables while working with sine bars.

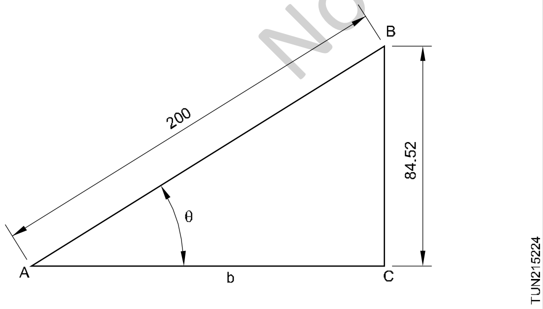
Tables are also available with ready worked out sine bar constants for standard lengths of sine bars.

Calculating the angle of tapered components

The height of the slip gauge used is 84.52 mm. The length of the sine bar used is 200 mm.

What will be the angle of the component? (Fig 4)

Fig 4



$$\text{Sine}\theta = \frac{a}{c} = \frac{84.52}{200}$$

$\text{Sin } \theta = 0.4226$

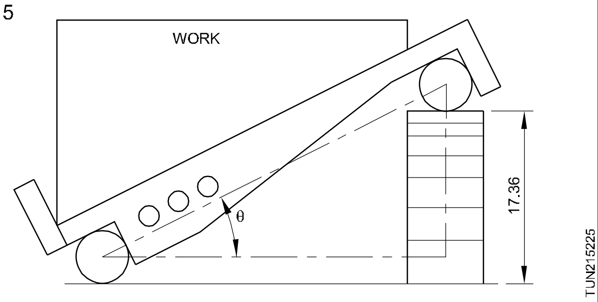
The value of sine of the angle is 0.4226.

\ the angle = 25°.

Examples

1 What will be the angle of the workpiece if the slip gauge pack height is 17.36 mm and the size of the sine bar used is 100 mm? (Fig 5)

Fig 5



$$\text{Sine}\theta = \frac{a}{c} = \frac{17.36}{100}$$

$= 0.1736$

$\Theta = 10°$

2 Calculate the height of the slip gauge pack required to raise a 100 mm sine bar to an angle of 3°35'.

$$\text{Sine}\theta = \frac{a}{c}$$

$$\text{Sine } 3^{o}.35' = \frac{a}{100\text{mm}}$$

A = 100 MM X SIN 3°.35'

= 100 X 0.0624 MM

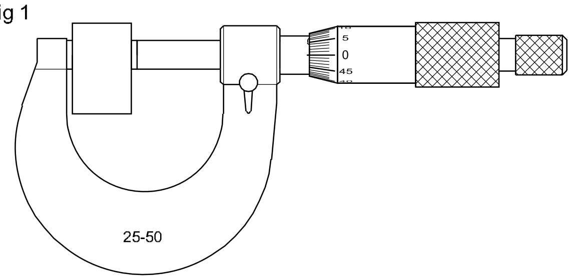
Height of the slip gauge = 6.24 mm

Slip Gauges, types uses and selection

Objectives : At the end of this lesson you shall be able to
- **state the features of slip gauges**
- **state the different grades of slip gauges and their uses**
- **state the number of slips in standard sets**
- **state the care and maintenance to be followed in the case of slip gauges.**

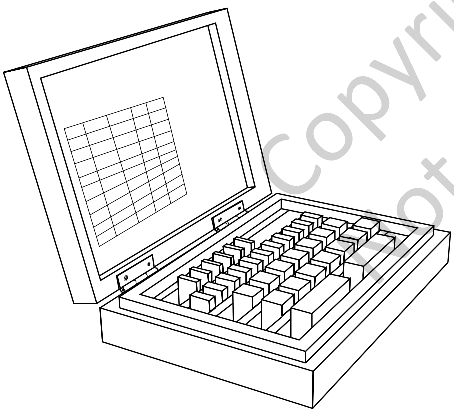
Slip gauges or gauge blocks are used as standards for precision length measurement. (Fig 1) These gauges are made in sets and consist of a number of hardened blocks made of high grade steel with low thermal expansion. They are hardened throughout, and further heat treated for stabilization. The two opposite measuring faces of each block are lapped flat and parallel to a definite size within extremely close tolerances.

Fig 1



These slip gauges are available in various sets with different numbers. (Fig2) (Ref.Table 1)

Fig 2



A particular size can be built up by wringing individual slip gauges together. (Figs 3 & 4)

Fig 3

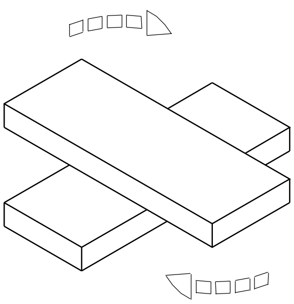
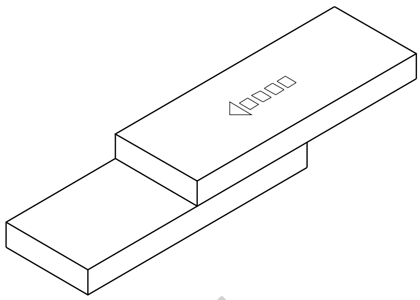


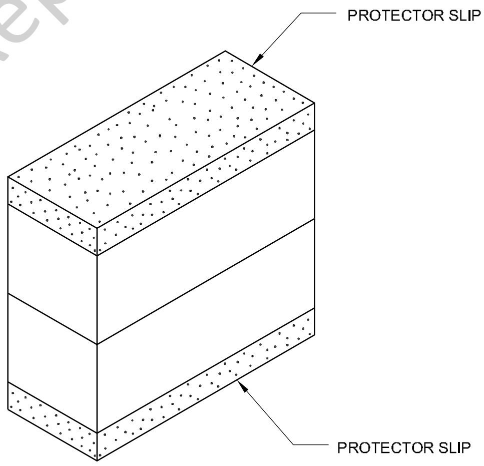
Fig 4



Wringing is the act of joining the slip gauges together while building up to sizes.

Some sets of slip gauges also contain protector slips of some standard thickness made from higher wear-resistant steel or tungsten carbide. These are used for protecting the exposed faces of the slip gauge pack from damage. (Fig 5)

Fig 5



B.I.S. recommendations

Four grades of slip gauges are recommended by B.I.S. (IS 2984). They are:

Grade 00 Reference

Grade 0 Calibration

Grade i Inspection

Grade ii Workshop

GRADES

Grade oo accuracy

It is a reference grade for reference standard and to calibrate the calibration grade slip gauges.

Grade o accuracy

It is a calibration grade used to calibrate the inspection grade slip gauges.

Grade i accuracy

It is an inspection grade used to calibrate workshop grade slip gauges and measuring instruments.

Grade ii accuracy

It is a workshop grade used for general workshop applications.

Care and Maintenance

Points to be remembered while using slip gauges

Use as minimum a number of blocks as possible while building up for a particular dimension.

While building the slip gauges, start wringing with the largest slip gauges and finish with the smallest.

While holding the slip gauges do not touch the lapped surfaces.

If available use protector slips on exposed faces.

After use clean the slips with carbon tetrachloride and apply petroleum jelly for protecting against rust.

Before use remove the petroleum jelly with carbon tetrachloride. Use chamois leather to wipe the surfaces.

TABLE 1

Different sets of slip gauges.

Set of 112 pieces

Range (mm)	Steps (mm)	No.of pieces
Special piece 1.0005	-	1
1st series 1.001 to 1.009	0.001	9
2nd series 1.01 to 1.49	0.01	49
3rd series 0.5 to 24.5	0.5	49
4th series 25.0 to 100.0	25	4
Total pieces		112

Set of 103 pieces

Range (mm)	Steps (mm)	No.of pieces
1st series 1.005	-	1
2nd series 1.01 to 1.49	0.01	49
3rd series 0.5 to 24.5	0.5	49
4th series 25 to 100	25.0	4
Total pieces		103

Set of 78 pieces

Range (mm)	Steps (mm)	No.of pieces
1.0025	-	1
1.005	-	1
1.0075	-	1
1.01 to 1.49	0.01	49
0.5 to 9.5	0.5	19
10.0 to 50.0	10.0	5
75.0 & 100.0	-	2
Total pieces		78

Set of 47 pieces

Range (mm)	Steps (mm)	No.of pieces
1st series 1.005	-	1
2nd series 1.01 to 1.09	0.01	9
3rd series 1.1 to 1.9	0.1	9
4th series 1.0 to 24.0	1.0	24
5th series 25.0 to 100.0	25.0	4
Total pieces		47

Set of 87 pieces

Range (mm)	Steps (mm)	No.of pieces
1st series		
1.001 to		
1.009	0.001	9
2nd series		
1.01 to		
1.49	0.01	49
3rd series		
0.5 to 9.5	0.5	19
4th series		
10.0 to		
100.0	10.0	10
Total pieces		87

Set of 32 pieces

Range (mm)	Steps (mm)	No.of pieces
1.005	-	1
1st series		
1.01 to 1.09	0.01	9
2nd series		
1.1 to 1.9	0.1	9
3rd series		
1 to 9.0	1.0	9
4th series		
10.0 to 30.0	10.0	3
60.0	1	
Total pieces		32

Set of 45 pieces

Range (mm)	Steps (mm)	No.of pieces
1st series		
1.001 to		
1.009	0.001	9
2nd series		
1.01 to		
1.09	0.01	9
3rd series		
1.1 to		
1.09	0.1	9
4th series		
1.0 to		
9.0	1.0	9
5th series		
10.0 to 90.0	10.0	9
Total pieces		45

Set of 86 pieces

Range (mm)	Steps (mm)	No.of pieces
1st series		
1.001 to 1.009	0.001	9
2nd series		
1.01 to 1.49	0.01	49
3rd series		
0.5 to 9.5	0.5	19
4th series		
10.0 to 90.0	10.0	9
Total pieces		86

Even though there are a number of sets of slip gauges available, the popularly recommended ones are:

1) Set No.45 (Normal set)

2) Set No.86 (Special set).

Selection and determination of slip gauges for different sizes

Objective : At the end of this lesson you shall be able to
- **select slip gauges for different sizes.**

For determining a particular size, in most cases a number of slip gauges are to be selected and staked one over the other by wringing the slip gauges.

While selecting the slip gauges for a particular size using available set of slip gauges:

- first consider the last digit of the size to be built up
- then consider the last digit or the last two digits of the subsequent value and continue to select pieces until the required size is available.

Example

Building up a size of 44.8725 mm with the help of 112 piece set. (Table 1)

Set of 112 pieces

Range (mm)	Steps (mm)	No.of pieces
1.0005	-	1
1.001 to 1.009	0.001	9
1.01 to 1.49	0.01	49
0.5 to 24.5	0.5	49
25.0 to 100.0	25.0	4
Total pieces		112

TABLE 1

	Procedure	Slip pack	Calculation
a)	First write the required dimension.		44.8725
b)	Select the slip gauge having 4th decimal place.	1.0005 Subtract	1.0005
			43.8720
c)	Select a slip gauge from the 1st series that has the same last figure.	1.002 Subtract	1.002
			42.87
d)	Select a slip gauge from the 2nd series that has the same last figure and that .0 will leave or 0.5 as last fig.	1.37 Subtract	1.37
			41.5
e)	Select a slip gauge from the 3rd series that will leave the nearest 4th series slip (41.5 25 = 16.5).	16.5 Subtract	16.5
			25.00
f)	Select a slip gauge that eliminates the final figure.	25.0 Subtract	25.00
		44.8725	0.00

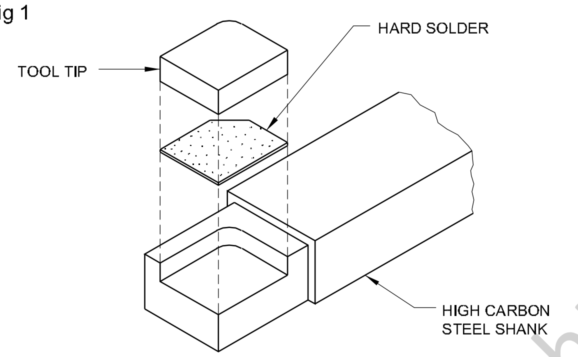
Methods of Brazing carbide tipped and tool

- **state the brazing materials used for brazing carbide tips on a carbon steel shank**
- **state the methods of brazing carbide tips**
- **explain the torch brazing method.**

The most common brazing alloys used for sinteredcarbides are silver alloys and copper alloys. Silver alloys always contain silver, copper, zinc and various quantities of nickel,
cadmium and manganese. The melting point lies between 620°C to 850°C. (Most common alloys melt at 690°C) Silver alloys can be used for tools not subjected to extreme working conditions or stresses. For silver brazing, special, easily fusible brazing fluxes are used.

The preparation for brazing the carbide tip on carbon steel shank is illustrated Fig 1. Fig 2 shows the shapes of carbide tips.

Fig 1

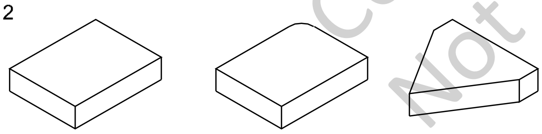


A PREPARED SHANK READY TO HAVE THE CARBIDE TOOL BLANK BRAZED INPLACE. BRAZING CALLS FOR EXTREME CARE OTHERWISE THE BLANK WILL NOT BE ATTACHED SOLIDLY CAUSING IT TO WEAR RAPIDLY.

BRAZING CARBIDE TIP

TUN215411

Fig 2



TUNGSTAN CARBIDE TOOL BLANKS ARE AVAILABLE IN A WIDE SELECTION OF SHAPES AND SIZES IN ADDITION TO DIFFERENT DEGREES OF TOUGHNESS AND HARDNESS

CARBIDE TIPS
DIFFERENT SHAPES

TUN215412

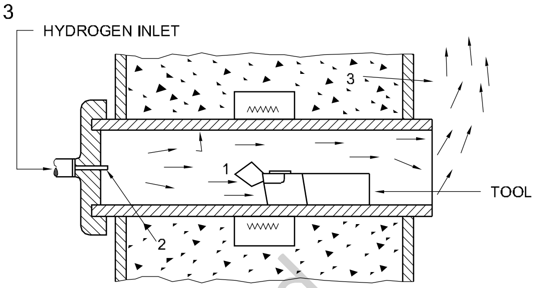
There are three methods of brazing a carbide tip with a shank.

- Furnace brazing (Fig 3)
- Induction brazing (Fig 4)
- Torch brazing

Torch brazing

The most commonly used method of brazing a carbide tip on a shank is torch brazing, since this method can be worked on a small scale. A welding torch is used for brazing. A flame adjustment must be made for the purpose of brazing, generally to get carburising flame by permitting more acetylene. Heating to the brazing temperature should be done relatively quickly as prolonged heating can lead to oxidation.

Fig 3



FURNACE BRAZING

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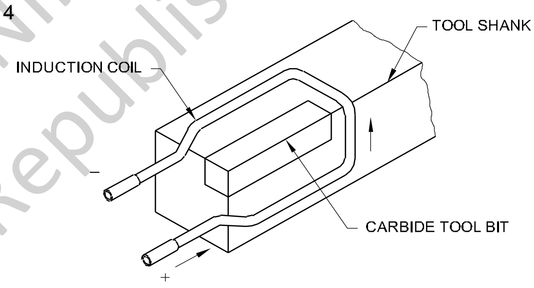
Fig 4



INDUCTION BRAZING

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When big steel shanks are used, it is better to use more than one torch. Always keep the shank on a fire-brick to avoid loss of heat due to conduction. Start heating with the flame directed against the underside of the tool and behind the seating of the tip, and around the shank until this is evenly heated. Finally the flame is put on to the carbide tip so that the solder melts and flows out. When this occurs, you can easily observe that the tip is 'swimming' on the solder. When the brazing material has run out completely, the heat is removed and the tip moved to and fro and pressure applied in the middle of the tip by means of a pointed rod.

Safety to be observed for cooling after brazing

When the brazing alloy has solidified, the tool must be slowly cooled in a heat isolating medium. This will allow the joint to adapt itself to the different contractions of sintered carbide and steel. Furthermore, it will prevent the steel from air hardening which may happen due to rapid cooling. Rapid cooling is detrimental to both the joint and the carbide. Suitable isolating mediums are mica powder or charcoal dust. Even dry sand can be used though it is a poor substitute. Sand absorbs humidity of the air and can subject the carbide to cooling shocks.

Basic process of soldering, welding and brazing

Objectives : At the end of this lesson you shall be able to
- **state the process of soldering**
- **state the method of application of soldering iron**
- **state the different types of solder and their application.**

There are different methods of joining metallic sheets. Soldering is one of them.

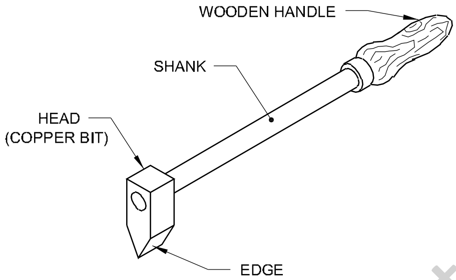
Soldering is the process by which metallic materials are joined with the help of another liquified metal (solder).

The melting point of the solder is lower than that of the materials being joined.

The solder wets the base material without melting it.

Soldering iron (Fig 1)

Fig 1



SOLDERING IRON (HATCHET TYPE)

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The soldering iron is used to melt the solder and heat the metal that are to be joinded togerther.

The soldering iron has the following parts,

- Head (copper bit)
- Shank
- Wooden handle
- Edge

Shape of head

The head of the iron is made of forged copper. This is because copper has a good heat conductivity and has a strong affinity for the solder so that the solder melts easily and sticks to the bit.

A Hatchet type soldering as in (Fig 1) has shank fitted at 60° to the head. The soldering edge is 'V' shaped.

This type is used for straight soldering joints. (Fig 2)

The other type is the square pointed soldering iron or a slandard workshop pattern soldering iron. (Fig 3) For this type the edge is shapped to an angle on four sides to form a pyramid shapr.

This is used for taking and soldering of joining points. (Fig 4)

Fig 2

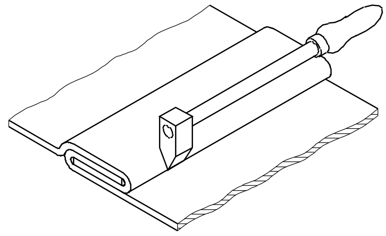

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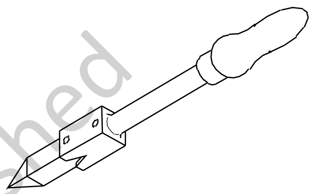
Fig 3



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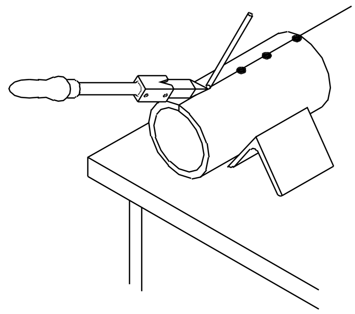
Solders

Pure metals or alloys are used for solders.

Solders are applied in the form of wires, sticks, ingots, rods, threads, tapes, formed sections, powder and pastes. (Fig 4)

Fig 4



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Types of solders

There are two types of solders.

- Soft solder
- Hard solder

One distinguishes between soft solders whose melting points are below 450° C and hard solders whose melting points lie above 450° C.

Soft solders

These are alloys of the metals- tin, lead, antinomy, copper, cadmium and zinc and are used for soldering heavy (thick) and light metals.

Hard solders

These are alloys of copper, tin, silver, zinc, cadmium and phosphorus, and are used for soldering heavy metals.

Flux

Objectives: At the end of this lesson you shall be able to
- **state the criteria for the selection of fluxes**
- **distinguish between corrosive and non-corrosive fluxes**
- **name the different types of flux and their application.**

Fluxes are non-metalic materials which are used at the time of soldering.

Functions of flux

- Flux removes oxides from the soldering surface.
- It prevents corrosion.
- It helps molten solder to flow easily in the required place.
- It promotes the wet surface.
- It localize the heat in molten fool

Selection of flux

The following criteria are important for selecting a flux.

- Working temperature of the solder
- Soldering process
- Materials to be joined.

Classes of flux

Flux can be classified into corrosive flux, and non-corrosive flux.

Corrosive flux in acid form and should be washed immediately after the soldering operation is completed.

Non-corrosive flux is in the form of lump, powder, paste or liquid.

Different types of fluxes

Hydrochloric acid

Concentrated hydrochloric acid is a liquid which fumes when it comes into contact with air. After mixing with water, 2 or 3 times the quantity of the acid, it is used as dilute hydrochloric acid.

Hydrochloric acid combines with zinc forming zinc chloride and acts as a flux. So it cannot be used as a flux for sheet metals other than zinc, iron or galvanised sheets.

Zinc chloride

It is mainly used for soldering copper sheets, brass sheets and tin plates.

As it is extremely corrosive, the flux must be perfectly washed off after soldering.

Ammonium chloride

This is in the form of powder or lump. It evaporates when heated.

Ammonium chloride, dissolved in water, is used as a flux for soldering steel.

A solution of a mixture of hydrogen chloride, zinc chloride and ammonium chloride is used as a flux for stainless steel sheets.

Resin

As resin is not very effective for removing oxidation coating, and, as it is not highly corrosive, it is used as flux for copper and brass. Resin melts at about 80° to 100°C.

Paste

This is a mixture of zinc chloride, resin, glycerine and others and is available as a paste.

Basic process of Welding

Objectives: At the end of this lesson you shall be able to
- **define welding process**
- **state clasification of welding**
- **state method of welding.**

Welding:

Welding is a process of joining similar metals by application of heat with or without application of pressure and addition of filler materials.

Welding Porcess:

According to the sources of heat, welding process can be broadly classified as:

- electric welding proces (heat source is electricity)
- gas welding processes (heat source is gas flame)
- other welding processes (heat source is neither electricity nor gas).

Electic welding processes can be classified as:

- electric arc welding
- electric resistance welding
- laser welding
- electron beam welding

Electric arc welding can be further classified as:

- metallic arc welding
- carbon arc welding
- atomic hydrogen arc welding
- inert gas arc welding
- CO2 gas arc welding
- submerged arc welding
- electro-slag welding
- plasma arc welding.

Electric resistance welding can be further classified as:

- spot welding
- seam welding
- butt welding
- flash butt welding
- projection welding.

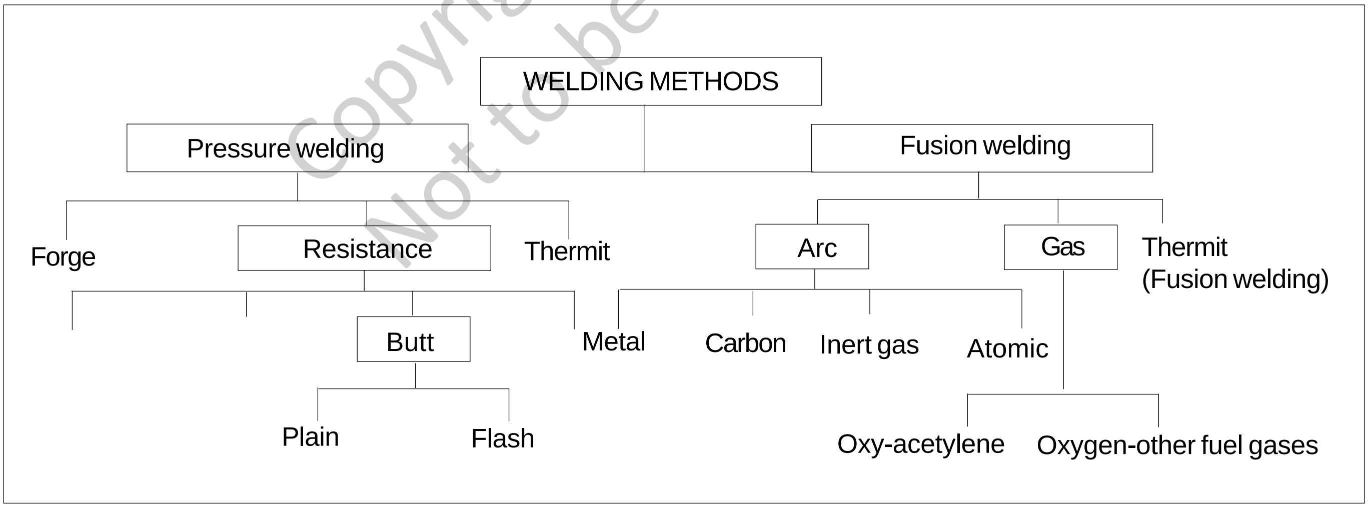
Gas welding process can be classified as:

- oxy-acetylene gas welding
- oxy-hydrogen gas welding
- oxy-coal gas welding
- oxy-liquified petroleum gas welding
- air acetylene gas welding.

The other welding processes are:

- thermit welding
- forge welding
- friction welding
- ultrasonic welding
- explosive welding
- cold pressure welding
- plastic welding.

Chart showing welding methods.



Welding rods

Welding rods also known as filler rods provides extra metal to the weld. The extra metal is obtained by melting the end of a rod or piece of wire known as either a filler rod or welding rod. In many instances the composition of the rod is the same as that of the material being welded.

Edge preparation

To obtain sound welds, good edge preparation is beveling the edges and carefully cleaning the faces to be welded from dust, sand, grit, oil and grease.

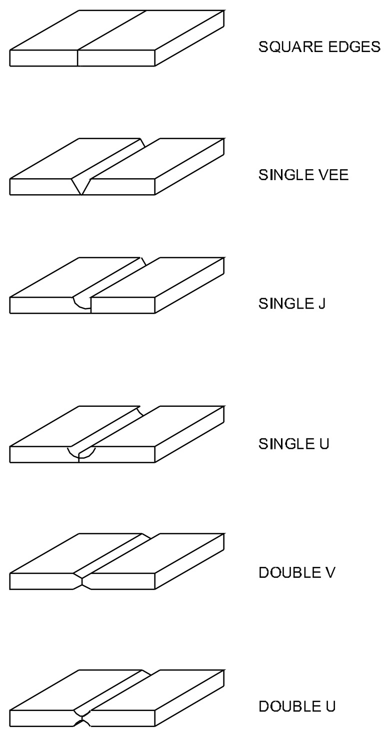
Different edge preparation which are used for butt welding are shown at fig 1, namely single V, single J single V etc.,

Welded joints

Weld joint is classified based on the relative position of the two metal pieces being joined, determines the type of joint. There are five basic type of joints that are used in welding namely butt, lap, corner, edge & T-joints. (Fig 2)

1. Butt joint
2. Lap joint
3. T-joint
4. Corner joint
5. Edge joint

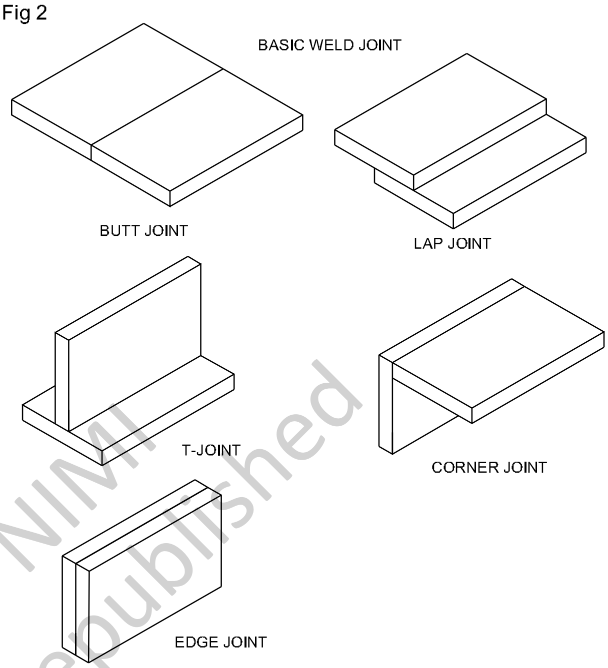
Fig 1



Gas Welding

It is by melting the edges or surfaces to be joined by gas flame and allowing the molten metal to flow together, thus forming a solid continuous joint after cooling. This process suitable for joining metal thickness of 2mm to 25 mm in one pass.

Fig 2



Systems of oxy-acetylene

Objectives : At the end of this lesson you shall be able to
- **distinguish between high pressure and low pressure acetylene plants**
- **distinguish the features of low pressure and high pressure blowpipes.**

Oxy-acetylene plants can be either high pressure or low pressure.

A high pressure plant utilizes acetylene under high pressure, upto 1 kg/cm^2. (Fig 1)

Dissolved acetylene (acetylene in cylinder) is a commonly used source.

A low pressure plant utilizes acetylene under low pressure (0.017 kg/cm^2) produced by an acetylene generator only. (Fig 2)

Fig 1

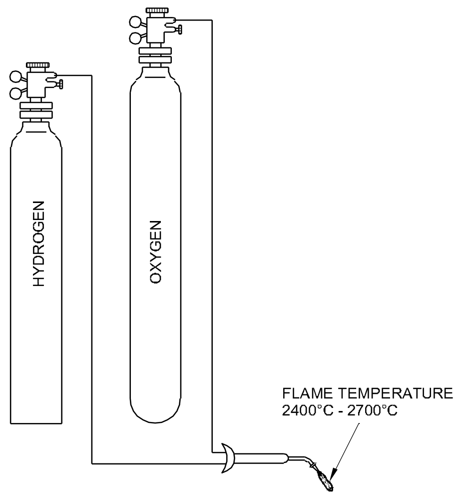
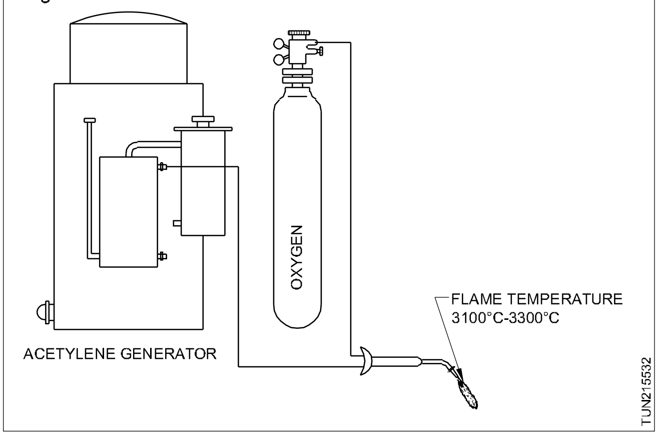


Fig 2



Gases used in gas welding

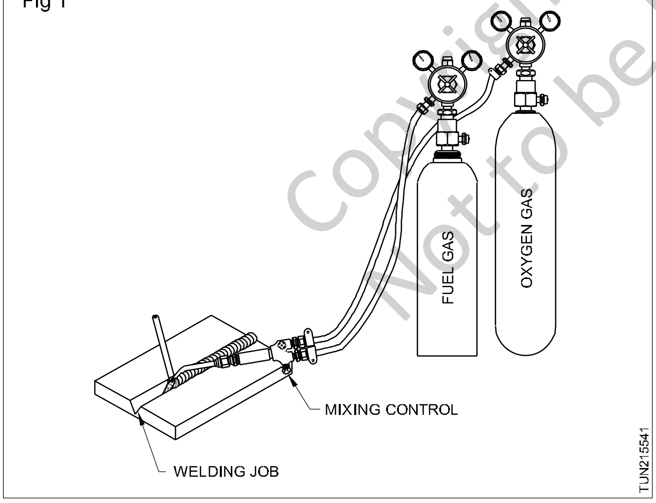
Objectives: At the end of this lesson you shall be able to
- **name the different types of gases used in gas welding**
- **state the different types of gas flame combinations**
- **state the temperatures and uses of the different gas flame combinations.**

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

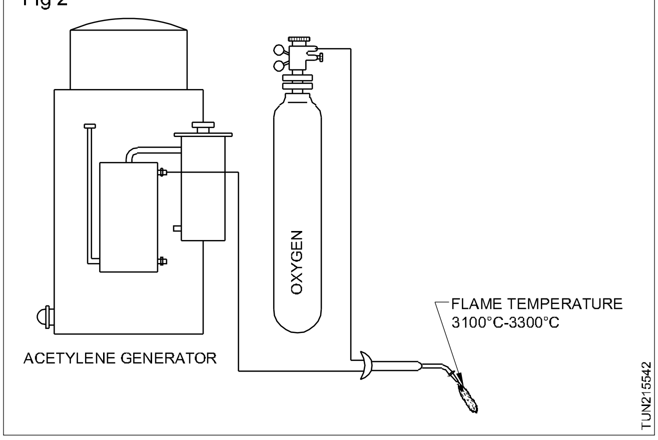
Oxygen + Coal = Oxy-coal gas flame

Oxygen + LPG = Oxy-LP gas flame

Temperature and uses of gas flame combinations

Oxy-acetylene gas flame (Fig 2)

Fig 2



Flame temperature : 3100° C to 3300° C

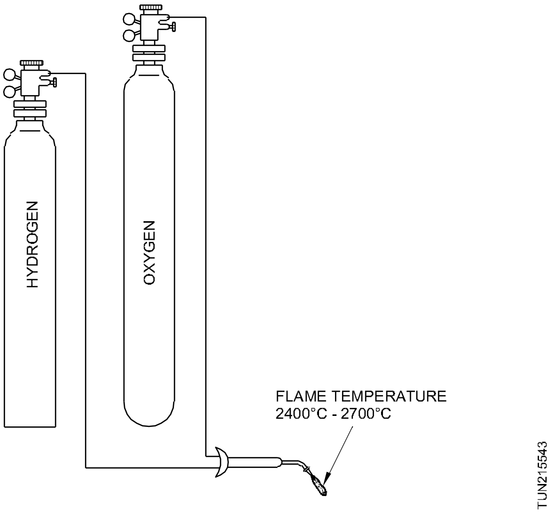
The oxy-acetylene gas flame is used for welding all ferrous and non-ferrous metals and their alloys, gas cutting, gouging, steel brazing, bronze welding, metal spraying and powder spraying, operations.w

Oxy-hydrogen gas flame (Fig 3)

Flame temperature : 2400°C to 2700°C

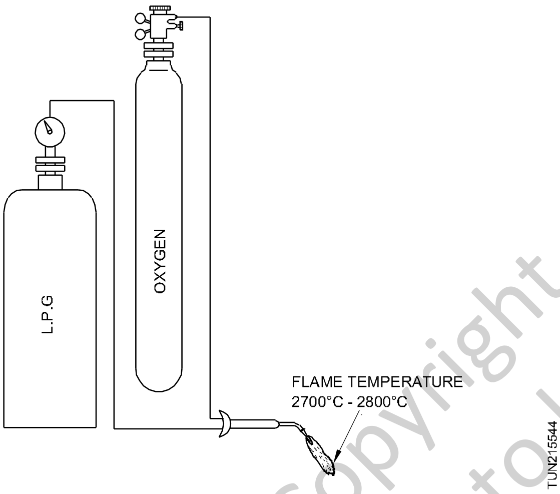
This type of flame is used only for brazing, silver soldering and underwater gas cutting of steel.

Fig 3



Oxy-liquid petroleum gas flame (Fig 4)

Fig 4



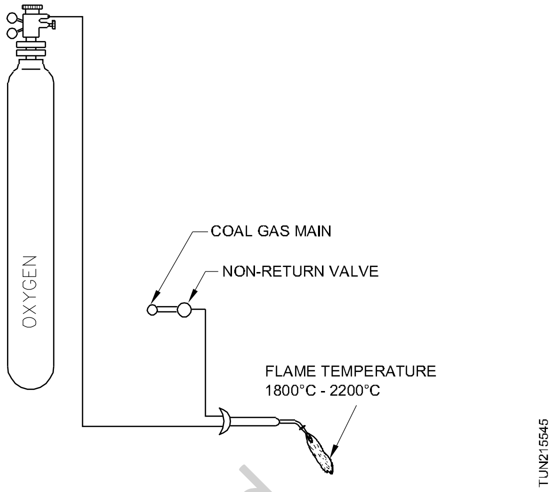
Flame temperature : 2700°C to 2800°C

This flame has carbon and moisture effect.

It is only used for gas cutting of steel, and for heating purposes.

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 highly suitable used for silver soldering and brazing.

The most commonly used gas flame combination is OXY-ACETYLENE.

Types of oxy-acetylene flames

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 flame.**

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.

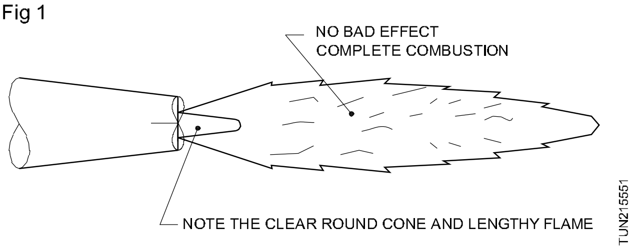
Flame types

The different flame types are

- Neutral flame
- Oxidising flame
- Carburising flame.

Neutral flame (Fig 1)

Fig 1



Characteristics

The neutral flame is formed with oxygen and acetylene in equal proportion.

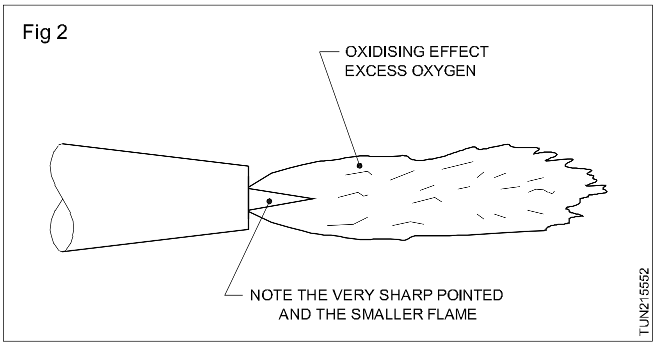
Complete combustion takes place in this flame.

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)



Characteristics

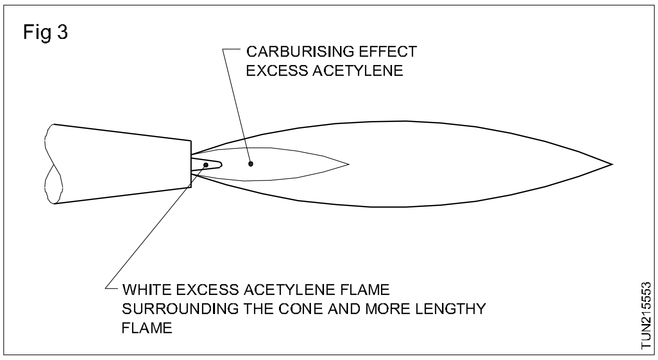
The oxidising flame is formed with excessive oxygen.

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 is formed with excessive acetylene .

The flame has a carburising effect on steel, causing hard, and brittle weld.

Uses

Useful for stelliting (hard facing), LINDE welding of steel pipes and flame cleaning.

> **The selection of the flame is based on the metal to be welded.**
>
> **Neutral flame is the most commonly used.**

Method of cleaning before welding

Objectives: At the end of this lesson you shall be able to
- **state the importance of cleaning before welding**
- **name the different methods of cleaning.**

Importance of cleaning

The basic requirement of any welding process is to clean the joining edges before welding in order to obtain a sound weld.

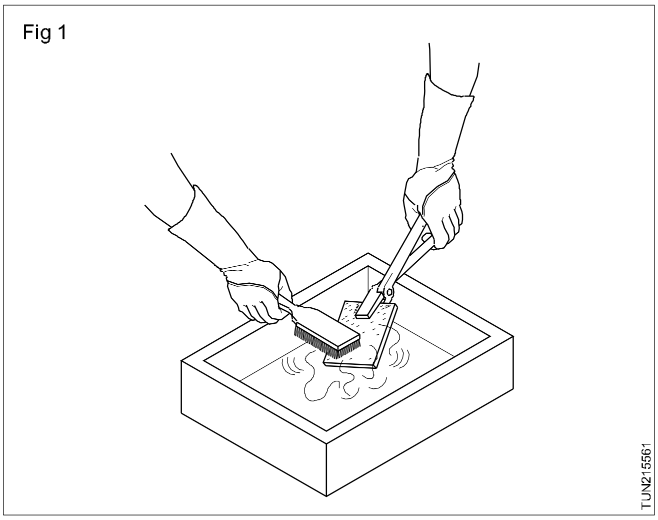
The joining edges or surface may have oil, paint, grease, rust, moisture, scale or other foreign matter. If these contaminants are not removed, the weld will become porous, brittle and weak.

The success of welding depends largely on the condition of the surfaces to be joined.

Methods of cleaning

Chemical cleaning

This includes washing the joining surface with solvents such as kerosene, paraffin, thinners, turpentine or petrol for removing oil, grease etc. (Fig 1 & 2)



Mechanical cleaning

Mechanical cleaning include wire brushing, grinding, chipping, sand blasting, scraping, metal gritting, machining or cleaning with emery paper. (Fig 3)

Fig 2

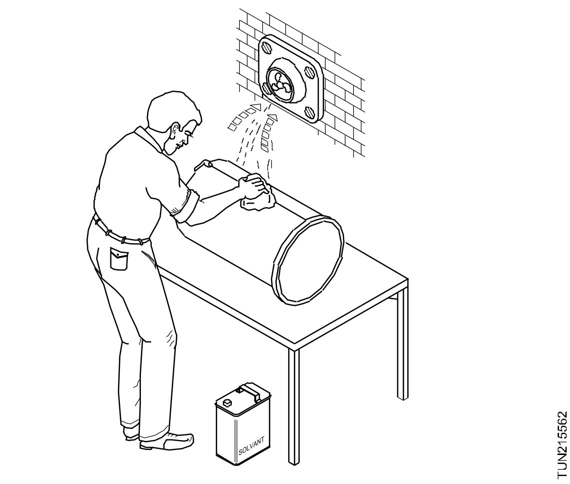
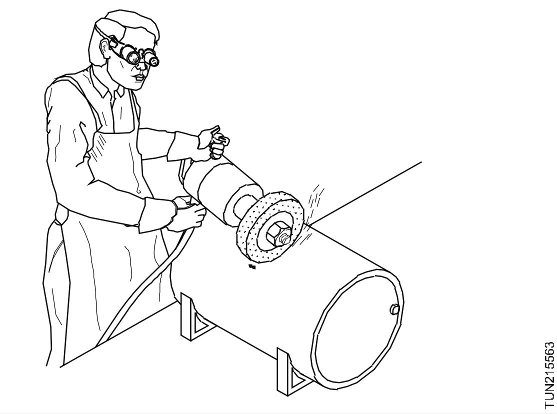


Fig 3

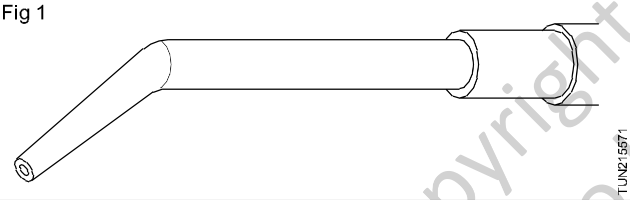


Welding Nozzles - sizes and selection

Objectives : At the end of this lesson you shall be able to
- **identify the different sizes of nozzles**
- **select the correct nozzle for the job**
- **select the correct gas pressure for the nozzles.**

The welding nozzle is a part of the welding blowpipe (made of copper with a small orifice) fitted at the end where the flame is ignited. (Fig 1)

Fig 1



Nozzle sizes

The size of the nozzle is determined by the diameter of its orifice.

Smaller orifice nozzles make a smaller flame useful for welding thin metals, whereas larger hole nozzles make a larger flame useful for welding thick metals, where more heat is required.

The common nozzle sizes are

1,2,3,4,5,7,10,13,18,25,35,45, 55,70 and 90.

The selection of a nozzle is determined by the

- Thickness of the metal to be welded
- Mass of the metal to be welded
- Kind of the metal to be welded.
- The gas pressure required for the flame. You may observe from the table that the nozzle size number increases with increased thickness of jobs to be welded.

Selection of gas pressure for nozzles

Smaller size nozzles require less pressure whereas the larger size nozzles require more pressure (Table 1)

Selection of Nozzle

Table 1

Plate thick-ness (mm)	Nozzle size	Oxygen Acetylene pressure (kg/cm)
0.8	1	
1.2	2	
1.6	3	0.15
2.4	5	
3.2	7	
4.0	10	
5.0	13	0.20
6.5	18	
8.2	25	
10.0	35	
13.0	45	
19.0	55	
25.0	70	0.40
Over 25.0	90	0.45

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 cylindedrs**
- **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 strictly as we all know that ''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.

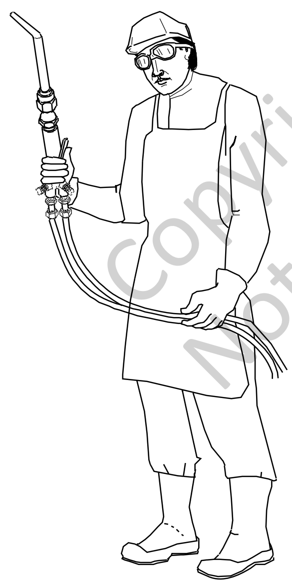
The following precautions are to be observed, to keep a gas welder accident-free.

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



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)

Even a small leakage can cause serious accidents.

Always keep fire-fighting equipment handy and in working condition to put out fires. (Fig 3)

Keep the work area free from any form of fire.

Fig 2

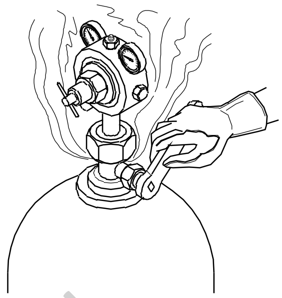
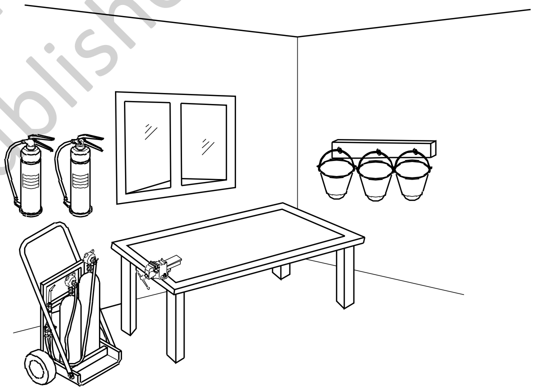


Fig 3



Safety gas cylinders

Do not roll gas cylinders or use them as rollers.

Use a trolley to the carry the cylinders.

Close the cylinder valves when not in use or empty.

Keep full cylinders seperate and empty cylinders separate.

Always open the cylinder valves slowly, not more than one and a half turn.

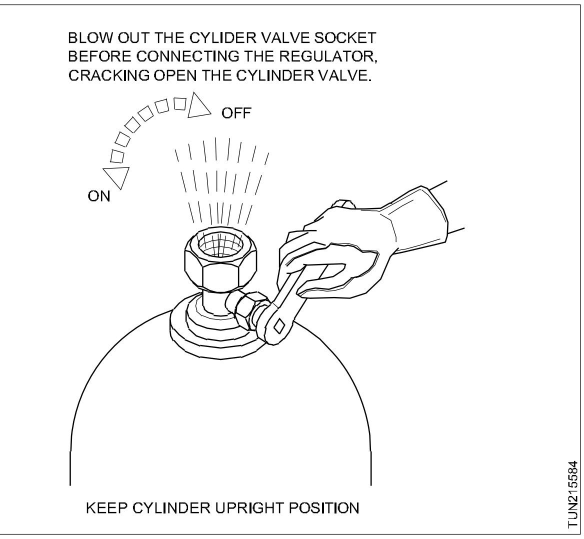
Use the correct cylinder keys to open the cylinders.

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.

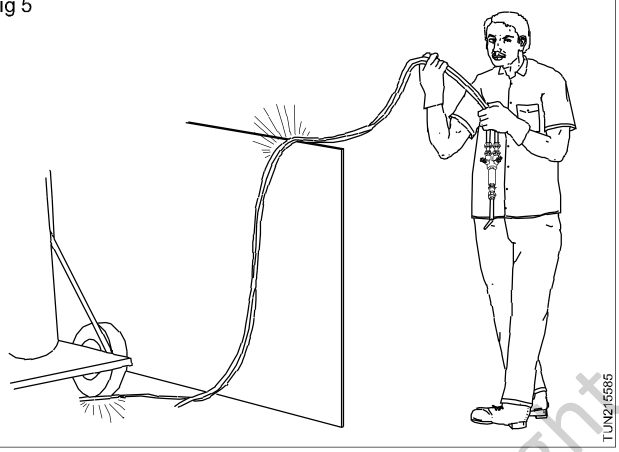
Always crack the cylinder valves to clean the valve sockets before attaching regulators. (Fig 4)

Fig 4



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 black hose pipes for oxygen and maroon 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.

Note right hand threaded connection for oxygen and left hand threaded connection for acetylene.

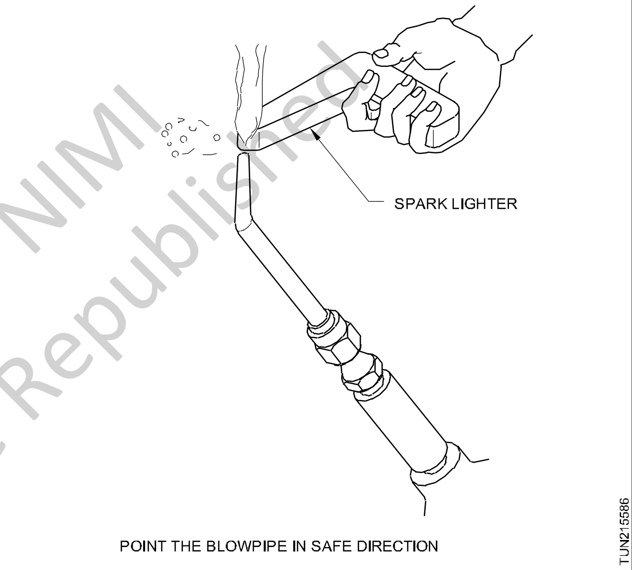
Safety for blowpipes

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 during 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.
- Do not throw the electrode stubs on the floor. Put them in a container. (Fig 3)

Fig 1

Fig 2

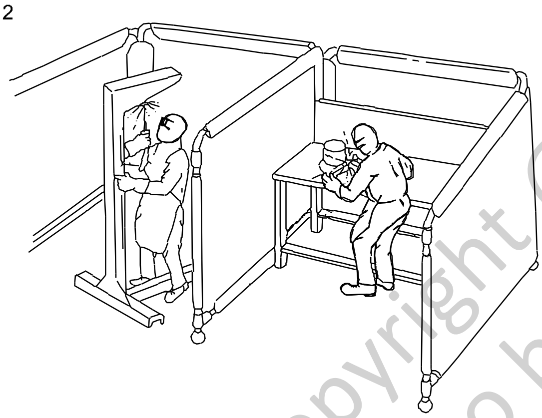
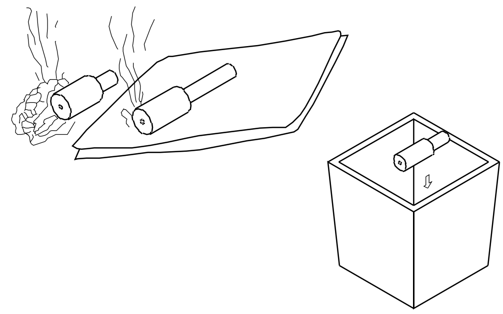
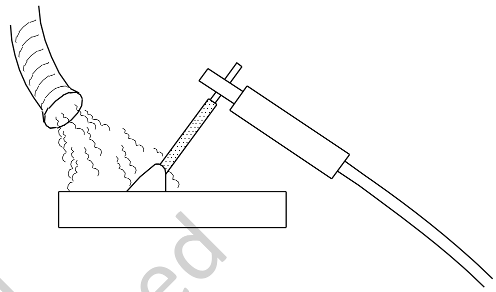


Fig 3



- Use exhaust fans to remove the arc-welding smoke and fumes. (Fig 4)

Fig 4



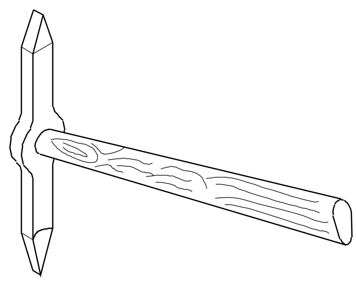
Keep the welding area always clean removing unused metal, scrap etc, to avoid getting hurt.

Arc-welding tools and accessories

Objectives : At the end of this lesson you shall be able to
- **identify the different arc-welding tools and accessories**
- **explain the uses of each.**

Chipping hammer (Fig 1)

Fig 1

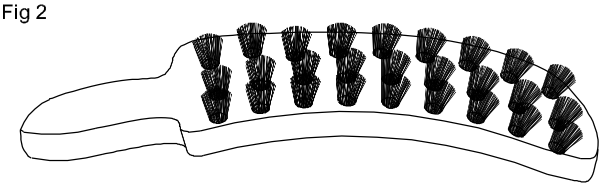


It is used to remove the slag from the weldment and is made of medium carbon steel, duly hardened.

One of its edges is pointed and the other is like that of a chisel. Pointed edge is used to remove dirt, slag in blow holes & chisel edge for removing slag.

Wire brush (Fig 2)

Fig 2

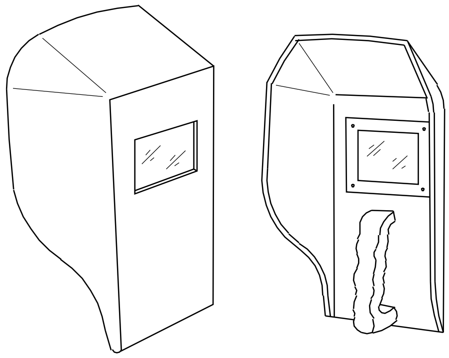


It is used for cleaning the surface metal as well as the slag from the welds.

The wire brush is made of stiff steel wires fitted on a wooden piece in three to five rows.

Welding hand screen (Fig 3)

Fig 3

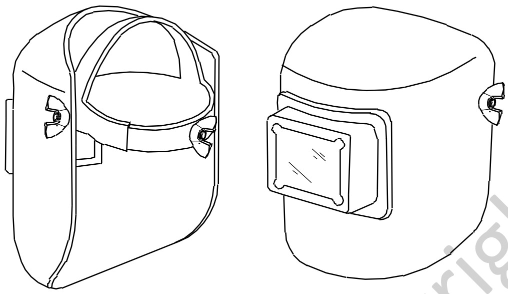


A welding hand screen is used as a shield and to protect the face and the eyes from the arc radiation.

It is fitted with a filter lens, and plain glass to protect the lens, from welding chaffers, plain glass is replaced from time to time.

Welding helmet screen (Fig 4)

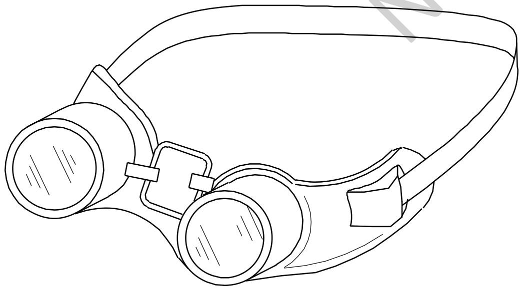
Fig 4



It can be used as a hand screen, also worn on the head of the welder to enable him to use both his hands .

Chipping goggles (Fig 5)

Fig 5



Chipping goggles are used to protect the eyes while chipping the slag.

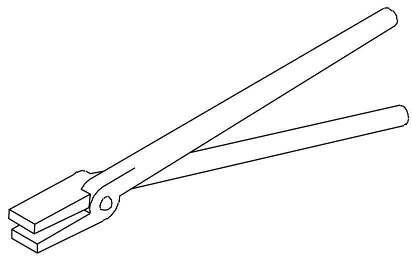
They are fitted with a plain glass to see the area to be cleaned.

Tong (Fig 6)

Tongs are used to handle the hot metal-welding job while cleaning.

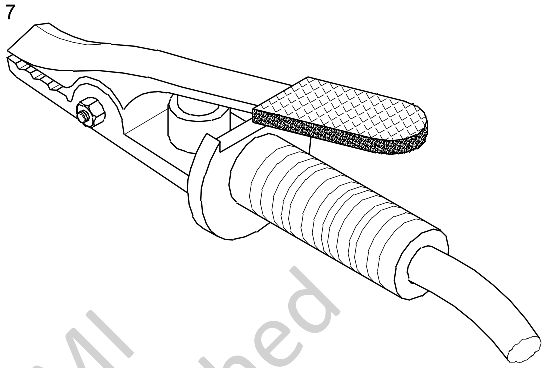
They are also used to hold the metal for hammering.

Fig 6



Electrode holder with cable (Fig 7)

Fig 7

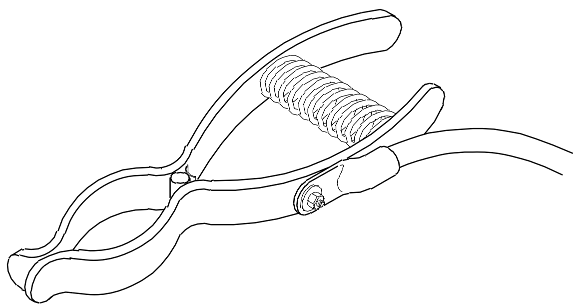


An electrode holder is used to hold and manipulate the electrode.

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 8)

Fig 8



An earth clamp is used to connect the return lead firmly to the job or to the welding table, to complete the circuit

Welding table

The welding table is used to keep the jobs and to assemble the pieces during welding. The top of the table is made of metal.

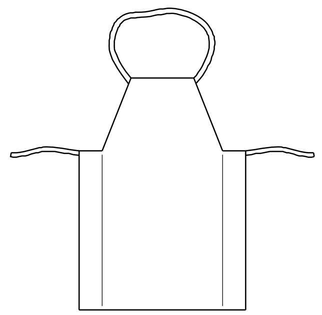
Apron (Fig 9)

An apron is used to protect the body.

It should be made of leather.

It must be worn for protection from the radiation of the heat rays and hot spatters.

Fig 9

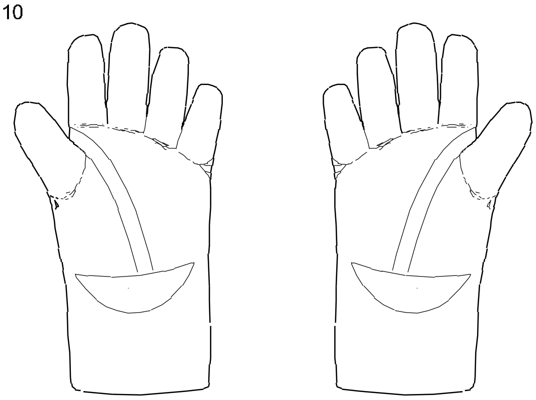


Hand gloves (Fig 10)

Hand gloves are used to protect the hands from electrical shock, arc radiation, heat, and hot spatters.

The gloves are also made of leather.

Fig 10



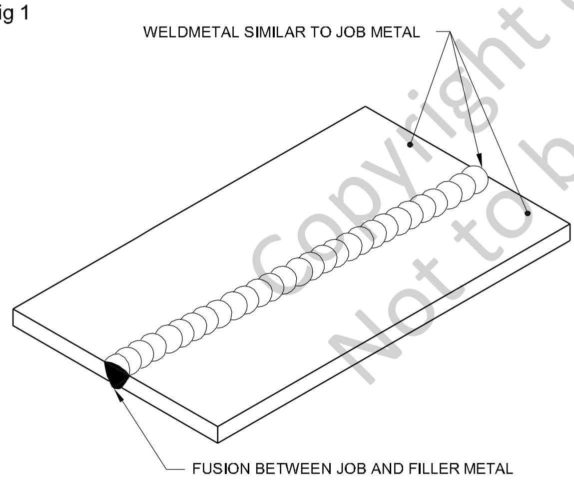
Braze welding

Objective: At the end of this lesson you shall be able to
- **distinguish between fusion welding and braze welding.**

Fusion welding (Fig 1)

A metal joining process wherein a permanent joint is made by melting and fusing the joining edges by a welding process is known as fusion welding.

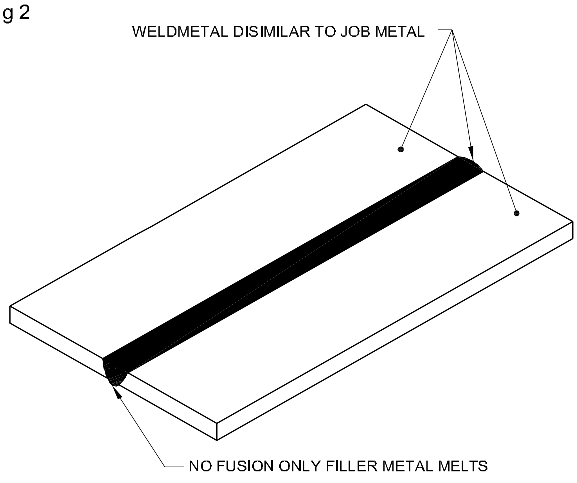
Fig 1



Braze welding (Fig 2)

Braze welding is a welding process in which a filler metal, having a melting point above 840°F (450° C) and below that of the base metal, is used. Unlike brazing, in braze welding, the filler metal is not distributed in the joint by capillary action.

Fig 2



Differences between fusion and braze welding

Fusion welding	Braze welding
Fusion welding makes a permenant joint.	Makes a temporary joint.
Requires more heat as the base metal and the filler metal are completely fused to effect the joining.	Requires less heat as a filler metal with a lower melting point is fused into the pre-heated joint.
The welding joint is provided without any colour change.	A distinct colour change is seen.

Fusion welding	Braze welding
There are more chances of distortion.	Less distortion during welding.
Can be done with/without a flux.	Cannot be done without a proper flux.
May require dismantling of the parts.	Can be done without dismantling the parts.
Cost is higher than that of a braze welding.	Can be done with a lesser skill.

Methods of brazing carbide tips

Objectives: At the end of this lesson you shall be able to
- **state the brazing materials used for brazing carbide tips on a carbon steel shank**
- **state the methods of brazing carbide tips**
- **explain the torch used in brazing method.**

The most common brazing alloys used for sintered carbides are silver alloys and copper alloys. Silver alloys always contain silver, copper, zinc and various quantities of nickel, cadmium and manganese. The melting point lies between 620°C to 850°C. (Most common alloys melt at 690°C) Silver alloys can be used for tools not subjected to extreme working conditions or stresses. For silver brazing, special, easily fusible brazing fluxes are used.

The preparation for brazing the carbide tip on carbon steel shank is illustrated in Fig 1. Fig 2 shows the shapes of carbide tips.

There are three methods of brazing a carbide tip with a shank.

Filler rods and fluxes for braze welding

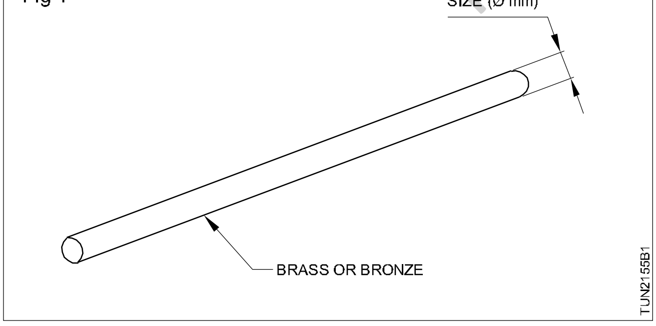
Objectives : At the end of this lesson you shall be able to
- **state the different types of filler rods required for braze welding**
- **state the functions and types of fluxes required for braze welding.**

Filler rods for braze welding

There are many types of braze-welding rods.

The most common rod used for ferrous metals is a copper-zinc alloy with the addition of a small percentage of silicon, manganese, nickel and tin. (Fig 1)

Fig 1



Types & application (Conforming to IS: 1278-1972)

Brass filler rods - Type S-C6

For use in the braze welding of copper and mild steel and for the fusion welding of materials of the same or a closely similar composition (oxidising flame).

Manganese bronze (high tensile brass) - Type S-C8

For use in the braze welding of copper, cast iron and malleable iron, and for the fusion welding of materials of the same or a closely similar composition (oxidising flame).

Medium nickel bronze - Type S-C9

For use in the braze welding of mild steel, cast iron and malleable iron. (oxidising flame)

Fluxes for braze welding

The purpose of the flux is to

- Chemically clean the joint.
- Remove impurities from the weld
- Allow the molten filler metal to flow and spread more easily into the joint surface.

For braze welding using the above filler rods, an oxydising flame is used.

For brazing with brass and bronze filler rods different fluxes are commercially available under different brand names. Borax may also be used as a flux.

Melting points of common metals

Objective: At the end of this lesson you shall be able to
- **determine the melting points of the common metals used in welding.**

Melting point

The temperature at which a solid metal changes to a liquid is known as its melting point.

Melting points of some common metals are given in Table 1.

Table 1

MELTING POINTS OF COMMON METALS

Metal	Melting Point (°C)
Tin	232
Lead	327
Zinc	419
Aluminium	659
Bronze	882-915
Brass	850-982
Silver	960

Melting points of some common metals are given in Table 1.

Metal	Melting Point (°C)
Copper	1083
Cast iron	1150
Monel metal	1342
High carbon steel	1371
Medium carbon steel	1426
Stainless steel	1426
Nickel	1449
Low carbon steel	1510
Wrought iron	1593
Tungsten	3410

Methods of cleaning (For Brazing)

Objectives : At the end of this lesson you shall be able to
- **state the mechanical cleaning methods**
- **state the chemical cleaning methods.**

Necessity for cleaning

Plates or sheets are often coated with rust, paint, oil, grease, scale etc. During brazing, they are trapped in the joint and cause defective brazed joints.

Mechanical cleaning

The joining edges/surfaces may be cleaned by

- Wire brushing (Fig 1)
- Sand blasting
- Filing
- Machining
- Grinding (Fig 2)
- Cleaning with steel wool.

Chemical cleaning

The joining edges/surfaces can also be cleaned chemically to remove oil, grease, dirt, rust etc.

Ferrous metal surfaces are washed with solvents such as kerosene, diesel and petrol. (Fig 3)

For cleaning copper and its alloys, use a solution consisting of 0.2 kg. sodium orthosilicate, 0.2 kg. sodium resinate and 3.8 litres of water at 51.7° to 82.2°c.

Dipping the plates in the solution or applying the solution at the joint will produce a clean surface required for brazing.

Fig 1

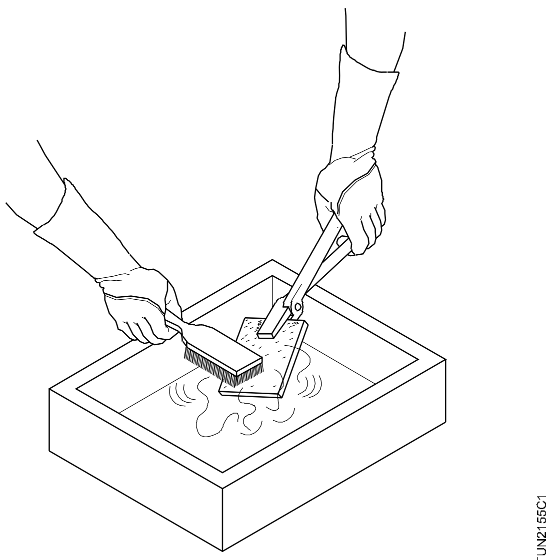


Fig 2

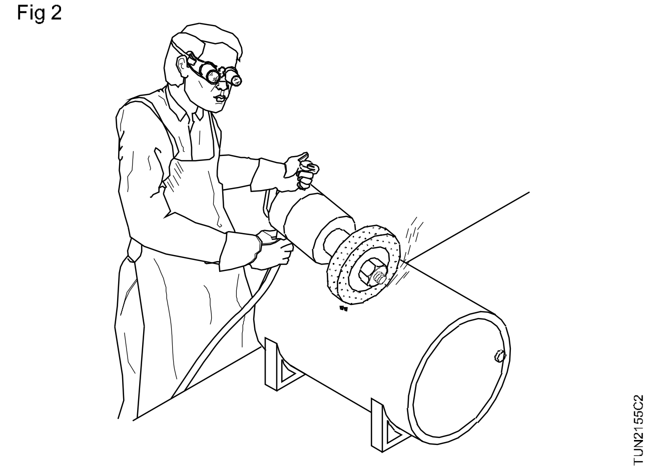
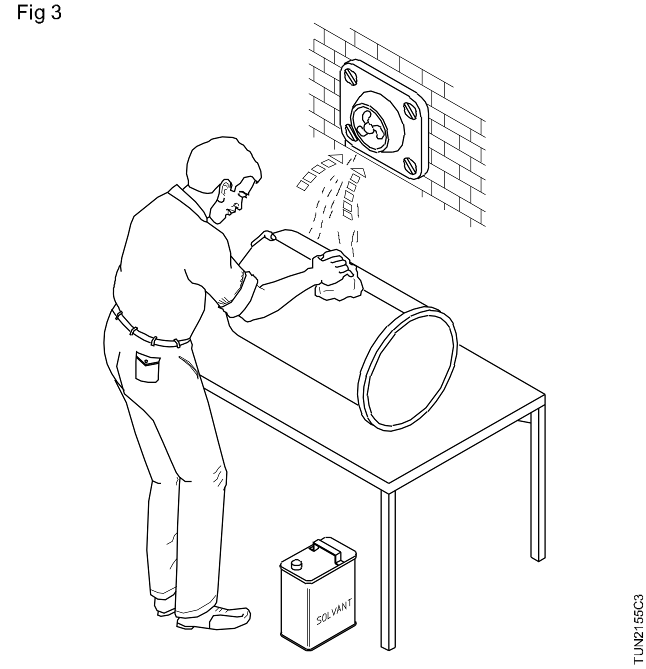


Fig 3



Vernier height gauge, Function and description

Objectives: At the end of this lesson you shall 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**
- **list 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

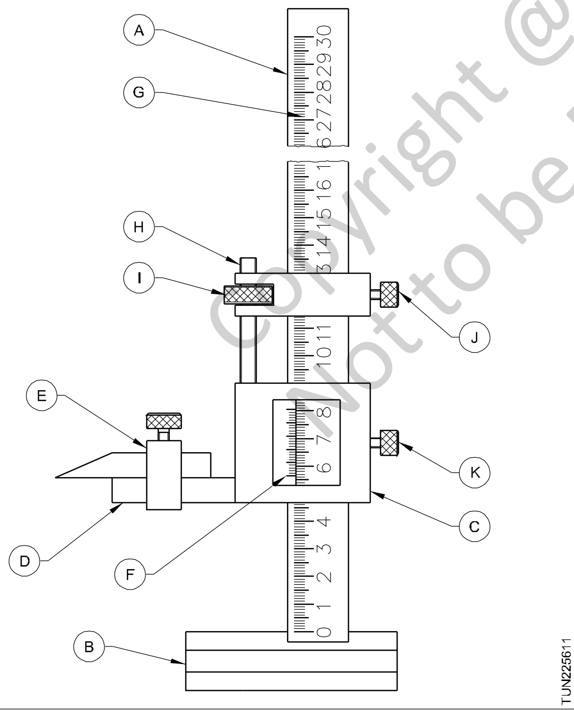
G Main scale

H Fine adjusting slide

I Fine adjusting nut

J&K Locking screws

Fig 1



Constructional features of a vernier height gauge

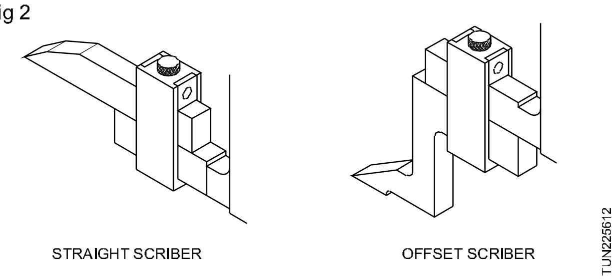
The construction of a vernier height gauge is similar to that of the vernier caliper except that it is vertical with a rigid base. It is graduated on the same vernier principle which is applied to the vernier caliper.

It consists of an upright steel beam fastened to a steel base. 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 intergral part of the main slide.

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 fine 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 lock screws. The vernier height gauges are available, in ranges of capacities reading from zero to 1000 mm.

Functional features of the vernier height gauge

Fig 2



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 fine 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.

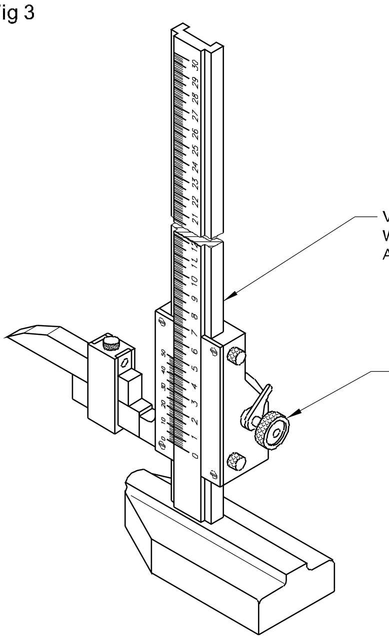
The fine adjusting slide has to be locked in position, for an approximate height as required. To get an exact mark able height, the fine adjustments have to be carried on the slider with the help of the adjusting nut. After obtaining the exact markable dimension, the main slide is also to be locked in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

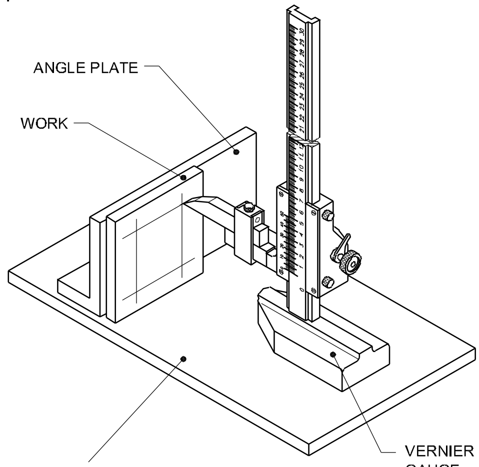
Fig 3



Application of vernier gauge in Engg

The vernier height gauge is mainly used for layout work,(Fig 4)

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.

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

Templates its function and construction

Objectives: At the end of this lesson you shall be able to
- **state the uses of templates**
- **define template.**

Templates: Templates are used in the sheet metal and plate fabrication industries. For example

1 To avoid repetitive measuring and marking the same dimension, where many identical parts are required.

2 To avoid unnecessary wastage of material and from information given on drawing, it is almost impossible to anticipate exactly where to begin in order that the complete layout can be economically accommodated.

3 To act as a guide for cutting processes.

4 As a simple means of checking bend angles and contours.

Information given on templates

Written on templates may be as follows:

1 Job or contract number

2 Size and thickness of plate

3 Quantity required

4 Bending or folding instructions

5 Drilling requirement

6 Cutting instructions

7 Assembly reference mark.

Templates as a means of checking is shown in Fig 4,5,6,7,8,9.

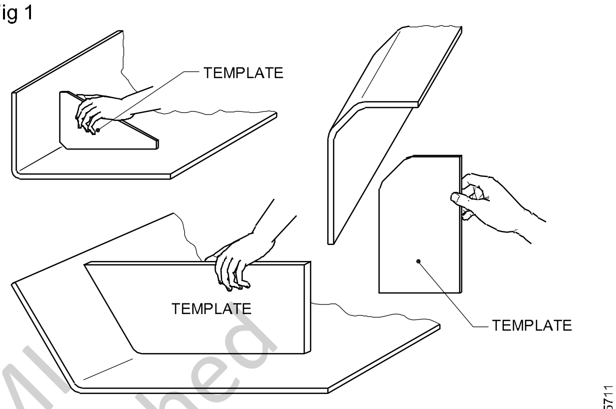
Templates for setting out sheet metal fabrications: For economy reasons, many patterns are made for marking out the sheet metal prior to cutting and forming operations. Fig 9,10,11 show a smoke cowl. Here a template is required to check and to mark out the contours of the intersection joint lines for the parts A,B & C whose developed sizes are marked out in the flat with the appripriate datum lines.

Fig 9 shows a square to round transformer is an isometric view of the sheet metal trans forming piece which is used to connect a circular duct to a square duct of equal area of cross section. In this example the dia of the round duct is 860 mm and length of one side of the square duct is 762 mm and the distance between the two ducts is 458 mm and sheet thickness is 1.2 mm.

Fig 10 shows a scale development pattern on which are marked the full size dimensions. This type of drawings are supplied by the drawing office for marking out purposes. Allowances for the seams and the joints must be added to the layout.

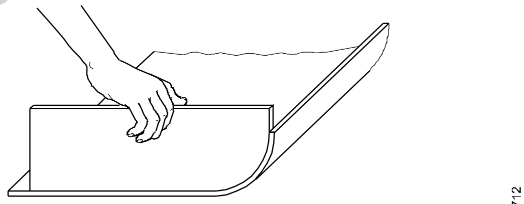
Fig 11 shows a simple sheet metal template may be used to check the form turning job

Fig 1



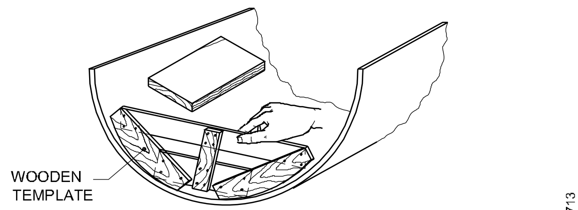
CHECKING ANGLES WITH A TEMPLATE

Fig 1



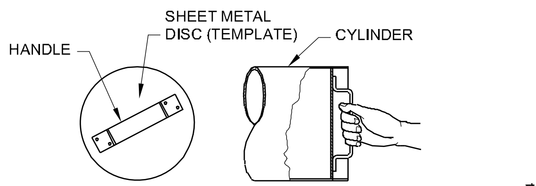
CHECKING THE CONTOUR OF A RADIUSED CORNER

Fig 3



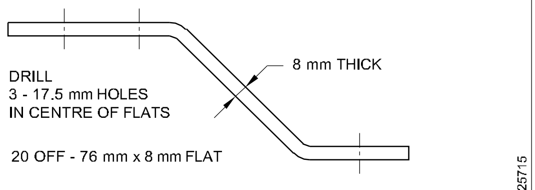
CHECKING THE CONTOUR OF A ROLLED PLATE

Fig 4



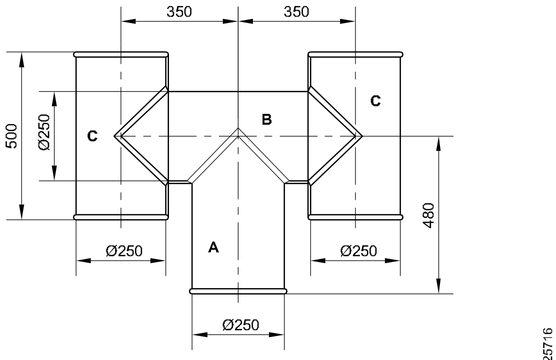
TEMPLATE USED FOR CHECKING CONTOUR OF CYLINDRICAL WORK SUCH AS DUCTWORK.

Fig 5



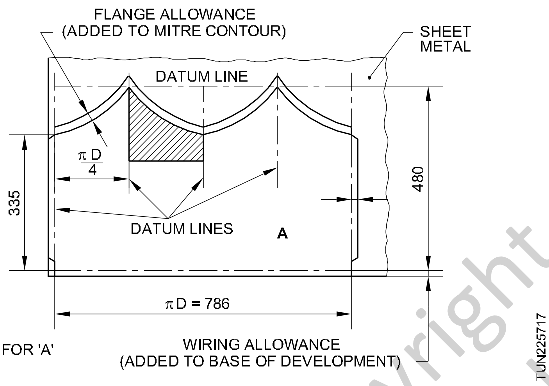
THE USE OF TEMPLATES AS A MEANS OF CHECKING

Fig 6



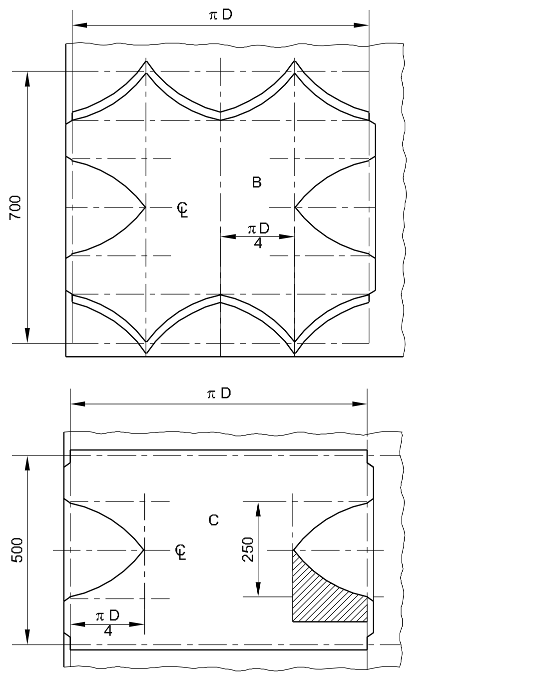
CHIMNEY SMOKE COWL

Fig 7



LAYOUT FOR 'A'

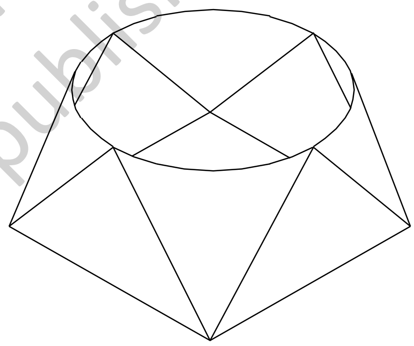
Fig 8



LAYOUT FOR B & C

AN EXAMPLE OF THE USE OF TEMPLATES

Fig 9



THE COMPLETE TRANSFORMER

Difference between gauges & Template:

Gauge	Template
• It is made from tool steel and has more thickness	It is thin sheet and low cost material
• More accurate	Less accurate
• Not used in heated jobs	Normally used in heated job
• It is used for greater accuracy	Rough and less accuracy jobs.
• Treated with heat treatment	To make simple and low cost material and grinding.

Fig 10

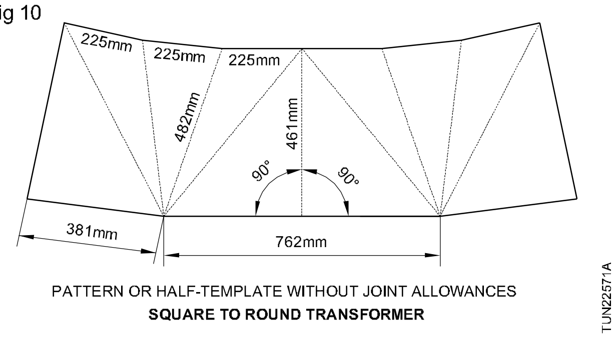
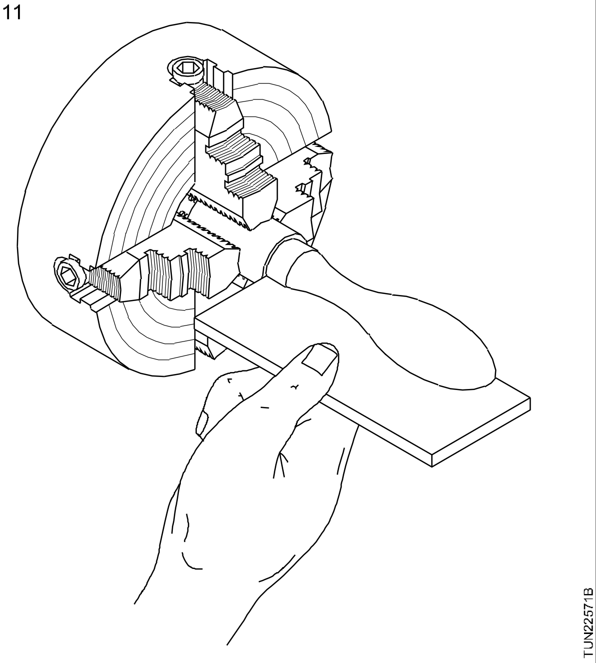


Fig 11



Combination set

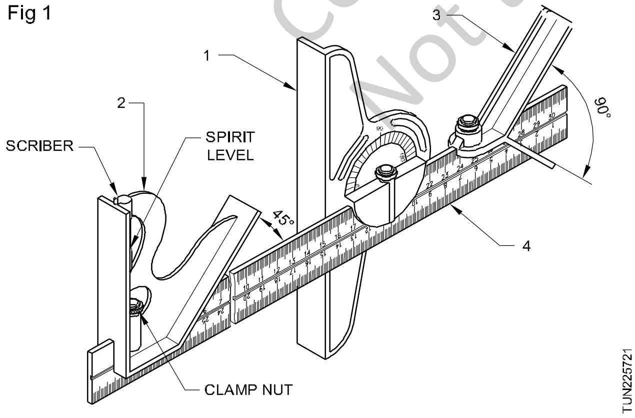
Objectives : At the end of this lesson you shall be able to
- **identify the parts of a combination set**
- **state the uses of each attachment in a combination set.**

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

- protractor head (1)
- square head (2)
- centre head, and (3)
- rule. (4)

Fig 1



Square head

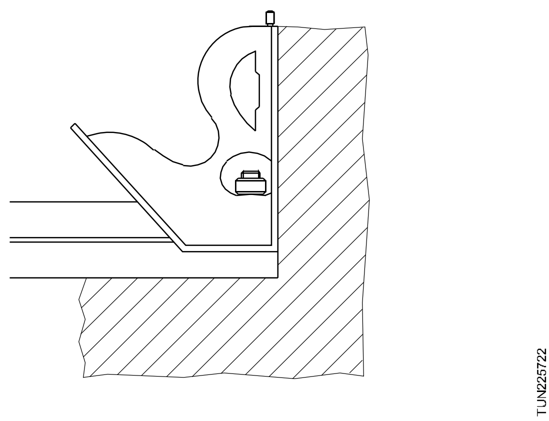
The square head has one measuring face at 90° and another at 45° to the rule. It is used to mark and check 90° and 45° angles. It can also be used to set workpieces on the machines and measure the depth of slots. (Figs 2,3 &4)

Centre head

This along with the rule is used for locating the centre of cylindrical jobs. (Fig 5)

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.

Fig 2



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 6)

Fig 3

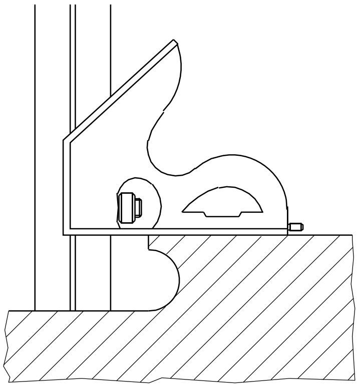


Fig 4

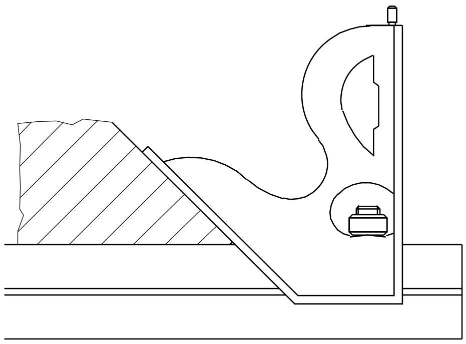
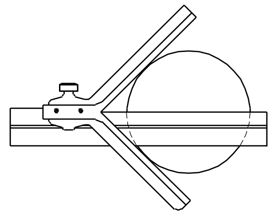
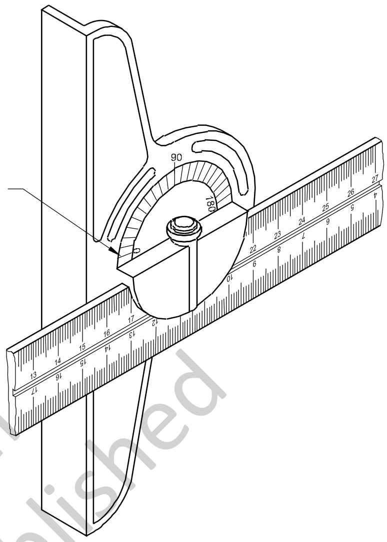


Fig 5



CENTRE HEAD

Fig 6



PROTRACTOR HEAD

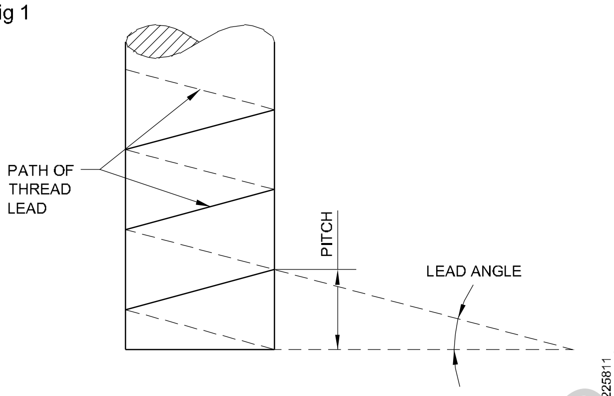
Screw thread - definition, purpose & its elements

Objectives : At the end of this lesson you shall be able to
- **define thread**
- **state the purpose of threads**
- **identify the parts of a thread (terminology).**

Definition

Thread is a ridge of uniform cross-section which follows the path of a helix around the cylinder or cone, either externally or internally. (Fig 1)

Fig 1



THREAD LEAD

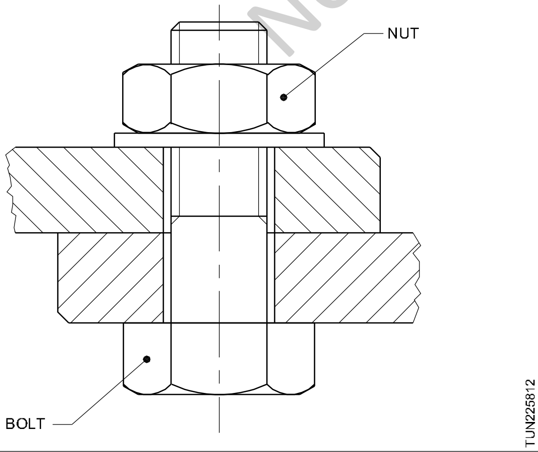
Helix is a type of curve generated by a point which is moving at a uniform speed around the cylinder or cone, and at the same time, moves at a uniform speed parallel to the axis. (Fig 1)

Purpose of thread

Threads are used for the following purposes.

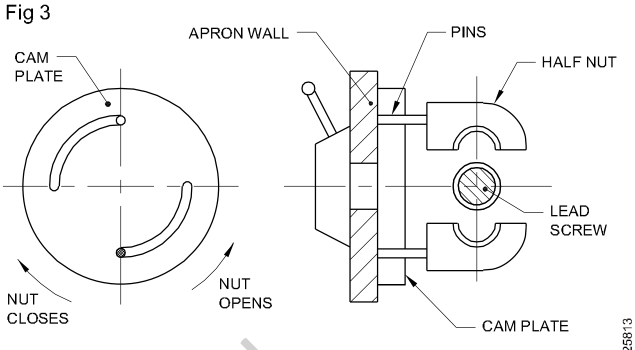
- For fastening purposes *Ex.* Bolts & nuts. (Fig 2)

Fig 2



- Transmission of motion *Ex.* Half nut with lead screw (Fig.3)
- Used in precision measuring instruments. *Ex.* Micrometer spindle.

Fig 3



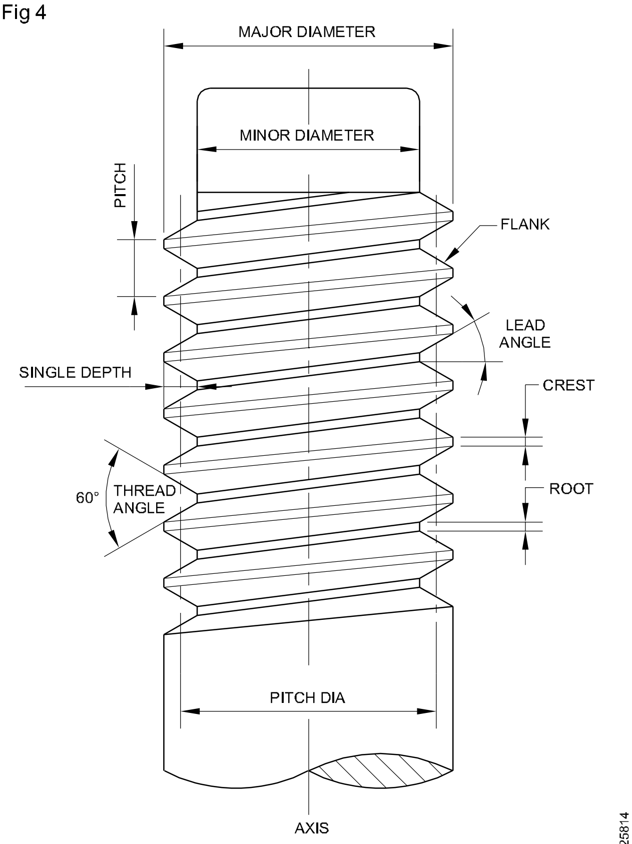
LEAD SCREW HALF NUT MECHANISM

- Load lifting purposes *Ex.*Screw-jack
- Elevating arm of radial drilling machines.

Elements of threads (Fig 4)

Elements of threads means naming the parts and other terms systematically. The parts of a thread are identified as follows. (Fig 4)

Fig 4



PARTS OF A SCREW THREAD

- Major diameter
- Minor diameter
- Pitch diameter
- Pitch of the thread
- Crest
- Root
- Flank of the thread
- Thread angle
- Depth of thread
- Lead angle (helix angle)
- Lead
- Hand
- Clearance

Major diameter

It is the largest diameter over which a thread is cut in the case of an external thread, and in the case of an internal thread, it is the largest diameter resulting after cutting the thread. (Fig 4)

Minor diameter

It is the smallest diameter formed after an external thread is cut, and in the case of internal thread, it is the diameter over which the thread is cut.

Pitch diameter

It is the diameter of an imaginary cylinder which passes through the thread such that the width of the space is equal to the width of the thread. It is equal to the major diameter minus one depth.

Pitch of thread

It is the horizontal distance from a point on one thread to the corresponding point on the adjacent thread measured parallel to the axis.

Crest

It is the top surface joining the flanks of the same thread.

Root

The bottom surface joining the flanks of the adjacent threads is called the root.

Flank

It is the surface connecting the crest and the root.

Thread angle

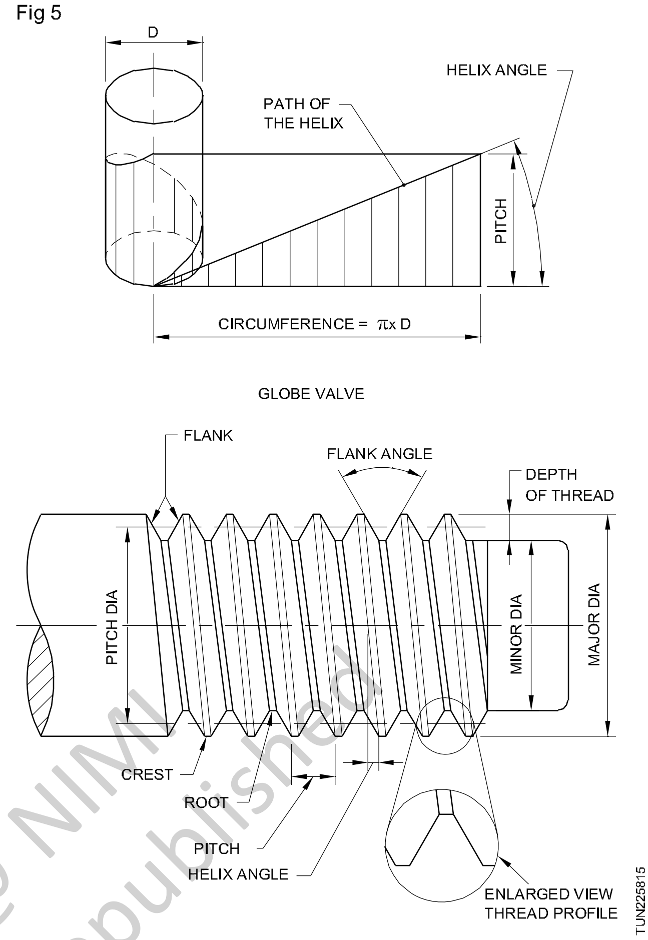
It is the included angle between two flanks of the thread.

Depth of thread

It is the perpendicular distance between the crest and the root of the thread.

Helix angle (Fig 5)

Fig 5



It is the angle which the helix makes with a line drawn perpendicular to the axis. It is calculated by the formula

$$\tan \alpha = \frac{lead}{pd}$$

where a = helix angle in degrees,

d = pitch diameter ofthe thread.

Hand of thread

The hand of the thread is the direction in which the thread is turned to advance. If the direction is clockwise it is right hand thread, and if the direction is anticlockwise, it is left hand thread.

Start of the thread

When there is only one helix formation on a work, the start of the thread is known as single start. If there are more than one helix, then the thread is known as a multi-start thread. The starting points of the threads in the case of multi-start threads are equally spaced on the face of the work, and may be determined by a careful look at the face to know the number of starts.

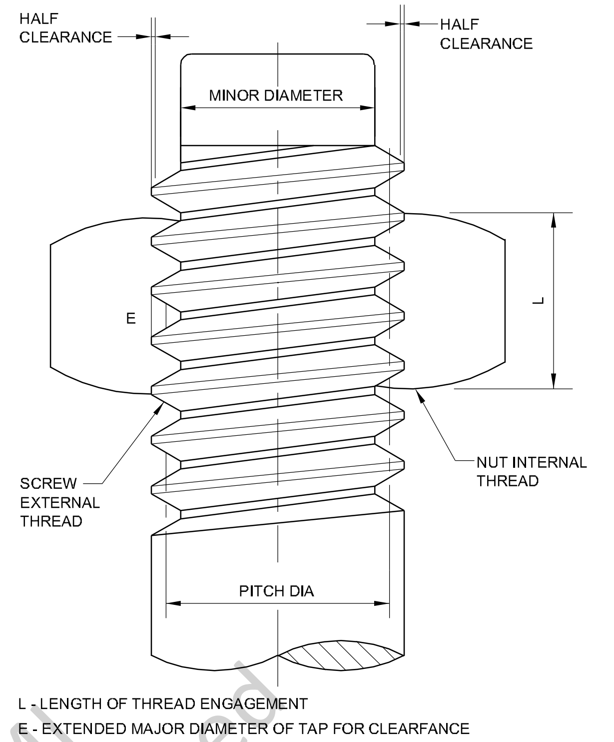
Threads of any form can be cut having multi-starts, depending upon their applications. The helix angle of a multi-start thread of a definite pitch is greater than that of a single start thread of the same pitch cut on the same diameter. Multi-start threads may be left hand or right hand threads according to the need. The term 'lead' is always used in conjunction with multi-start threads which will be equal to the pitch of the thread multiplied by the number of starts.

Multi-start threads are cut on parts to have faster transmission of motion with the diameter of the work, the pitch of the thread being kept to the minimum.

Clearance

It is a space left between the mating of external and internal threads to facilitate easy rotation of the threaded parts. (Fig.6)

Fig 6



FIT OF NUT AND BOLT

Multi-start, right hand and left hand threads

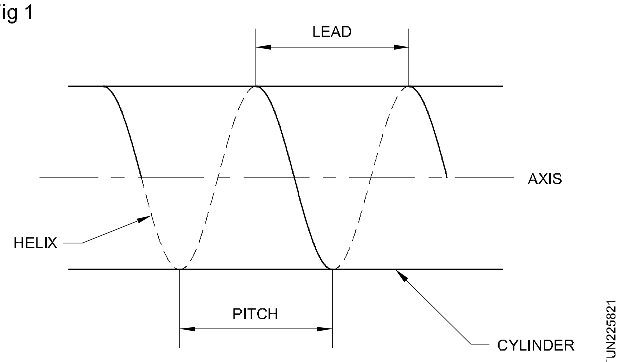
Objectives: At the end of this lesson you shall be able to

- **distinguish between the features of single start and multi-start threads**
- **give examples of a multi-start thread's applications**
- **distinguish between the features of right hand and left hand threads**
- **give examples on the application of right hand and left hand threads**
- **identify right hand and left hand threads.**

Threads are formed on screws in a helix. Helix is the path of a point travelling around an imaginary cylinder such that its axial and circumferential velocities maintain a constant ratio.

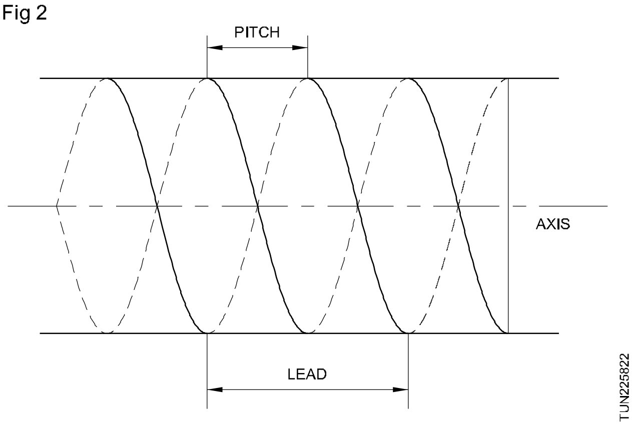
When a single helix is making a screw, it is called a SINGLE START thread. In a single start thread the LEAD and PITCH are the same. (Fig 1)

Fig 1



In the case of TWO START (DOUBLE START) threads, one thread is wound within the other exactly in the middle (Fig.2). This enables the lead of the helix increased without increasing the pitch.

Fig 2



Lead = Pitch x Number of starts

A screw-thread may have any number of starts. The general term for such threads other than single start is MULTI- START. Application of multi-start threads can be found in fly presses, pen caps etc. A multi-start thread makes it possible to keep the depth of thread less, and provides a rapid axial movement of the screws.

Driving plate and lathe carriers & their usage

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 lathe carriers**
- **understand types of lathe carriers.**

Driving plates

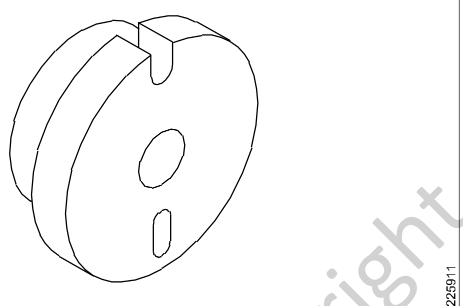
When turning a work in between the centres, the driving plate is used for transmitting the drive to the work, from drive plates

They are grouped as catch plates and driving plates and safety driving plates.

Catch plate

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

Fig 1

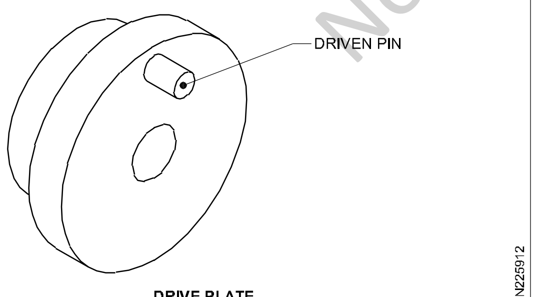


CATCH PLATE

Driving plate

It is designed with a projected pin which locates the straight tail of the lathe carrier. (Fig 2)

Fig 2



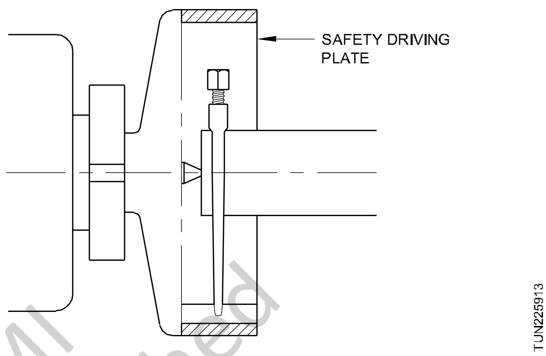
DRIVE PLATE

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)

The safety driving plates are made of cast steel and are machined to have their face perfectly at right angles to the bore. They are provided with a stepped collar at the back. The bore is designed to suit the spindle nose to which the plate has to be mounted.

Fig 3



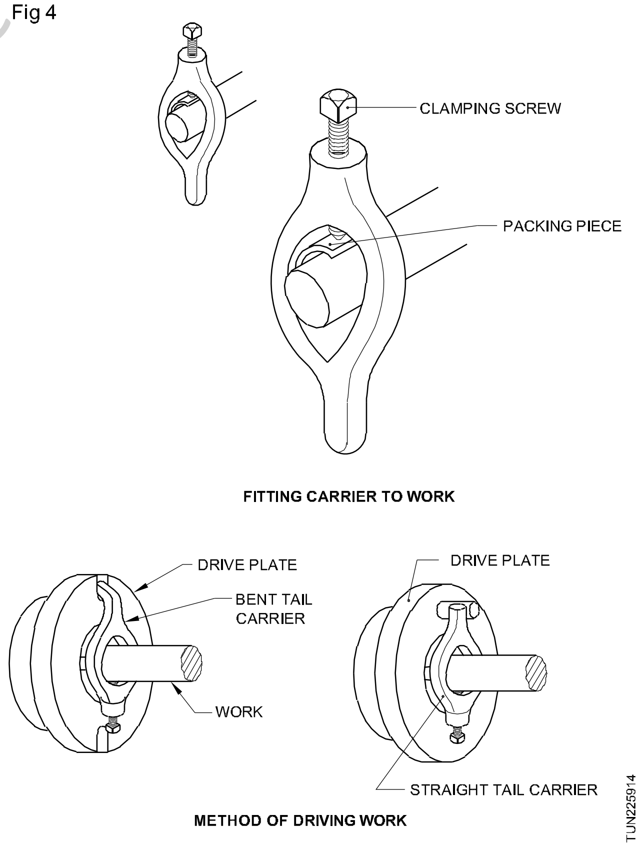
The driving plate with a straight tail carrier provides a positive drive for the workpiece.

A catch plate with a bent tail carrier uses a minimum clamping length of the workpiece for clamping purposes.

A safety driving plate prevents likely injuries to the operator.

Lathe carriers

Fig 4



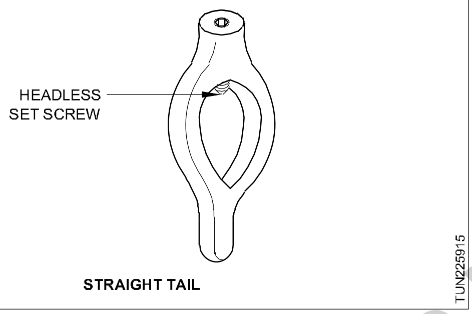
They are also called lathe dogs. They are used to drive the work during turning between centres. The work is clamped firmly in the lathe carrier. It consists of a cast iron or forged steel body and a clamping screw. It is designed with a straight or bent tail. It is available in a set of 10, capable 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 4) To protect the finished surface from damages, a soft metal packing piece is used under the clamping screw.

The following are the four types of lathe carriers.

Straight tail carrier, Bent tail carrier, Clamp type carier and Safety clamp type carrier.

A straight tailed carrier locates against the driving pin of the diving plate and provides a positive drive for the workpiece. (Fig 5)

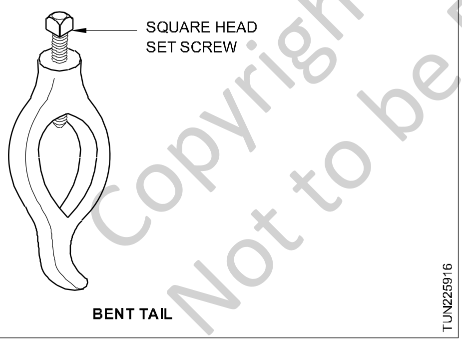
Fig 5



STRAIGHT TAIL

A bent tailed lathe carrier engages into a 'u' slot of the catch plate and drives the workpiece. (Fig 6).

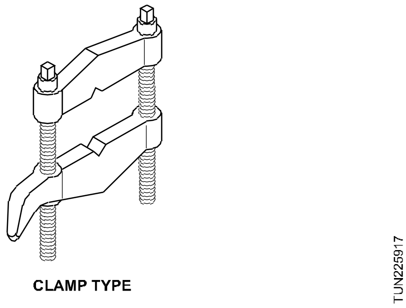
Fig 6



BENT TAIL

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 7)

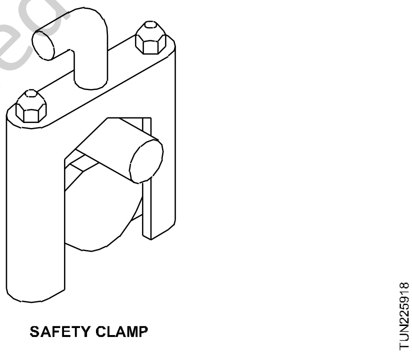
Fig 7



CLAMP TYPE

Safety clamp lathe carriers are desinged with safety - top and bottom clamping plates. These plates provide a positive grip of the work during turning. (Fig 8)

Fig 8



SAFETY CLAMP

Fundamentals of thread cutting on lathe

Objectives : At the end of this lesson you shall be able to
- **state the principle of thread cutting on lathe**
- **identify the parts involved in the thread cutting mechanism and state their functions**
- **State the method of setting tool, depth of cut and feeding method.**

Screw threads

Principle of thread cutting

The principle of thread cutting is to produces a uniform helical groove on a cylindrical or conical surface by rotating the job at a constant speed, and moving the tool longitudinally at a rate equal to the pitch of the thread per revolution of the job, with required tool feed.

The cutting tool moves with the lathe carriage by the engagement of a half nut of the lead screw. The shape of the thread profile on the work will be the same as that of the tool ground. The direction of rotation of the lead screw determines the hand of thread being cut.

Parts involved in thread cutting (Fig 1)

Fig 1

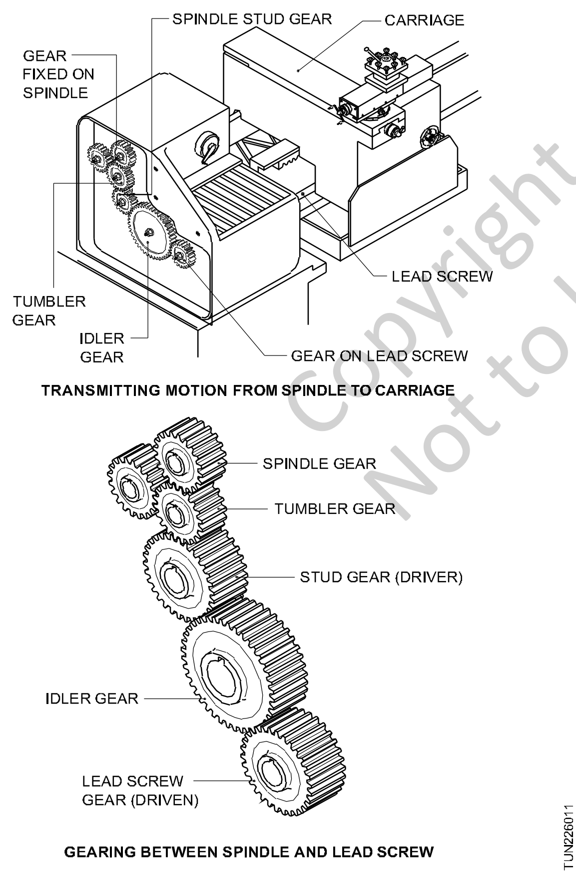
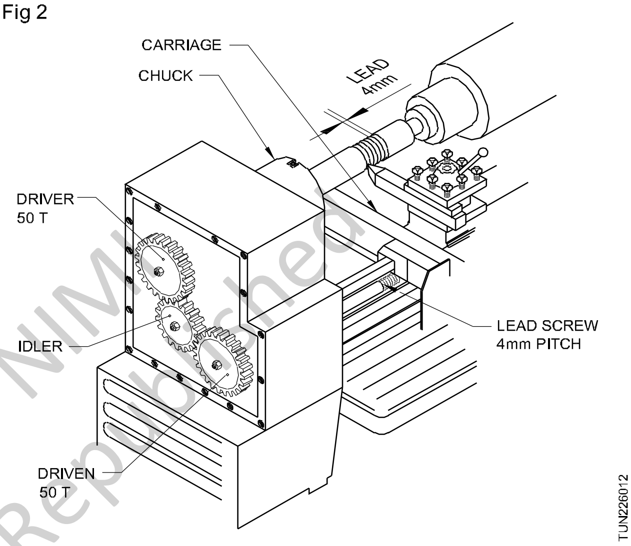


Figure illustrates how the drive is transmitted from the spindle to the lead screw through the change gear arrangement. From the lead screw the motion is transmitted to the carriage by engaging the half nut with the lead screw.

We have to cut a 4 mm pitch (lead) thread on a job in a lathe having a lead screw of 4 mm pitch. When the job rotates once, the lead screw should make one revolution to move the tool by 4 mm. Hence, if the stud gear (driver) has 50 teeth, the lead screw should be fixed with a gear of 50 teeth (driven) to get the same number of revolutions as the spindle.

Fig 2



If we have to cut 2 mm pitch threads instead of 4 mm in the same lathe, then the job makes one rotation and the lead screw should rotate 1/2 revolution so that the lead screw rotation is slower. Therefore, the driven wheel (lead screw gear) should be of 100 teeth if the driver (stud gear) has 50 teeth.

If we have to cut a 8 mm pitch thread on the job, the tool should move 8 mm per revolution of the job. The lead screw should rotate 2 revolutions when the job makes one rotation, making the L.S to run twice the speed of the spindle. So the driven wheel (lead screw gear) should be of 25 teeth if the driver wheel has 50 teeth.

Thread cutting on lathe

After the chares gear set up on lathe next step to do lathe is to turn the blank to required sixe and then setting the V-tool. The excess material is turned to the required thread to be cut to major diameter size and chamfered. The thread cutting tool is set in line with lathe axis and perpendicular with help of thread tool gauge as shown in fig.

The depth of cut given in two ways:

1. Advancing the tool perpendicular to the lathe axis, usually it varies from 0.05 to 0.2 mm depth
2. Advanced at an angle, by setting the compound rest at half of the thread angle, if it is metric 30° the methods shown in figure.

Different types of screw threads-forms, elements and applications

Objectives: At the end of this lesson your 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.**

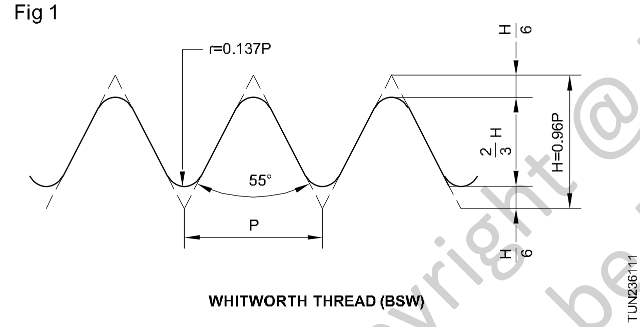
The different types of V threads are

- BSW Thread: British Standard Whitworth Thread
- BSF Thread: British Standard Pipe Thread
- B.A. Thread: British Association Thread
- I.S.O. Metric thread: Interantional Standard Organisation metric thread
- American National or sellers ‘thread

BIS Metric thread: Bureau of Indian Standard metric thread.

BSW thread (Fig 1)

Fig 1



WHITWORTH THREAD (BSW)

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 betweem the pitch and the other elements of the thread.

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

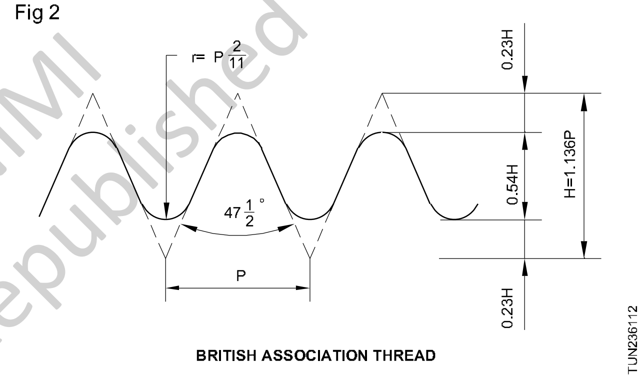
This thread is recommended for pipe and pipe fittigs. The table shows the pitch for different diameters. it is also similar to BSW thread. The thread is cut externally with a small taper for the threaded length. This avoids the leakage in the assembly and provides for further adjustment when slackness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

BA Thread (Fig 2)

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 2

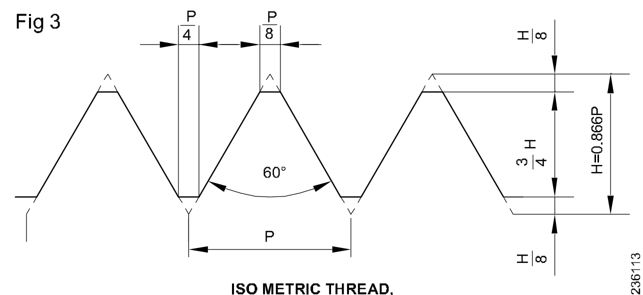


BRITISH ASSOCIATION THREAD

For both the metric and inch series, ISO has devleoped 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.

Fig 3



ISO METRIC THREAD,
UNIFIED INCH SERIES THREAD

EX: M14, M12, etc.

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

EX: M14 x 1.5

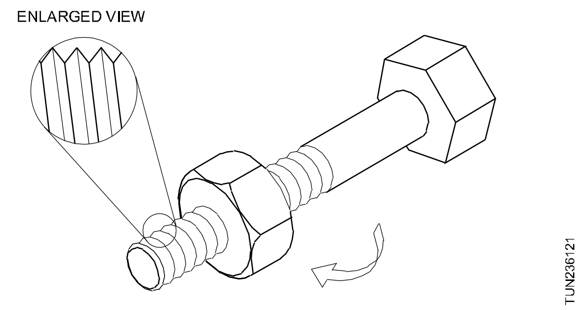
M24 x 2

Screw thread applications

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)

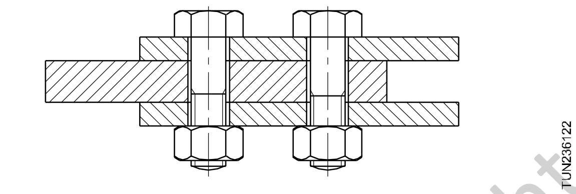
Fig 1



Uses of Screw Threads

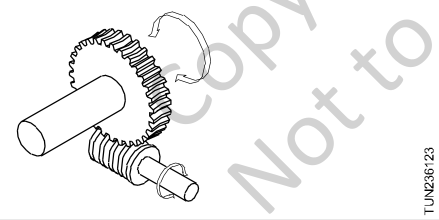
Screw threads are used as fasteners to hold together and dismantle components when needed (Fig 2)

Fig 2



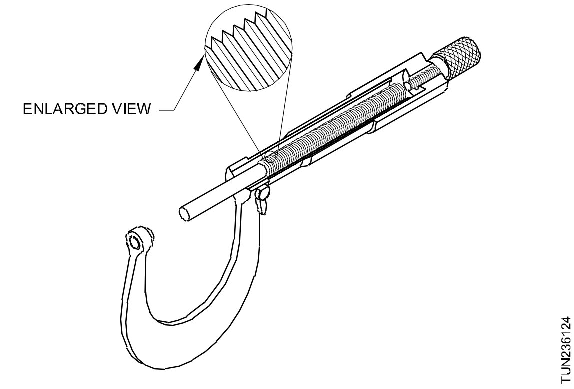
To transmit motion on machines from one unit to another (Fig 3)

Fig 3



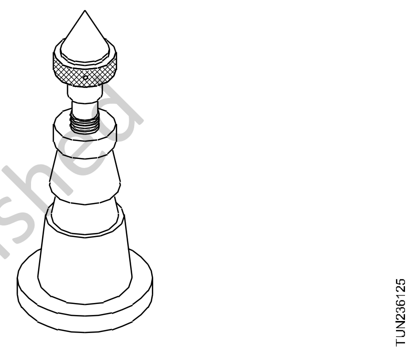
To make accurate measurements (Fig 4)

Fig 4



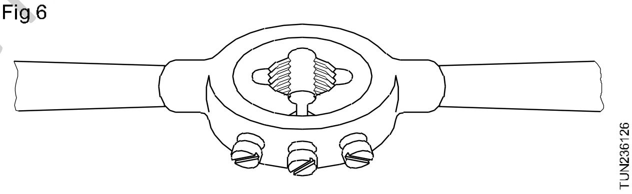
To apply pressure (Fig 5)

Fig 5



to make adjustments. (Fig 6)

Fig 6



Forms of screw threads

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.

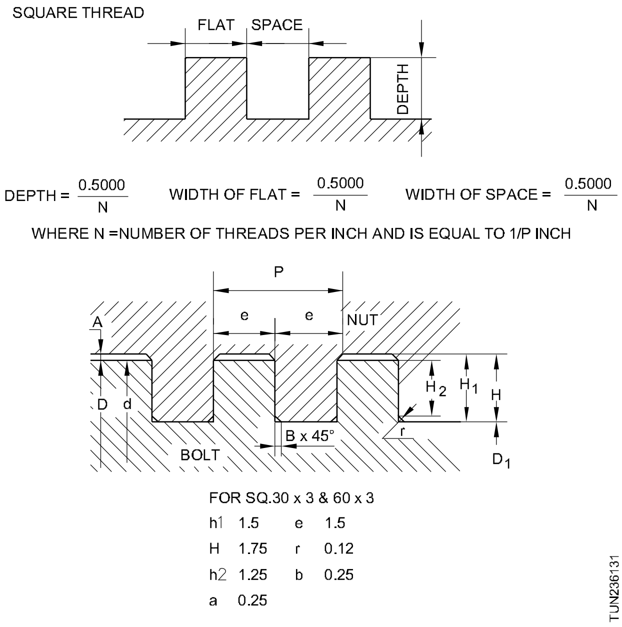
Square and trapezoidal threads

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.

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.

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:

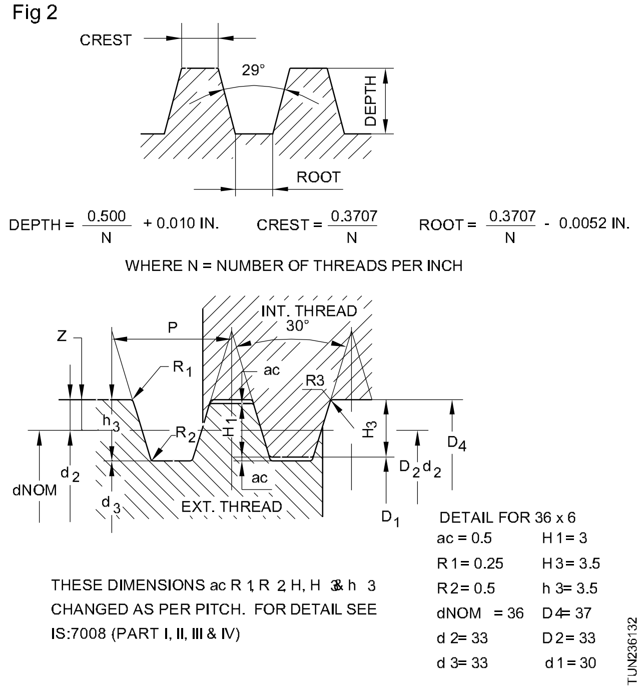
- acme thread
- buttress thread
- saw-tooth thread
- worm thread.

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.

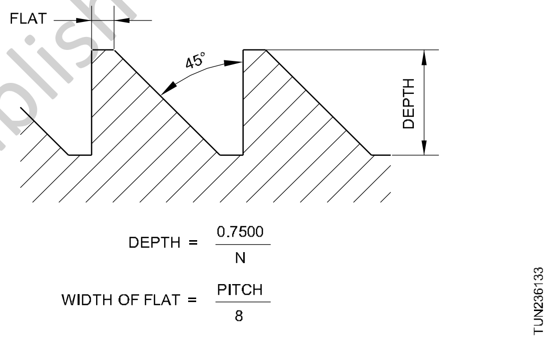
Acme threads are used in lathe lead screws. This form of thread enables the easy engagement of the half nut. The metric acme thread has an included angle of 30°. The relationship between the pitch and the various elements is shown in the figure.

Fig 2



Buttress thread (Fig 3)

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.

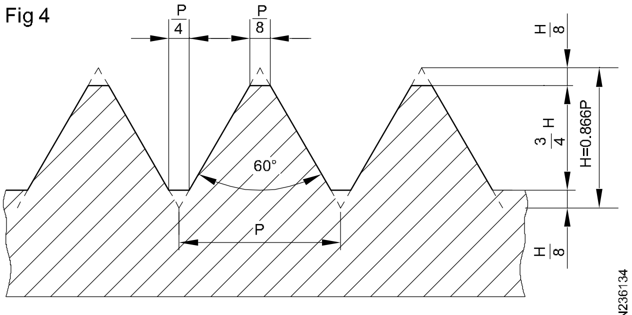
American National Thread (Fig 4)

These threads are also called as seller's threads. It was more commonly used prior to the introduction of the ISO unified thread.

Saw-tooth thread

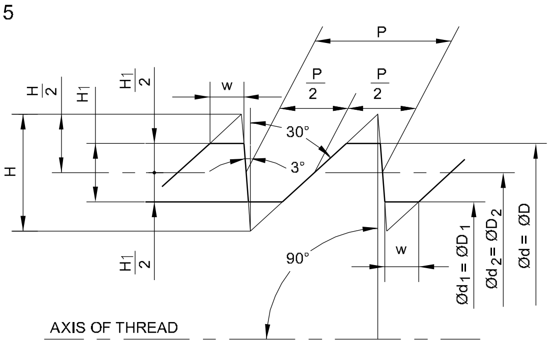
This is a modified form of buttress thread. In this thread, the flank taking the load is inclined at an angle of 3°, whereas the other flank is inclined at 30°. The basic profile of the thread illustrates this phenomenon. (Fig 5) The proportionate values of the dimensions with respect to the pitch.

Fig 4



AMERICAN NATIONAL THREAD ,SI & DIN METRIC THREADS

Fig 5



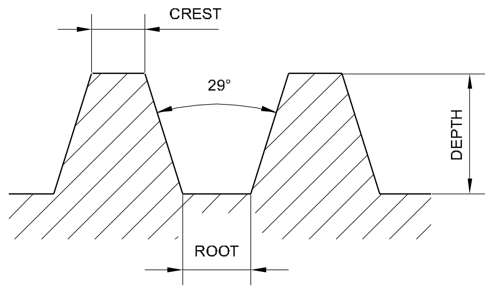
BASIC PROFILE FOR SAW TOOTH THREADS

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. Figure 6 shows the elements of a worm thread.

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.

Fig 6



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

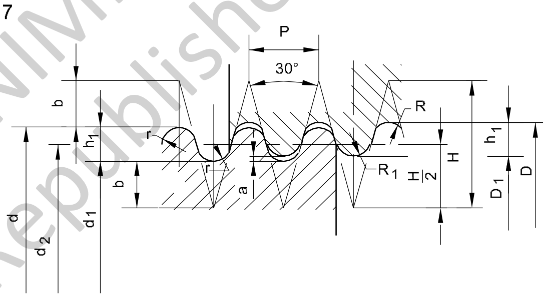
$\text{CREST} = \frac{0.335}{N}$

WORM THREAD

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

Screw thread and elements

A screw thread is a ridge of uniform section formed helically on the surface of a cylindrical body. (Fig 1)

An external screw thread is formed on the outer surface of a cylindrical part. *Examples:* bolts, screws, studs, threaded spindles, etc. (Fig 1)

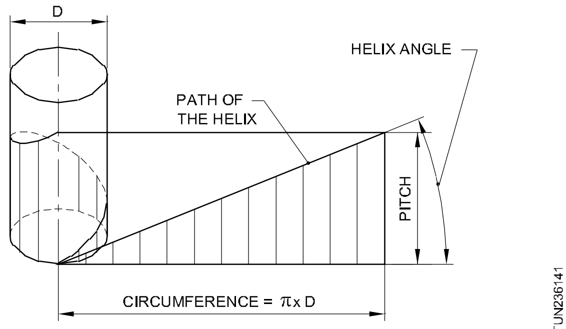
An internal screw thread is formed on the inner surface of a hollow cylindrical part. Examples: nuts, threaded lids etc.

External threads and internal threads are assembled together for different engineering uses. (Fig 2)

Uses of Screw Threads

Screw threads are used as fasteners to hold together and dismantle components when needed (Fig 3)

Fig 1



To transmit motion on machines from one unit to another (Fig 4)

Fig 2

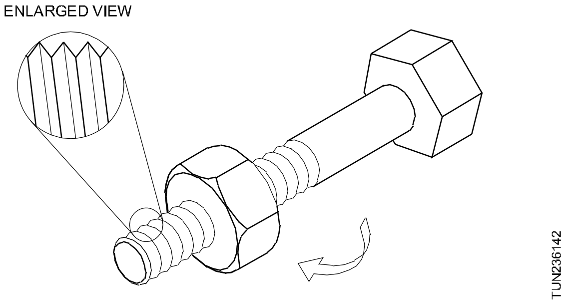


Fig 3

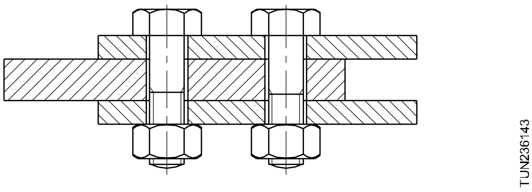
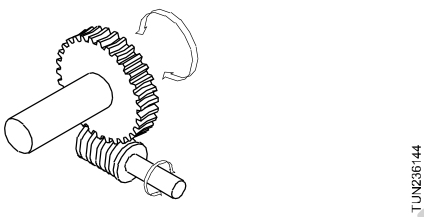
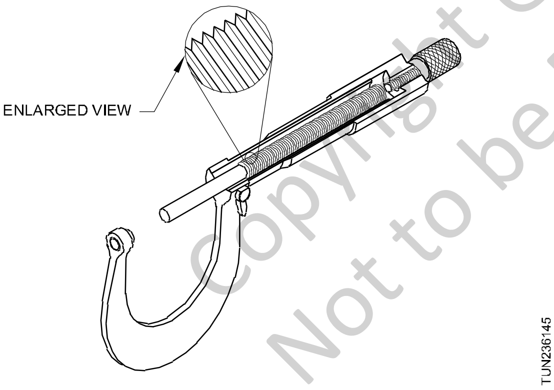


Fig 4



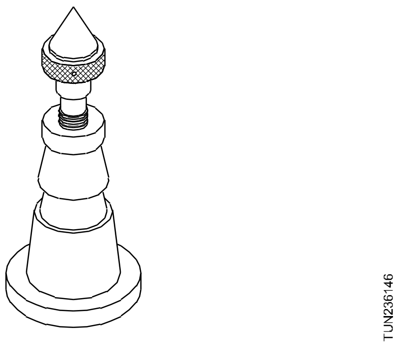
To make accurate measurements (Fig 5)

Fig 5



To apply pressure (Fig 6)

Fig 6



Screws are used to make adjustment on die opening fig 7.

Parts of a screw thread fig 8.

Fig 7

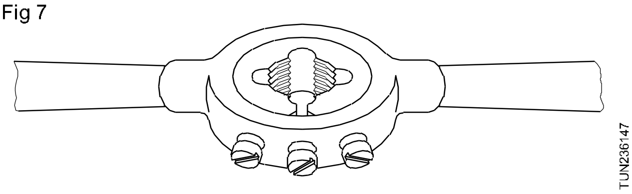
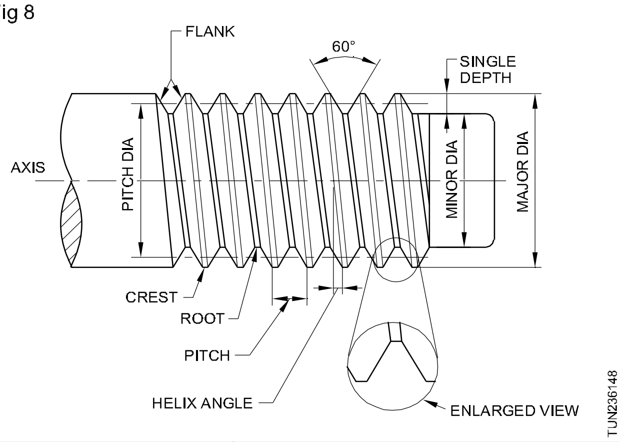


Fig 8



Crest

The top surface joining the two sides of a thread.

Root

The bottom surface joining the two sides of adjacent threads.

Flank

The surface joining the crest and the root.

Thread Angle

The included angle between the flanks of adjacent threads.

Depth

The perpendicular distance between the roots and crest of the thread.

Major Diameter

In the case of external threads it is the diameter of the blank on which the threads are cut and in the case of internal threads it is the largest diameter after the threads are cut that are known as the major diameter. (Fig 9)

This is the diameter by which the sizes of screws are stated.

Minor Diameter

For external threads, the minor diameter is the smallest diameter after cutting the full thread. In the case of internal threads, it is the diameter of the hole drilled for forming the thread which is the minor diameter.

Pitch Diameter (effective diameter)

The diameter of the thread at which the thread thickness is equal to one half of the pitch.

Pitch (Fig 8)

It is the distance from a point on one thread to a corresponding point on the adjacent thread measured parallel to the axis.

Lead

Lead is the distance a threaded component moves along the matching component during one complete revolution. For a single start thread the lead is equal to the pitch.

Helix Angle

The angle of inclination of the thread to the imaginary perpendicular line.

Hand

The direction in which the thread is turned to advance. A right hand thread is turned clockwise to advance, while a left hand thread is turned anticlockwise. (Fig 10)

Fig 9

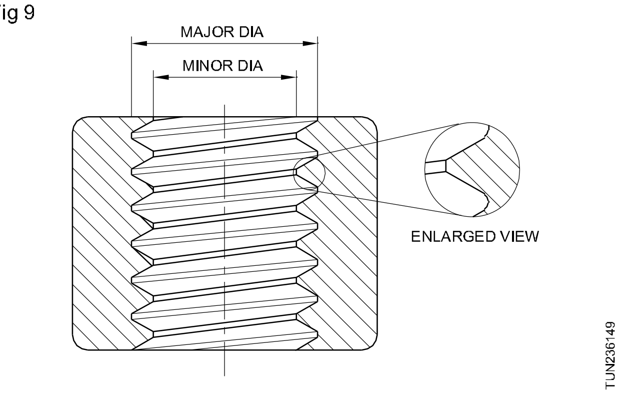
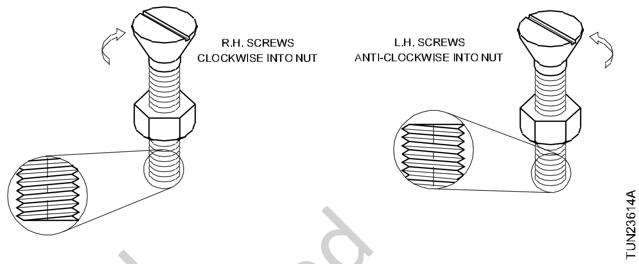


Fig 10



Drive train - change gear formula & calculation

Objectives : At the end of this lesson you shall be able to
- **state what is a change gear train**
- **identify and name the different types of change gear trains**
- **distinguish between a simple gear train and a compound gear train.**

Change gear train

Change gear train is a train of gears serving the purpose of connecting the fixed stud gear to the quick change gearbox. The lathe is generally supplied with a set of gears which can be utilized to have a different ratio of motion between the spindle and the lead screw during thread cutting. The gears which are utilized for this purpose comprise the change gear train.

The change gear train consists of driver and driven gears and idler gears.

Simple gear train

A simple gear train is a change gear train having only one driver and one driven wheel. Between the driver and the driven wheel, there may be an idler gear which does not affect the gear ratio. Its purpose is just to link the driver and the driven gears, as well as to get the desired direction to the driven wheel.

Fig 1 shows an arrangement of a simple gear train.

Fig 1

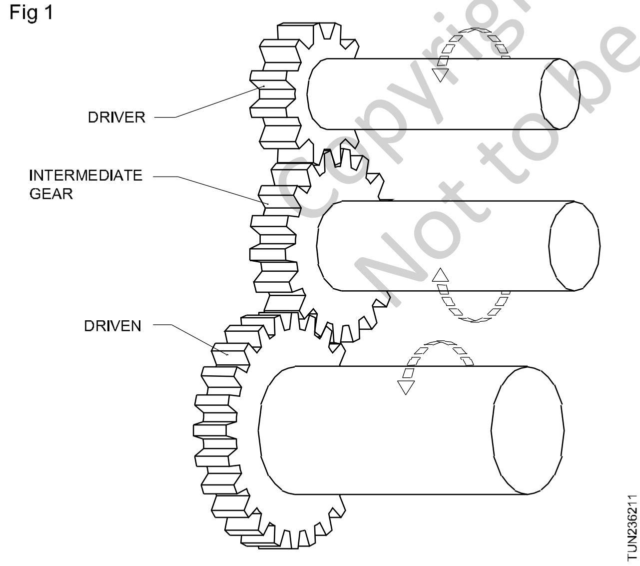


Fig 2 shows mountings of the driver and driven gears in a lathe.

The driver gear and the driven gear are changed according to the pitch of the thread to be cut on the job.

Compound gear train

Sometimes, for the required ratio of motion between the spindle and the lead screw, it is not possible to obtain one driver and one driven wheel. The ratio is split up and then the change gears are obtained from the available set of gears which will result in having more than one driver and one driven wheel. Such a change gear train is called a compound gear train.

Fig 3 shows the arrangement of a compound gear train.

Fig 2

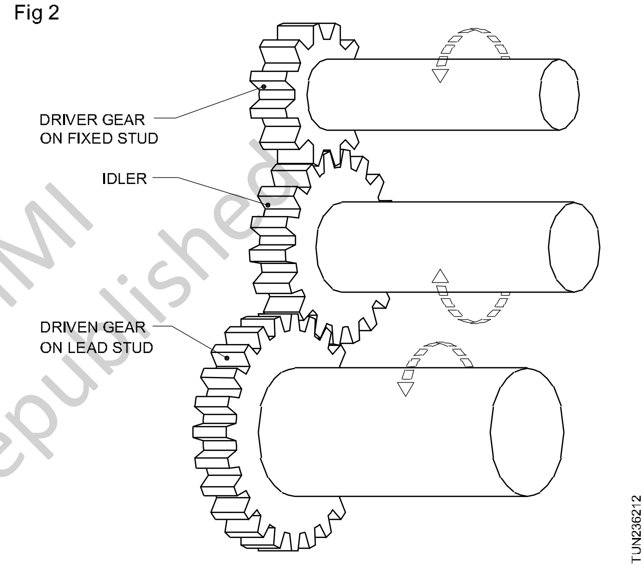
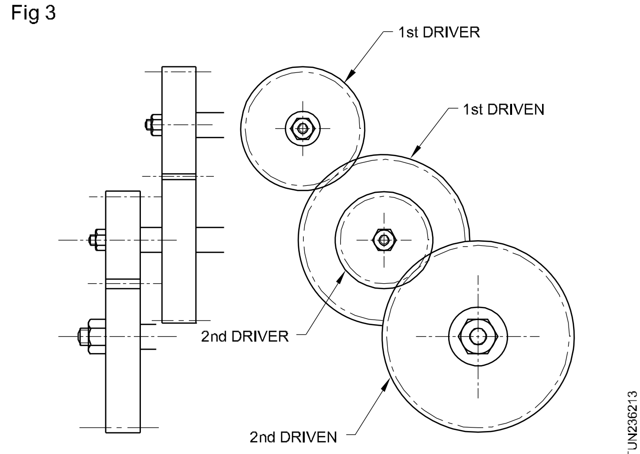


Fig 3



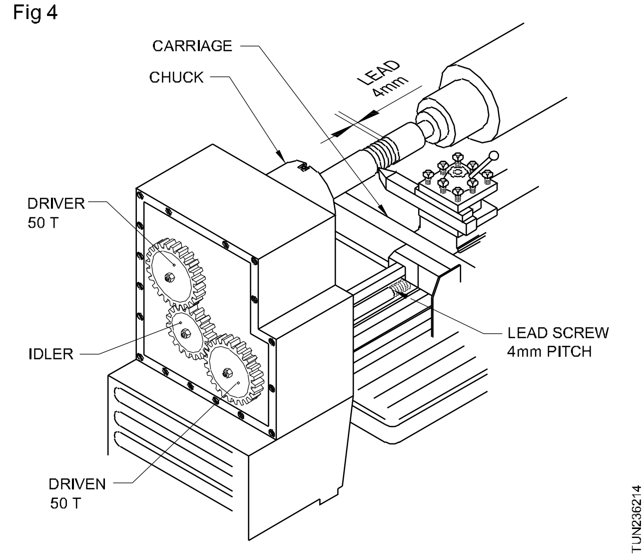
Derivation of the formula for change gears

Examples

CASE 1

We have to cut a 4 mm pitch (lead) thread on a job in a lathe having a lead screw of 4 mm pitch. When the job rotates once, the lead screw should make one revolution to move the tool by 4 mm. Hence, if the stud gear (driver) has 50 teeth, the lead screw should be fixed with a gear of 50 teeth (driven) to get the same number of revolutions as the spindle. (Fig 4)

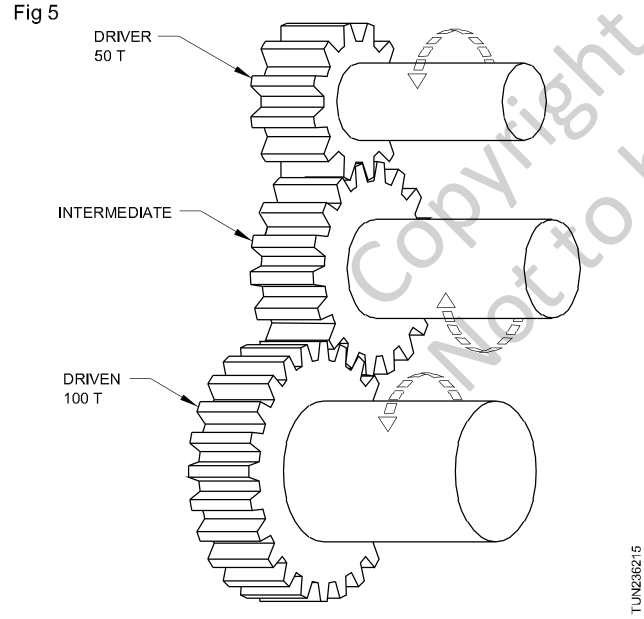
Fig 4



CASE 2

If we have to cut 2 mm pitch threads instead of 4 mm in the same lathe, then the job makes one rotation and the lead screw should rotate 1/2 revolution so that the lead screw rotation is slower. Therefore, the driven wheel (lead screw gear) should be of 100 teeth if the driver (stud gear) has 50 teeth.(Fig 5)

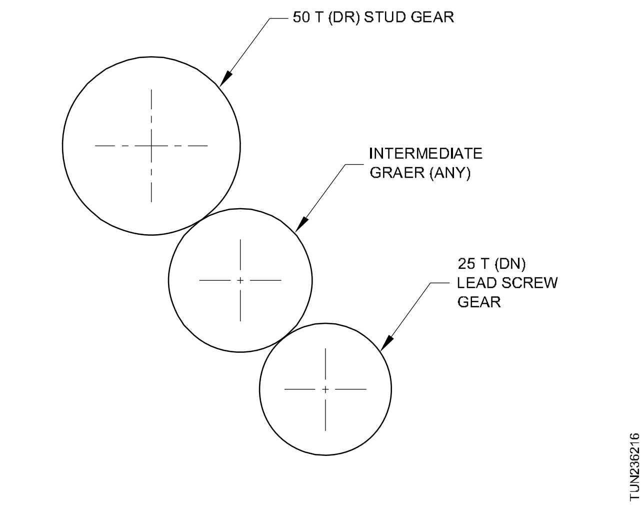
Fig 5



CASE 3

If we have to cut a 8 mm pitch thread on the job, the tool should move 8 mm per revolution of the job. The lead screw should rotate 2 revolutions when the job makes one rotation, making the L.S to run twice the speed of the spindle. So the driven wheel (lead screw gear) should be of 25 teeth if the driver wheel has 50 teeth. (Fig 6)

Fig 6



Let us compare the above three examples.

	I	II	III
Pitch(Lead) of job	4	2	8
Pitch(Lead) of L.S	4	4	4
Driver	50	50	50
Driven	50	100	25

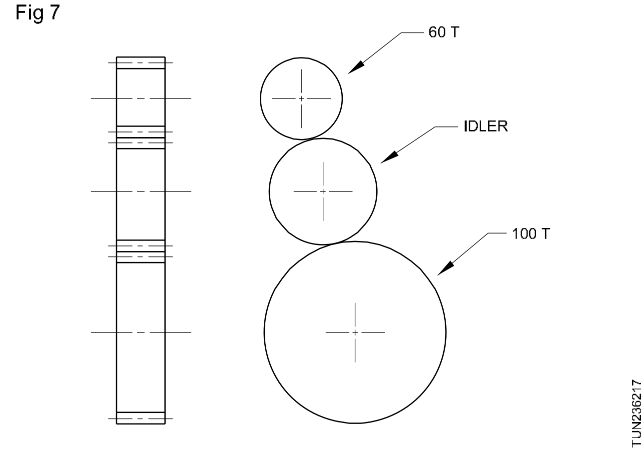
Stating the above in the form of a formula

$$\text{the gear ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of Lead Screw}}$$

Solved examples

1 Find the change gears required to cut a 3 mm pitch on a job in a lathe having a lead screw of 6 mm pitch. (Fig.7)

Fig 7



$$\text{Ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of L/S}} = \frac{3}{6}$$

$$= \frac{3}{6} \times \frac{20}{20} = \frac{60}{120}$$

Driver 60 teeth

Driven 120 teeth.

2 Find the change gears to cut a 2.5 mm pitch in a lathe having a lead screw of 5 mm pitch.

$$\text{Ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of Lead Screw}}$$

$$= \frac{2.5}{5}$$

$$= \frac{2.5 \times 20}{5 \times 20}$$

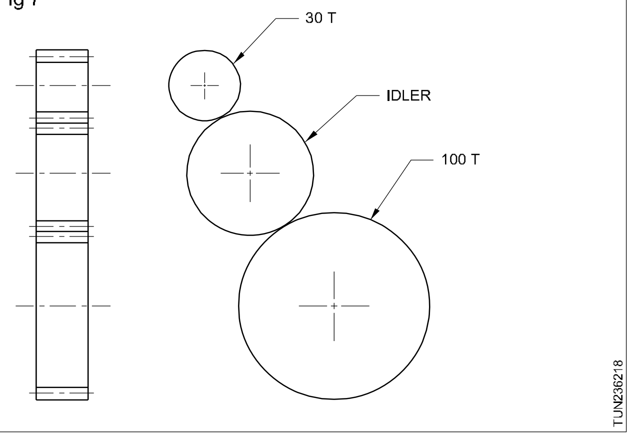
$$= \frac{50.0}{100} = \frac{50}{100}$$

Driver 50 teeth

Driven 100 teeth.

3 Calculate the gears required to cut a 1.5 mm pitch in a lathe having a lead screw of 5 mm pitch. (Fig 8)

Fig 7



$$\text{Ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of Lead screw}}$$

$$= \frac{1.5}{5} = \frac{3}{5 \times 2} = \frac{3 \times 10}{10 \times 10} = \frac{30}{100}$$

Driver 30 teeth

Driven 100 teeth.

Different methods of forming threads

Objectives : At the end of this lesson you shall be able to
- **state the different methods of forming threads**
- **distinguish the procedure of forming threads by different methods.**

The different methods of forming threads depend on many factors.

Type and number of components required

Type accuracy of thread and its surface finish

Availability of machine tools

Skill of the operator, etc.

The different methods of forming threads are:

by hand tools like tapes and dies

by using a single point cutting tool on the table

by using a multi-point cutting tool called chasers

by using a coventry die-head and collapsible taps in production lathes

by thread rolling

by thread milling

by thread grinding

by thread casting (die - casting or moulding).

Using taps and dies (Fig 1 & 2)

Fig 1

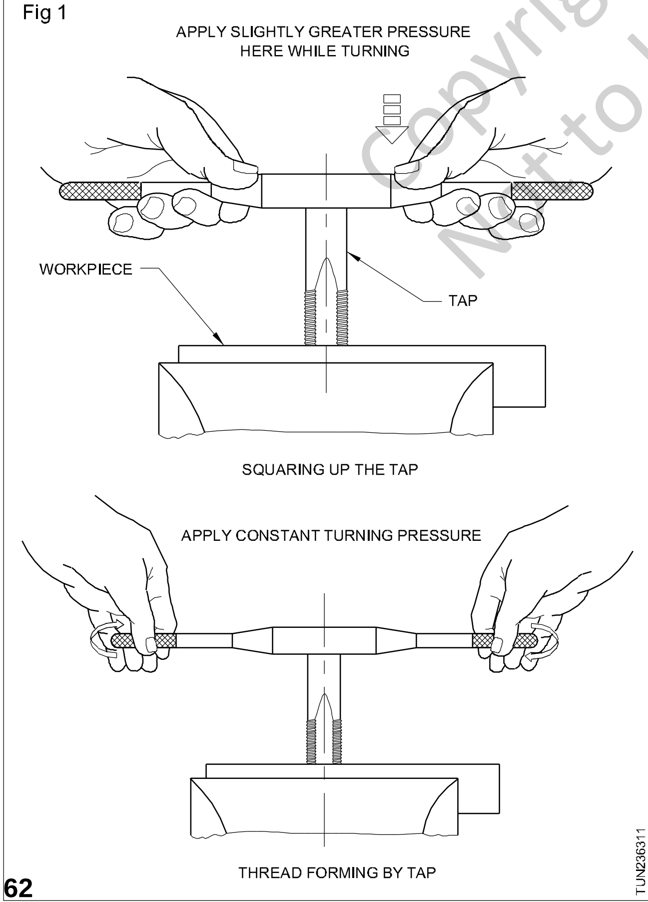
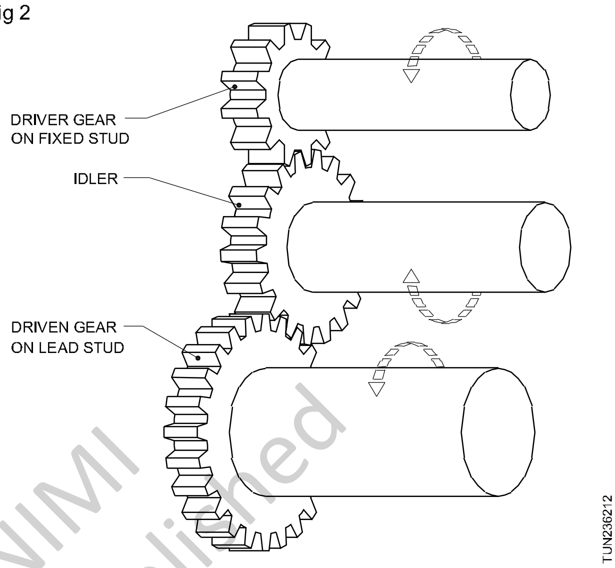


Fig 2

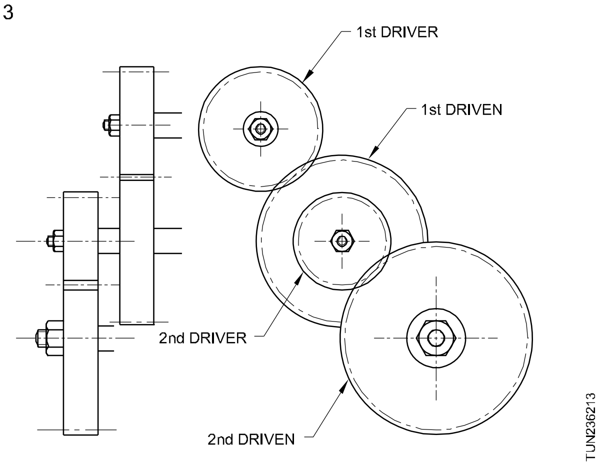


Taps and dies are commonly used for general purpose bolts and nuts. Taps are used to produce internal threads. Dies are used to produce external threads.

Taps and dies can be used only for products standarad 'V' threads for both coarse and fine pitches. Machine taps are also available for cutting threads.

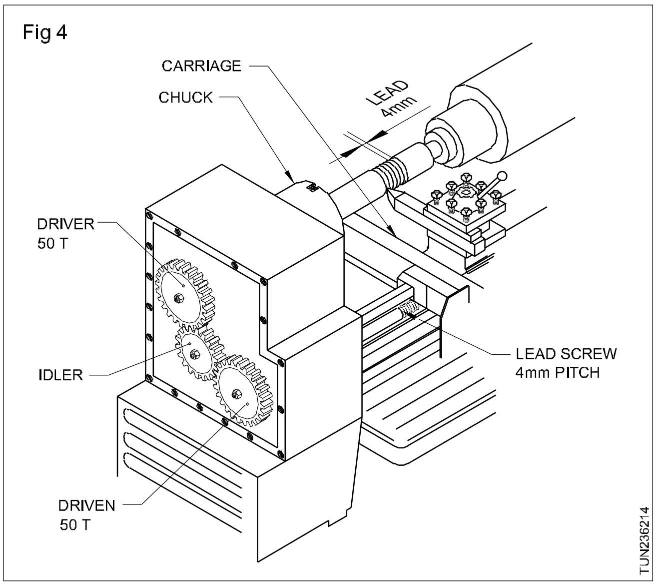
Using single point cutting tools on lathe (Fig 3)

Fig 3



Both internal and external right hand and left hand threads can be cut by this method. Any form of thread to a required pitch can be cut or produced by using the corresponding tools. Accuracy of the thread depends on the skill of the operator.

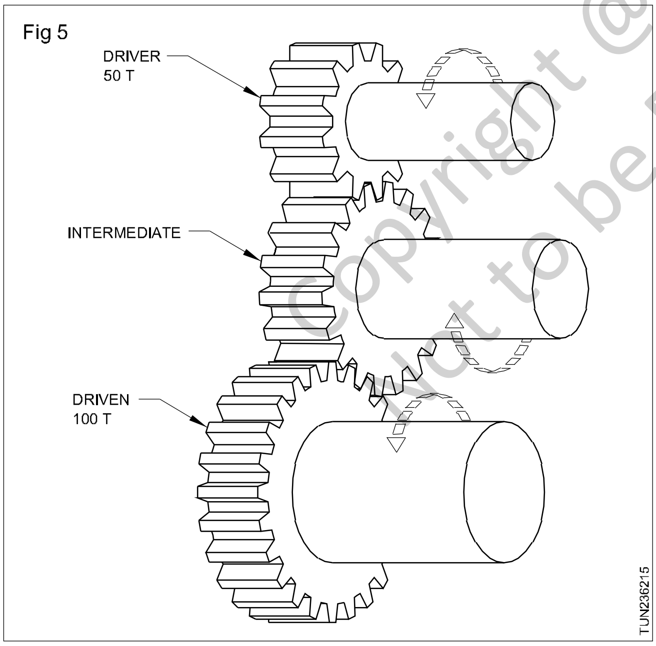
Using chasers (Fig 4)



Chasers are multi-point cutting tools to produce external 'V' threads. There are different types of chasers, each one having its own special characteristics.

Usually, hand chasers are used to finish the thread, and machine chasers for producing the threads. Machine chasers are used in conjunction with the die-heads.

Using coventry die-heads and collapsible taps (Fig 5)

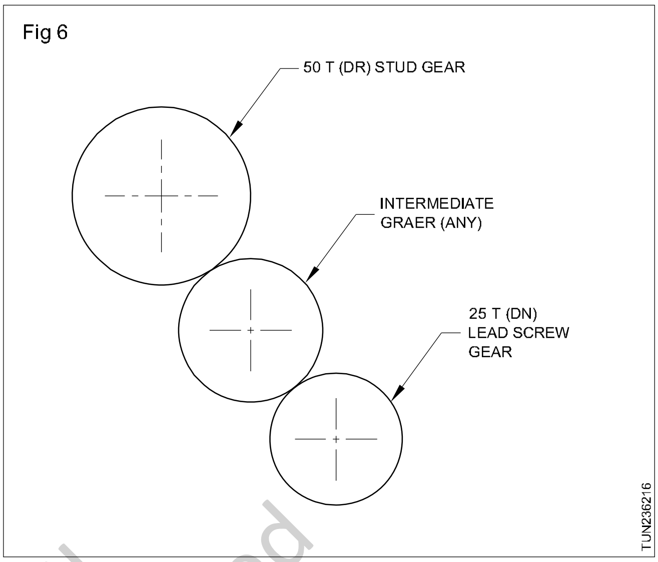


They are used in mass production to produce threads on capstan, turret lathes and automats. A highly skilled operator is not essential for cutting threads but for setting, skilled setters are required. This method is limited to producing 'V' threads.

Collapsible taps are used with floating holders for producing internal threads.

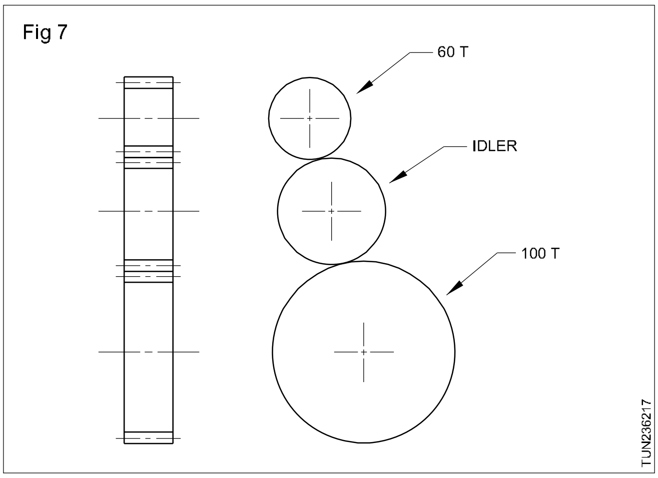
Thread rolling (Fig 6)

It is used in mass, production. In this method, the thread is not cut and chips will not be produced. Thread is produced by rolling. Rolling is a process of cold forging resulting in a plastic deformation. The job is turned to pitch diameter before rolling. The rollers may be flat or disc type. Threads produced by rolling have better strength and good finish.



Thread milling (Fig 7)

Threads are produced by thread milling cutters. The operation is performed on a special thread milling machine to produce accurate threads in small or large quantities. In this operation there are three driving motions, that is, for cutter, work, and longitudinal movement of the cutter. The thread is completed in one cut by setting the cutter to the full depth of thread and then feeding it along the entire length of the workpiece. Internal thread milling can also be performed to produce accurate internal threads.



Thread grinding (Fig 8 and 9)

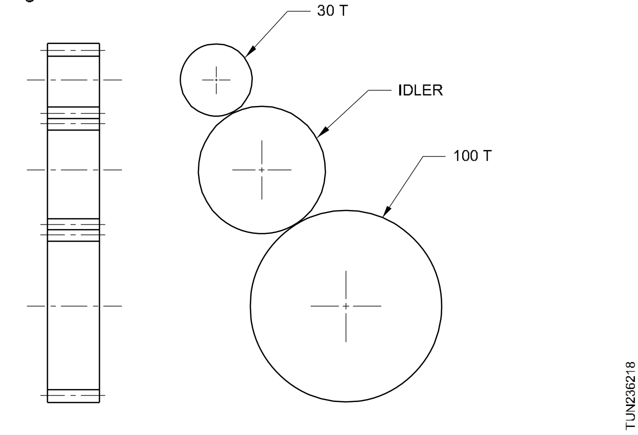
Special grinding machines are required for thread grinding. Both the external threads and internal threads can be ground.

There are two main types of thread grinding i.e single rib and multiple rib.

Single rib grinding involves the use of a narrow grinding wheel which is shaped to the required form of thread.

Multiple-rib grinding is done with a grinding wheel with many grooves on its face. This type of wheel grinds many threads at one time. (Fig 9)

Fig 7



Thread casting

Threads can be produced by casting for crude threads. It is produced either by die casting or moulding. Threads on non-metals are produced by this method.

Calculation involved in finding core dia, gear train

Objectives : At the end of this lesson you shall be able to
- **describe change gear calculation**
- **calculate change gear calculation for simle and compound gear train**
- **calculate chen**

Calculation for change gears

To calculate change gear to cut thread to required pitch, it is to know ration of driving and driven gear to be fixed. for example if the lathe lead screw pitch is 12mm and the thread to be cut 3mm pitch, the spindle must rotate 4 times the speed of lead screw

Therefore $\frac{\text{Spindle turn}}{\text{Lead screw turn}} = \frac{4}{1}$

for which we must have

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1}{4} = \frac{\text{Lead screw turn}}{\text{Spindle turn}}$$

$$= \frac{\text{Pitch of the thread to be cut}}{\text{Pitch of the lead screw}}$$

(for British standard screws $\frac{\text{TPI on lead screw}}{\text{TPI on work}}$)

The gear fixed on spindle shaft drive called driver.

Example: The pitch of lead screw is 6mm pitch of the thread to be cut is 2mm. find change gears. for simple gear train.

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{pitch of the work}}{\text{pitch of the lead screw}} \frac{2}{6} = \frac{2x20}{6x60} = \frac{40}{120}$$

The driver gear will have 40T and driven gear will have 120T

Example: The pitch of the leadscrew is 12mm and thread to be cut 1.5mm find change gear for compound gear train.

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{Pitch of the work}}{\text{Pitch of the lead screw}} = \frac{1.5}{12}$$

$$= \frac{1.5x2}{12x2} \quad \frac{63}{48} \quad \frac{63}{14} \quad \frac{1}{12}$$

Change wheel calculations for fractional pitch threads

Objectives : At the end of this lesson you shall be able to
- **calculate change wheels for cutting fractional pitch threads (BritishSystem)**
- **calculate change wheels for cutting decimal fractional pitch threads (BritishSystem)**
- **calculate change wheels for fractional pitch threads by continued fraction method.**

It is necessary to calculate the ratio of change gears to cut fractional leads for worms, hobs etc. on a centre lathe at times.

To obtain a formula; suppose it is required to cut a lead of 1/4" on a lathe which has a lead of 1/2". If one to one ratio were used between the driver and the driven gears, the carriage would move 1/2" per revolution of the lathe spindle. Therefore, to cut a lead of 1/4" the ratio of the driver and driven gears must be as

$$\frac{1}{4}\frac{1}{2}$$

That is $\frac{1/4}{1/2}$ or $\frac{1}{2} \equiv \frac{\text{Driver}}{\text{Driven}}$

Expressed as a formula:-

$$\frac{DR}{DN} \equiv \text{ratio of change gears} \equiv \frac{\text{Lead screw to be cut}}{\text{Lead of lead screw}}$$

or alternatively:-

$$\frac{\text{lead of screw to be cut}}{1} \times \frac{1}{\text{lead of screw}} = \frac{\text{Driver}}{\text{Driven}}$$

lead of screw to be cut x

No.of threads / inch of lead screw $= \frac{\text{Driver}}{\text{Driven}}$

Example

Calculate the change gears necessary to cut a thread of 7/16" lead on a lathe with a lead screw of 4 threads per inch.

lead of screw to be cut x

No.of threads / inch of lead screw $= \dfrac{\text{Driver}}{\text{Driven}}$

$$= \frac{7}{16} \text{ x } 4 = \frac{28}{16} = \frac{7}{4}$$

$$= \frac{7}{4} \text{ x } \frac{10}{10} = \frac{70}{40} = \frac{\text{Driver}}{\text{Driven}}$$

If the lead to be cut is a whole number and a vulgar fraction, change it to an improper fraction and apply the above formula.

Example

Calculate the change gears required to cut an oil groove having 8 turns in 11 inches on a lathe with a lead screw of 4 threads per inch.

Pitch of the groove x

No.of threads / inch of lead screw $= \dfrac{\text{Driver}}{\text{Driven}}$

$$\text{Pitch of groove} = \frac{\text{travel or given number of turns}}{\text{number of turns}}$$

$$= \frac{11}{8} \text{inches}$$

$$\text{Gear ratio} = \frac{\frac{11}{8}}{\frac{1}{4}}$$

$$= \frac{11}{8} 4 = \frac{44}{8} = \frac{4 \text{ x } 11}{2 \text{ x } 4} = \frac{4}{2} = \frac{11}{4}$$

$$\text{First fraction} = \frac{4}{2} \text{ x } \frac{15}{15} = \frac{60}{30}$$

$$\text{2nd fraction} = \frac{11}{4} \text{ x } \frac{10}{10} = \frac{110}{40}$$

$$\text{Thus } \frac{DR}{DN} = \frac{60}{30} \text{ x } \frac{110}{40} \text{ (Fig 1)}$$

Example

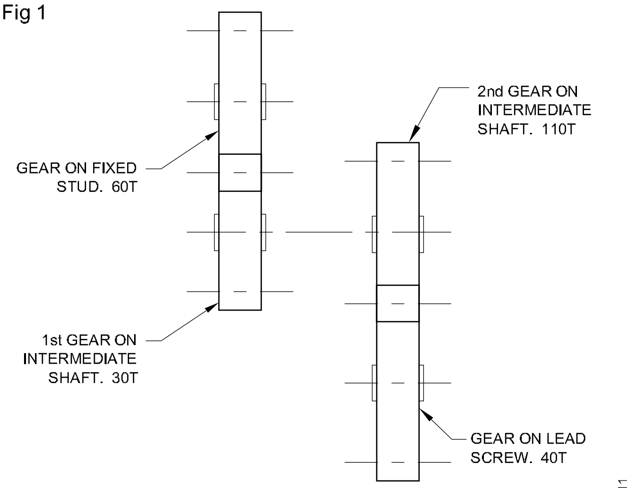
Calculate the change gears to cut a worm of 0.35 inches lead on a lathe with a lead screw having 4 threads per inch. lead to be cut x no.of threads/inch of lead screw

$$= \frac{DR}{DN} = 0.35 \text{ x } 4$$

$$= \frac{35}{100} \text{ x } \frac{4}{1} = \frac{7}{5} \text{ x } \frac{10}{10} = \frac{70}{50} = \frac{\text{driver}}{\text{driven}}$$

When the lead occurs as a decimal, it may be necessary to use the method of continued fractions to obtain a suitable approximation of the change gear ratio, for which the change gears may be selected from the available set of gears.

Fig 1



GEAR TRAIN ARRANGEMENT

Example

Calculate the change gears required to cut a worm of 0.55 inches lead on a lathe, with a lead screw of 6 threads per inch.

lead to be cut x no.of threads/inch of lead screw $= \dfrac{DR}{DN}$

= 0.55 x 6

$$= \frac{55}{100} \text{ x } \frac{6}{1}$$

$$\text{1st fraction} = \frac{55}{100}$$

$$\text{2nd fraction} = \frac{6}{1} \text{ x } \frac{20}{20} = \frac{120}{20}$$

$$\frac{\text{driver}}{\text{driven}} = \frac{55}{100} \text{ x } \frac{120}{20}$$

Example

Calculate the change gears required to cut a worm of 0.95 inches lead on a lathe with a lead screw of 6 threads per inch.

lead to be cut x no.of threads/inch of lead screw $= \dfrac{DR}{DN}$

= 0.95 x 6

$$= \frac{95}{100} \text{ x } \frac{(6 \text{ x } 20)}{(1 \text{ x } 20)} = \frac{95}{100} \text{ x } \frac{120}{20}$$

$$\frac{\text{driver}}{\text{driven}} = \frac{95}{100} \text{ x } \frac{120}{20}$$

Example

Calculate the change gears to cut 2BA threads (0.81mm pitch) on a lathe which has a lead screw of 1/4 inch - pitch by the continued fraction method.

This could be cut exactly if the 1/5 ratio were combined with a 81T driver and a 127T driven change gears.

If special gears are not available we have to obtain the nearest fraction by the continued fraction method. For this nearest fraction gears may be selected from the available set of gears.

$$\text{Ratio}: \frac{\text{driver}}{\text{driven}} = \frac{0.81}{1/4 \times 25.4} = \frac{0.81}{6.35}$$

$$\frac{\text{driver}}{\text{driven}} = \frac{81}{635} \times \frac{1 \times 81}{5 \times 127}$$

Determining the convergents by the continued fraction method.

```
81)   635 (7
      567
      ___
      68 ) 81   (1
           68
           ___
           13 ) 68 (5
                65
                ___
                3) 13 (4
                   12
                   ___
                    1) 3 (3
```

		7	1	5	4	3
1	0	1	1	6	25	81
0	1	7	8	47	196	635
		7	1	5	4	3

The convergents are : $\frac{1}{7}; \frac{1}{8}; \frac{6}{47}; \frac{25}{196}; \frac{81}{635}$

The 4th convergent : $\frac{25}{196}$ may be written $\frac{5}{14} \times \frac{5}{14}$

$$\frac{\text{driver}}{\text{driven}} = \frac{25}{70} \times \frac{25}{70}$$

and this could be obtained with duplicate 25 T and 70 T gears, a circumstance not unlikely, provided two similar lathes are available.

The actual pitch obtained from this driver and driven gears is:

an error of 0.00005mm, which is equivalent to a total pitch error of about 0.0016mm (0.00006 in) over a 1 in. length of the thread. This is well within the permissible limits of accuracy of an ordinary commercial lead screw.

Thread chasing dial - Function, construction and use.

Objectives : At the end of this lesson you shall be able to
- **state the necessity of a thread chasing dial**
- **state the constructional details of a British thread chasing dial**
- **state the functional features of a British thread chasing dial.**

Thread chasing dial

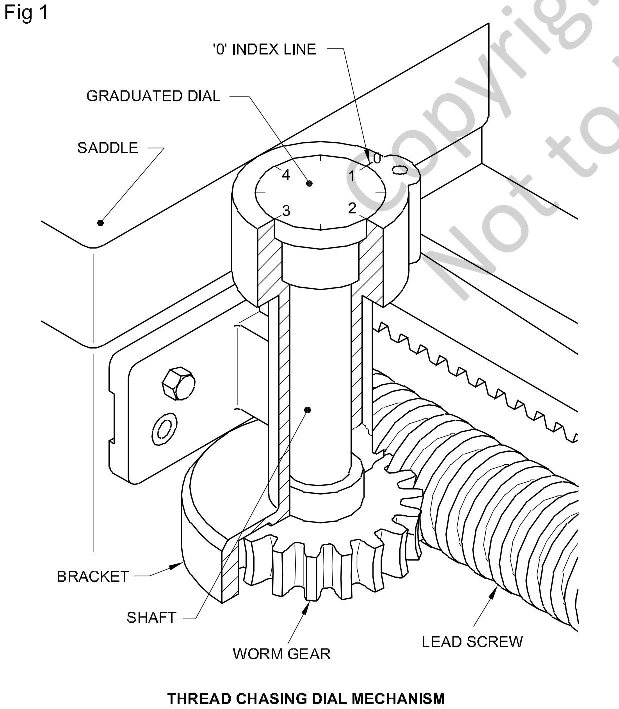
To catch the thread quickly and to save manual labour, use of a chasing dial is very common during thread cutting by a single point cutting tool. A thread chasing dial is an accessory.

Constructional details (Fig 1)

The figure shows constructional details of a British thread chasing dial. It consists of a vertical shaft with a worm wheel made out of brass or bronze, attached to the shaft at the bottom. On the top, it has a graduated dial. The shaft is carried on a bracket in bearing (bush) which is fixed to the carriage. The worm wheel can be brought into an engaged or disengaged position with the lead screw as needed. When the lead screw rotates it drives the worm wheel which causes the dial to rotate. The movement of the dial is with reference to the fixed mark ('O' index line).

The face of the dial is usually graduated into eight (8) divisions, having 4 numbered main divisions and 4 unnumbered subdivisions in between.

Fig 1



THREAD CHASING DIAL MECHANISM

The number of teeth on the worm gear is the product of the number of threads per inch on the lead screw and the number of numbered divisions on the dial.

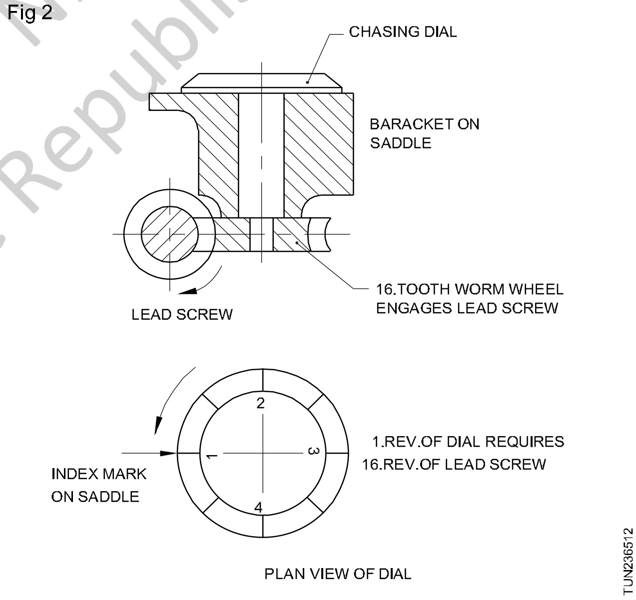
Each numbered division represents 1 inch travel of the carriage.

Let the worm wheel have 16 teeth, and the lead screw 4 TPI. The number of numbered graduations and unnumbered graduations are 4 each.

The half nut can be engaged 16 times for one revolution of the graduated dial. The movement of the carriage for one complete revolution of the dial is 4". (Fig 2) Since the dial is having totally 8 graduations marked, each graduation represents 1/2" travel of the carriage.

The chart given here shows the positions at which the half nut is to be engaged when cutting different threads per inch, when a British thread chasing dial with the above data is fitted to the lathe.

Fig 2



THREAD CHASING DIAL CHART

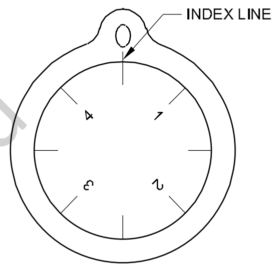
Threads per inch to be cut	Dial graduation at which the half nut can be engaged to catch the thread	Reading on the dial illustrated
Threads which are a multiple of the number of threads per inch of the lead screw.	Engage at any position the half nut meshes.	Use of dial unnecessary.

Example T.P.I. to be cut - 8

$$\frac{DR}{DN} \quad \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} \quad \frac{4}{8} \quad \frac{1}{2}$$

The predetermined travel of 1/4" is represented by the dial position in the exact middle between any numbered division and adjacent un-numbered division. The half nut engagement can be done at any position at which it can be engaged (ie. 16 positions).

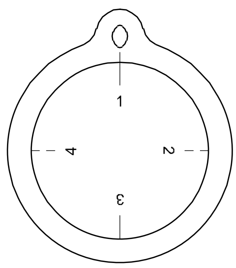
Referring to the dial is not necessary.

Even number of threads	Engage at any graduation on the dial. 8 positions	1 1 1/2 2 2 1/2 3 3 1/2 4 4 1/2	

Example T.P.I. to be cut - 6

$$\frac{DR}{DN} \quad \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} \quad \frac{4}{6} \quad \frac{2}{3}$$

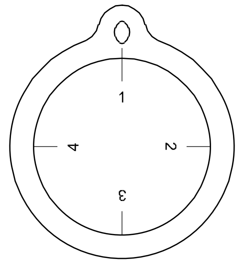
The predetermined travel of 1/2" is represented by dial movement from any numbered division to the next adjacent unnumbered division. The half nut can be engaged when any numbered or unnumbered graduation coincides with the zero line (8 positions).

Odd number of threads	Engage at any main division. 4 positions	1 2 3 4	

Example T.P.I. to be cut - 5

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{5} = \frac{4}{5} \qquad \text{Predeterminedtravel} = 4 \times \frac{1"}{1} = 1"$$

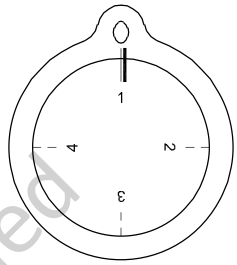
The predetermined travel of 1" is represented by the dial movement from any numbered division to the next numbered division or from any unnumbered division to the next unnumbered division. Therefore, if the first cut is taken when a numbered division of the dial coincides with zero, then the half nut engagement for successive cuts can be done when any numbered division coincides with the zero mark. If the first cut is taken when an unnumbered division coincides with the zero, then the half nut for successive cuts, is engaged when any unnumbered division coincides with the zero. (4 positions)

Half fractional number of threads	Engage at every other main division. 2 positions	1 & 3 or 2 & 4	

Example T.P.I. to be cut - 3 1/2

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{3\,1/2} = \frac{8}{7}$$

The half nut can be engaged only at opposite numbered or unnumbered graduations (2 positions).

Quarter fractional number of threads ——	Engage at the same main division. 1 position	1 or 2 or 3 or 4	

Example T.P.I. to be cut - 2 3/4

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{2\,3/4} = \frac{16}{11}$$

$$\text{Predetermined travel} = 16 \times \frac{1''}{4} = 4''$$

The half nut can be engaged to catch the thread only when the same numbered or unnumbered graduated line, at which the first cut is taken, coincides with the zero line (1 position only).

Example T.P.I. to be cut - 1 3/8

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{1\,3/8} = \frac{32}{11}$$

$$\text{Predetermined travel} = 32 \times \frac{1''}{4} = 8''$$

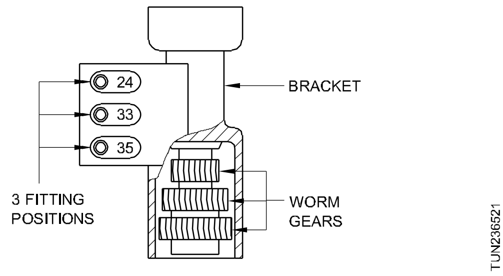
The half nut engaged for the first cut should remain at the engaged position till thread cutting is completed and the machine is reversed as it takes a long time to cover the predetermined travel arrived at by calculation.

Metric thread chasing dial

Objectives : At the end of this lesson you shall be able to
- **state the constructional details of a metric thread chasing dial**
- **state the functional features of a metric thread chasing dial.**

Construction of a metric thread chasing dial (Fig.1)

Fig 1



The construction of a metric thread chasing dial is similar to that of a British chasing dial. The shaft carries a set of worm/spur wheel of different numbers of teeth which vary according to the type of the lathe. But there is always more than one worm/spur wheel. The dial graduation of the metric chasing dial also differs from that of the British thread chasing dial.

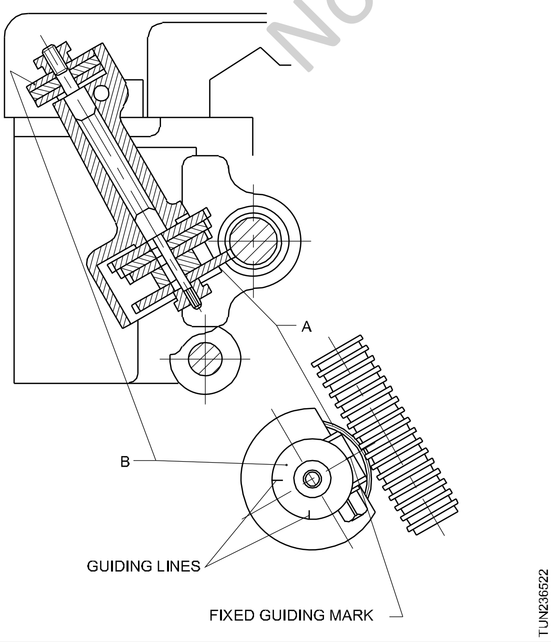
Fig 1 shows the construction of a metric thread chasing dial.

For cutting metric threads, using a metric thread chasing dial, the product of the pitch of the lead screw and the number of teeth on the worm wheel must be an exact multiple of the pitch of the thread to be cut. Accordingly the corresponding worm wheel has to be engaged with the lead screw.

For instance, if the lead screw thread has a 4 mm pitch and the number of teeth on the worm wheel is 15, then the product is 4 x 15 = 60.

Therefore, the following pitches can be cut which exactly divide the product.

Fig 2



ie. 1,1.25,1.5, 2, 2.5, 3, 3.75, 4, 5, 6, 7.5, 10, 12, 15, 20, 30 and 60.

The figure shows the metric thread chasing dial of an HMT lathe and the chart indicates the worm wheel and graduated dial plate to be chosen for cutting threads of different pitches. (Fig. 2)

LEAD SCREW 6 mm PITCH					
Threads in m/m	Driving pinion A	No. of lines on Disc B	Threads in m/m	Driving pinion A	No. of lines on Disc B
.5			3.25	39	3
.625	35	7	3.5	35	5
.75			4	36	18
.875	35	5	4.5	36	12
1			5	35	7
1.125	36	12	5.5	33	3
1.25	35	7	6		
1.375	33	3	6.5	39	3
1.5			7	35	5
1.625	39	3	8	36	9
1.75	35	5	9	36	12
2			10	35	7
2.25	36	12	11	33	3
2.5	35	7	12	36	18
2.75	33	3	13	39	3
3			14	35	5

The following are worked out examples, showing the selection of the dial and worm wheel for a given pitch in the above HMT lathe.

Example 1

TO CUT 0.625 mm PITCH

$$\text{Gear ratio} = \frac{DR}{DN} = \frac{\text{Pitch to be cut}}{\text{Pitch of lead screw}}$$

$$= \frac{0.625}{6} = \frac{5/8}{6}$$

$$= \frac{1}{8} \times \frac{5}{6} = \frac{5}{48}$$

The thread will be in unison, if the lead screw makes 5 revolutions when the job makes 48 revolutions predetermined travel.

P.D.T. = 5 x Pitch of lead screw

= 5 x 6 = 30 mm.

The product of the number of teeth on the worm wheel and the pitch of the lead screw

= 35 x 6 = 210.

A dial with 7 graduations marked is to be selected since

$$\frac{210}{PDT} = \frac{210}{30} = 7.$$

So to cut a 0.625 mm pitch, the half nut is engaged for any of the 7 graduations coinciding with the zero line.

Example 2

TO CUT A 4.5 mm PITCH

$$\text{Gear ratio} = \frac{DR}{DN} = \frac{\text{Pitch to be cut}}{\text{Pitch of lead screw}}$$

$$= \frac{4.5}{6} \text{ or } \frac{9/2}{6} = \frac{9}{2 \times 6} = \frac{9}{12} = \frac{3}{4}$$

P.D.T. = 3 x Pitch of lead screw

= 3 x 6 = 18 mm.

The product of the number of teeth on the worm wheel and the pitch of the lead screw= 36 x 6 = 216

A dial with 12 graduations marked is selected since

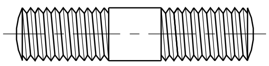
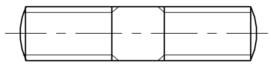
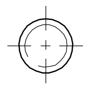
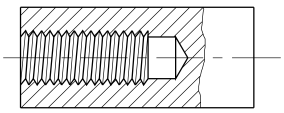
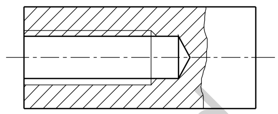
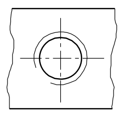
$$\frac{216}{PDT} = \frac{216}{18} = 12.$$

So to cut a 4.5 mm pitch, the half nut is engaged for any of the 12 graduations coinciding with the zero line.

Conventional chart for different profile of metric, BA, whitworth and pipe thread

Objectives : At the end of this lesson you shall be able to
- **describe the symbol for internal and external threads**
- **read the chart to find, pitch, core diameter and depth etc.**

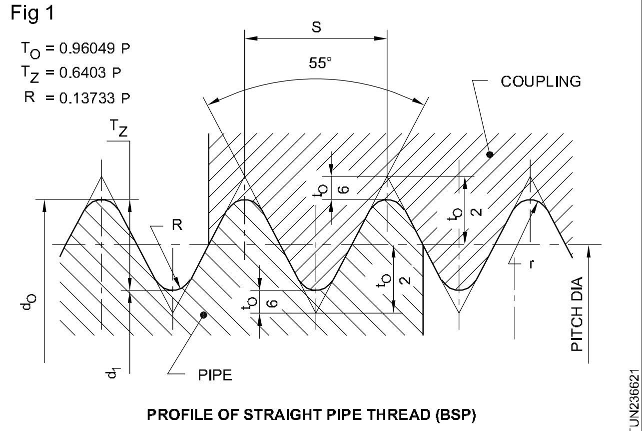
Conventional representation of threads

Title	Actual Projection/Section	Convention	Symbol
External Threads			
Internal Threads			

OD	Imperial MM	TPI	Pitch MM	Pitch Imperial Impe-rial	Core in MM	Core Dia Male imperial	Thread Dia Male MM	Thread Depth Female Imperial	Thread Depth female MM	Thread Depth MM	Hex Depth Flats MM	Head A/ MM	Tapping Depth Imperial	MM Size	Imperial
1	0.0394	102	0.0098	0.25	0.0274	0.693	0.0060	0.153	0.0053	0.135			0.0290	0.75	69
1.1	0.0433	102	0.0098	0.25	0.0312	0.793	0.0060	0.153	0.0053	0.135			0.0335	0.85	65
1.2	0.0472	002	0.0098	0.25	0.0351	0.893	0.0060	0.153	0.0053	0.135			0.0374	0.95	62
1.4	0.0551	85	0.0118	0.30	0.0407	1.032	0.0072	0.184	0.0064	0.612			0.0433	1.10	57
1.6	0.0630	73	0.0138	0.35	0.0460	1.171	0.0085	0.215	0.0074	0.189	3.2		0.0492	1.25	3/64
1.8	0.0709	73	0.0138	0.35	0.0539	1.371	0.0085	0.215	0.0074	0.189			0.0570	1.45	54
2	0.0787	64	0.0157	0.40	0.0595	1.510	0.0096	0.245	0.0085	0.217	4.00	1.5	0.0630	1.60	1/16
2.2	0.0866	56	0.0177	0.45	0.0648	1.648	0.0109	0.276	0.0096	0.244			0.689	1.75	51
2.3	0.0906	56	0.0177	0.45	0.0688	1.750	0.0109	0.276	0.0096	0.244			0.0730	1.85	49
2.5	0.0984	56	0.0177	0.45	0.0766	1.950	0.0109	0.276	0.0096	0.244			0.0810	2.05	46
2.6	0.1024	56	0.0177	0.45	0.0832	2.05	0.0109	0.276	0.0096	0.244	5.00		0.0870	2.20	44
3	0.1181	50.8	0.0197	0.50	0.0967	2.387	0.0121	0.307	0.0107	0.271	5.50	2.13	0.0984	2.50	40
3.5	0.1378	42.3	0.0236	0.60	0.1088	2.767	0.0145	0.368	0.0128	0.325			0.1142	2.90	33
4	0.1575	36.3	0.0276	0.70	0.1237	3.141	0.0169	0.429	0.0149	0.379	7.00	2.93	0.1300	3.30	30
4.5	0.1772	33.9	0.0295	0.75	0.141	3.580	0.0181	0.460	0.0160	0.406			0.1500	3.80	24
5	0.1968	31.8	0.0315	0.80	0.1582	4.019	0.0193	0.491	0.0170	0.433	8.00	3.65	0.1650	4.20	19
5.5	0.2165	28.2	0.0354	0.90	0.1705	4.331	0.0230	0.584	0.0205	0.520			0.1770	4.50	16
6	0.2362	25.4	0.0394	1.00	0.1880	4.773	0.0241	0.613	0.0213	0.541	10.00	4.15	0.1970	5.00	9
7	0.2756	25.4	0.0394	1.00	0.2274	5.773	0.0241	0.163	0.0213	0.541	11.00		0.2362	6.00	B
8	0.3150	20.3	0.0492	1.25	0.2668	6.466	0.0301	0.767	0.0267	0.677	13.00	5.65	0.2720	6.90	I
9	0.3543	20.3	0.0492	1.25	0.2939	7.466	0.0302	0.767	0.0267	0.677	13.00		0.3071	7.80	N
10	0.3937	16.9	0.0590	1.50	0.3213	8.160	0.0362	0.920	0.320	0.812	17.00	7.18	0.3346	8.50	Q
11	0.4331	16.9	0.0590	1.75	0.3878	9.852	0.0423	1.074	0.0373	0.947	19.00	8.18	0.4015	10.20	Y
12	0.4724	14.5	0.0689	1.75	0.3878	9.852	0.0423	1.074	0.0373	.947	19.00	8.18	0.4015	10.20	Y

OD	Imperial MM	TPI	Pitch Imperial MM	Pitch in Impe-rial	Core Dia MM	Core Dia Male imperial	Thread Depth Male MM	Thread Depth Female Imperial	Thread Depth female MM	Thread Depth MM	Hex A/ Flats MM	Head Depth MM	Tapping Size Imperial	MM	Imperial
14	0.5512	12.7	0.0787	2.00	0.4546	11.546	0.0483	1.227	0.0426	1.083	22.00		0.4724	12.0	15/3
16	0.6299	12.7	0.0787	2.00	0.5333	13.546	0.0483	1.227	0.0426	1.083	24.00	10.18	0.551	14.00	35/64
18	0.7087	10.2	0.0984	2.50	0.5879	14.932	0.0604	1.534	0.0533	1.353	27.00		0.6102	15.50	39/64
20	0.7874	10.2	0.0984	2.50	0.6666	16.932	0.0604	1.534	0.0533	1.353	30.00	13.22	0.6889	17.50	11/16
22	0.8661	10.2	0.0984	2.50	0.7453	18.932	0.0604	1.534	0.0533	1.353	32.00		0.7677	19.50	49/64
24	0.945	8.5	0.1181	3.00	0.8002	20.320	0.0724	1.840	0.0640	1.624	36.00	15.22	0.8267	21.00	53/64
26	1.024	8.5	0.1181	3.00	0.8792	22.32	0.0724	1.840	0.0640	1.624			0.9055	23.00	29/32
27	1.063	8.5	0.1181	3.00	0.9182	23.320	0.0724	1.840	0.0640	1.624	41.00		0.9448	24.00	15/16
28	1.102	8.5	0.1181	3.00	0.9572	24.320	0.0724	1.840	0.0640	1.624			0.9920	25.2	63/64
30	1.181	7.3	0.1378	3.50	1.0120	25.706	0.0845	2.147	0.0781	1.894	46.00	19.26	1.0430	26.50	1-3/64
32	1.299	7.3	0.1378	3.50	1.1300	28.706	0.0845	2.147	0.0781	1.894	50.00		1.1614	29.50	1-5/32
33	1.299	7.3	0.1378	3.50	1.1300	28.706	0.0845	2.147	0.0781	1.894	50.00		1.1614	29.50	1-5/32
34	1.339	7.3	0.1378	3.50	1.1700	29.71	0.0845	2.147	0.0781	1.894			1.210	30.70	1-13/64
36	1.417	6.4	0.1575	4.00	1.2238	31.093	0.0966	2.454	0.0852	2.165	55.00	23.26	1.260	32.00	1-1/4
38	1.496	6.4	0.1575	4.00	1.3028	33.092	0.0966	2.454	0.0852	2.165			1.377	35.00	1-11/32
39	1.535	6.4	0.1575	4.00	1.3418	34.093	0.0966	2.454	0.0852	2.165	60.00		1.377	35.00	1-3/8
40	1.575	6.4	0.1575	4.00	1.3818	35.100	0.0966	2.454	0.0852	2.165			1.4252	36.20	1-29/64
42	1.654	5.6	0.1772	4.50	1.4366	36.480	0.1087	2.760	0.959	2.436			1.4252	36.20	1-15/32
44	1.732	5.6	0.1772	4.50	1.5146	38.48	0.1087	2.760	0.959	2.436			1.551	39.4	1-35/64
45	1.772	5.6	0.1772	4.50	1.5546	39.480	0.1087	2.760	0.0959	2.436			1.594	40.50	1-19/32
46	1.811	5.6	0.1772	4.50	1.5936	40.48	0.1087	2.760	0.0959	2.435			1.653	42.00	1-21/32
48	1.890	5.1	0.1968	5.00	1.6486	41.866	0.1207	3.067	0.1065	2.706			1.692	43.00	1-23/32
50	1.969	5.1	0.1968	5.00	1.7276	43.870	0.1207	3.067	0.1065	2.706			1.772	45.00	1-25/32
52	2.047	5.1	0.1968	5.00	1.8056	45.866	0.1207	3.067	1.1065	2.706			1.850	47.00	1-55/64
56	2.205	4.6	0.2165	5.50	1.9394	49.252	0.1328	3.374	0.1172	2.0977			1.988	50.50	2-5/32
60	2.362	4.6	0.2165	5.50	2.0964	53.252	0.1328	3.374	0.1172	2.977			2.283	58.00	2-9/32
64	2.677	4.2	0.2362	6.00	2.3872	60.638	0.1449	3.681	0.1279	3.248			2.283	58.00	2-9/32
68	2.677	4.2	0.2362	6.00	2.3872	60.638	0.1449	3.681	0.1279	3.248			2.441	62.00	2-19/32
72	2.835	4.2	0.2362	6.00	2.5452	64.64	0.1449	3.681	0.1279	3.248			2.598	66.00	2-19/32
76	2.992	4.2	0.2362	6.00	2.7022	68.640	0.1449	3.681	0.1279	3.248			2.756	70.00	2-3/4
80	3.150	4.2	0.2362	6.00	2.8602	72.64	0.1449	3.681	0.1279	3.248			2.933	79.00	3-7/64
85	3.346	4.2	0.2362	6.00	3.0562	77.640	0.1449	3.681	0.1279	3.248			3.110	79.00	3-5/16
90	3.543	4.2	0.2362	6.00	3.2532	82.64	0.1449	3.681	0.1279	3.248			3.504	84.00	3-1/2
95	3.740	4.2	0.2362	6.00	3.4502	87.64	0.1449	3.681	0.1279	3.248			3.504	89.00	3-1/2
100	3.937	4.2	0.2362	6.00	3.6472	92.64	0.1449	3.681	0.1279	3.248			3.700	94.00	3-1/2

Fig 1



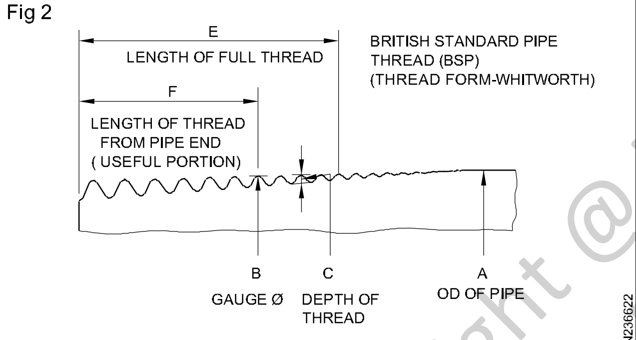
PROFILE OF STRAIGHT PIPE THREAD (BSP)

Pipe thread

The Standard table given here helps to identify the diameter of the pipes from 1/8" to 10", and corresponding outer diameter of pipes, depth of threads and threads per inch.

The table also has reference to Fig 2.

Fig 2



THREAD ON END OF PIPE

Standard Table

Size = Bore dia. of pipe	A	B	C	Threads per inch	E
in	in	in	in		in
1/8	15/32	0.383	0.0230		3/8
1/4	17/32	0.518	0.0335	19	7/16
3/8	11/16	0.656	0.0335	19	1/2
1/2	27/32	0.825	0.0455	14	5/8
3/4	1 1/16	1.041	0.0455	14	3/4
1	1 11/32	1.309	0.0580	11	7/8
1 1/4	1 11/16	1.650	0.0580	11	1
1 1/2	1 29/32	1.882	0.0580	11	1
2	2 3/8	2.347	0.0580	11	1 1/8
2 1/2	3	2.960	0.0580	11	1 1/4
3	3 1/2	3.460	0.0580	11	1 3/8
3 1/2	4	3.950	0.0580	11	1 1/2
4	4 1/2	4.450	0.0580	11	1 5/8
4 1/2	5	4.950	0.0580	11	1 5/8
5	5 1/2	5.450	0.0580	11	1 3/4
6	6 1/2	6.450	0.0580	11	2
7	7 1/2	7.450	0.0640	10	2 1/8
8	8 1/2	8.450	0.0640	10	2 1/4
9	9 1/2	9.450	0.0640	10	2 1/4
10	10 1/2	10.450	0.0640	10	2 3/8

Calculation involving gear ratio & gearing

Objectives: At the end of this lesson you shall be able to
- **calculate the core dia (minor dia) of thread**
- **state the methods of measuring core dia (minor dia) of thread.**

Calculation of minor dia of thread (metric)

If the thread designation is M12 x 1.5 how much will be minor dia of the thread

Formula minor dia = major dia - 2 depth

depth of the thread = 0.6134 x pitch of screw

2 depth of thread = 6.134 x 2 x pitch

= 1.226 x 1.5 mm

= 1.839 mm

= 8.161 mm or 8.2 mm

Minor dia (core dia) = 10mm - 1.839 mm

The measurement of the minor diameter and checking the form of the thread are important for producing accurate threads.

Checking the thread minor diameter

Use of the vernier caliper

The knife edge of a vernier caliper can be used for measuring the minor diameter - within a reasonable degree of accuracy.

Checking with the micrometer

Two methods are adopted using the micrometers

Using Vee piece/prism

In this method the minor diameter is determined by using a Vee piece/prism of known dimensions from the apex to the base. (Fig. 1 & 2)

Selection of the size of the prism is very important for accurate measurement.

The sizes of the prisms are indicated by A, B, C and D.

Fig 1

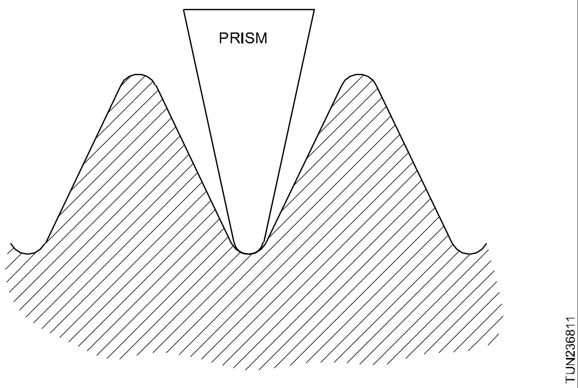


Fig 2

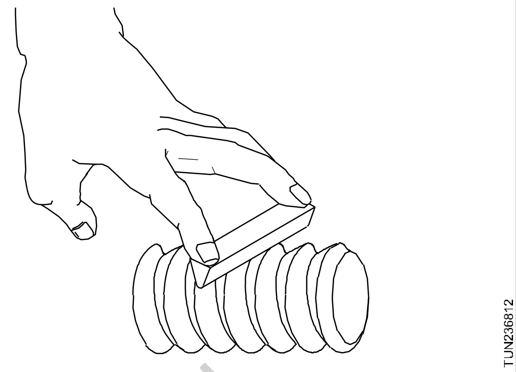


Fig 3

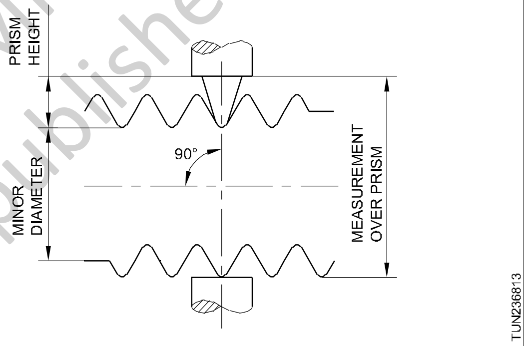


Table 1 will help in determining the correct size of the prism for the different types and pitches of the threads.

For determining the minor diameter, first measure the major diameter of the threaded piece.

Then measure by placing one prism in the thread as shown in Figure 3. It may be noted that one of the anvils of the micrometer is on the prism and the other on the major diameter of the thread.

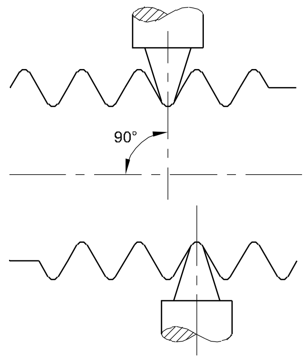
TABLE 1

Prism designat-ing size	Thread form		
	Metric pitch in mm	Unified BSW threads inch	BA No.
A	1.0-1.25	56-44	9-16
B	1.5-2.25	40-28	3-8
C	2.5-4.5	26-14	0-2
D	5.0-6.0	12-4	

Using special micrometers

A special micrometer which can accommodate specially shaped anvils is used for this. This directly measures the minor diameter. It is important to ensure that the micrometer is placed perpendicular to the axis of the thread being measured (Fig 4) for accurate measurement.

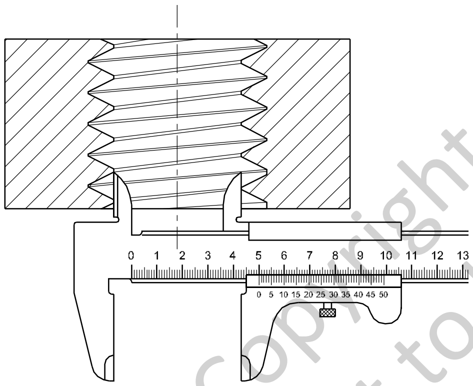
Fig 4



Measuring minor diameter of internal threads

The knife edge of a vernier caliper can be used to measure the minor diameter of an internal thread. This cannot be adopted when very accurate measurements are to be taken. (Fig 5)

Fig 5



Direct accurate measurement of internal minor diameter is a difficult task.

The commonly used methods are by using slip gauges and precision rollers (Figs6&7) and taper parallels and micrometer.

Fig 6

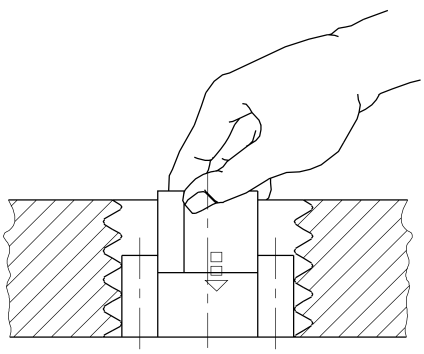


Fig 7

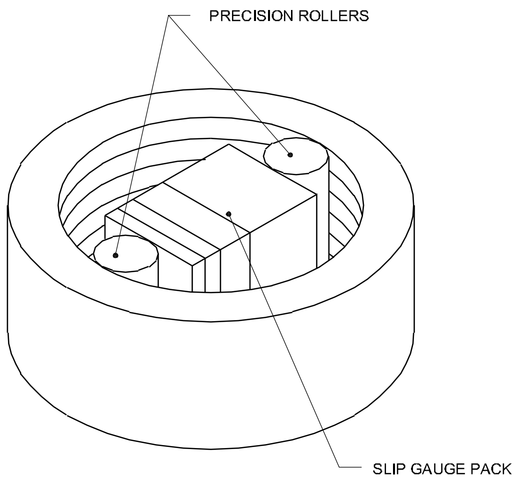
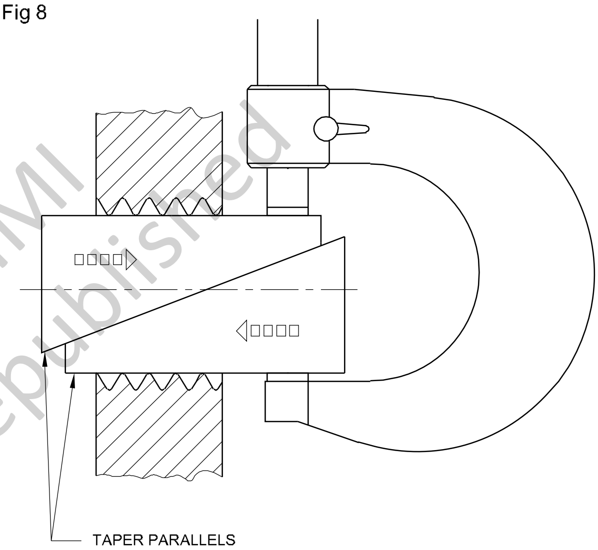


Fig 8



Using slip gauges and precision rollers

While using slip gauges and precision rollers of known diameter, the rollers are first placed diametrically opposite the bore.

Then the slip gauge pack is selected until it just slides between the rollers.

The sum of the size of the slip gauge pack and the diameters of the rollers is the minor diameter.

Using taper parallels

Precision tapered parallels can be inserted as shown in Figure 8 and the measurement can be taken using a micrometer.

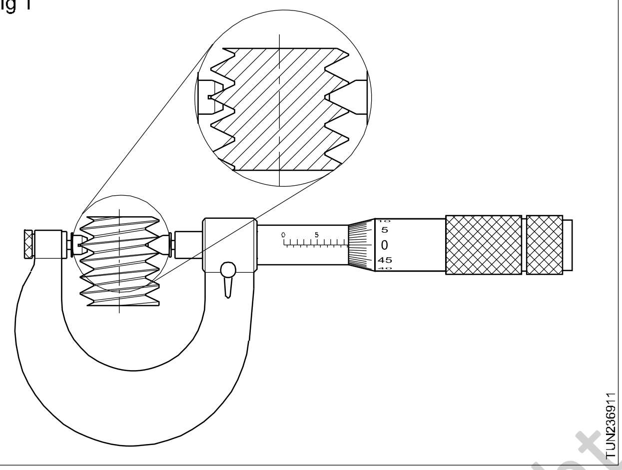
Screw thread micrometer and its uses

Objectives : At the end of this lesson you shall be able to
- **state the features of a screw thread micrometer**
- **state the features of the three-wire system of measurement with the help of tables**
- **select the best wire with the help of tables for using in the three-wire method.**

The screw thread micrometer

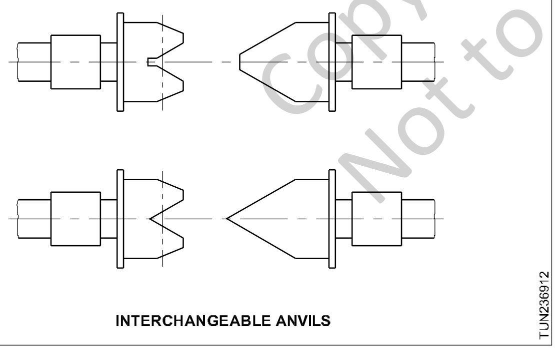
This micrometer (Fig 1) is used to measure the effective diameter of the screw threads. This is very similar to the ordinary micrometer in construction but has facilities to change the anvils.

Fig 1



The anvils are replaceable and are changed according to the profile and pitch of the different systems of threads. (Figs 2 & 3)

Fig 2



INTERCHANGEABLE ANVILS

The three-wire method

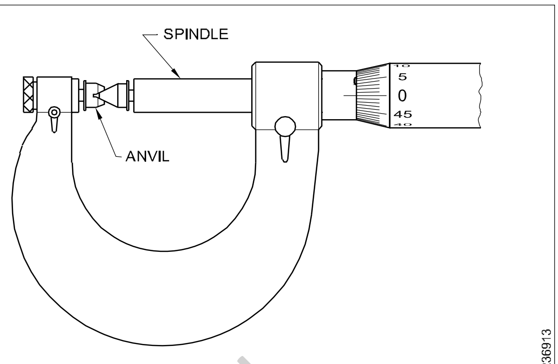
This method uses three wires of the same diameter for checking the effective diameter and the flank form. The wires are finished with a high degree of accuracy.

The size of the wires used depends on the pitch of the thread to be measured.

For measuring the effective diameter the three wires suitable for the thread pitch are placed between the threads. (Fig 4)

The measuring wires are fitted in wire-holders which are supplied in pairs. One holder has provisions to fix one wire and the other for two wires. (Fig 5)

Fig 3



SPINDLE AND ANVIL OF MICROMETER AT ZERO SETTING

Fig 4

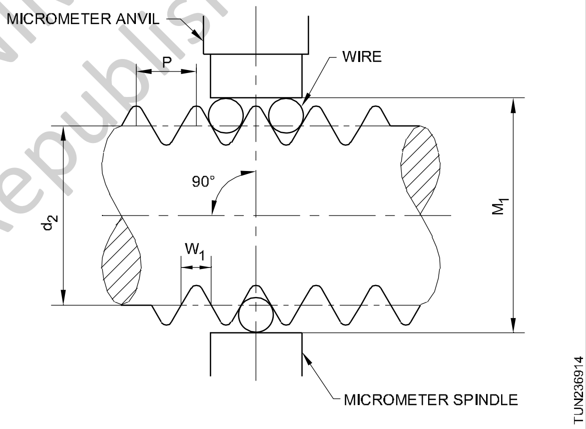
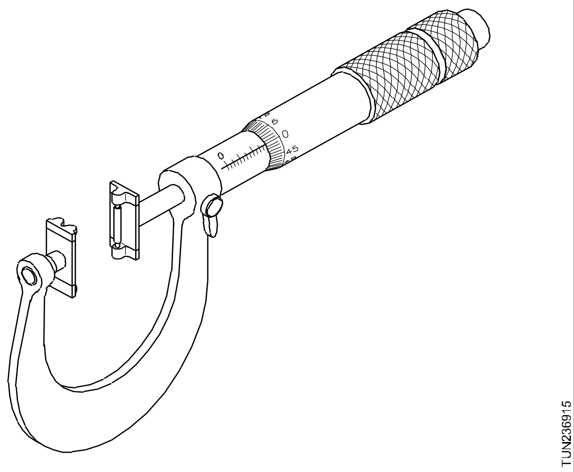


Fig 5



While measuring the screw thread, the holder with one wire is placed on the spindle of the micrometer and the other holder with two wires is fixed on the fixed anvil. (Fig.6)

Fig 6

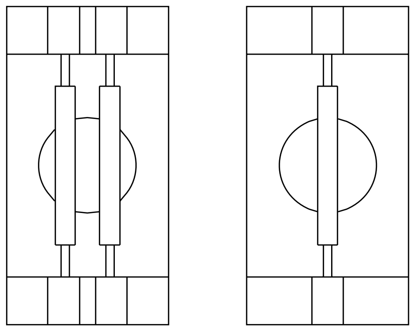


TABLE 1

Measurement with measuring wires. Metric threads with coarse pitch (M)

Thread designation	Pitch P mm	Basic measurement d_2 mm	Measuring wire dia. mean W_1 mm	Dimension over wire M_1 mm
M 1	0.25	0.838	0.15	1.072
M 1.2	0.25	1.038	0.15	1.272
M 1.4	0.3	1.205	0.17	1.456
M 1.6	0.35	1.373	0.2	1.671
M 1.8	0.35	1.573	0.2	1.870
M 2	0.4	1.740	0.22	2.055
M 2.2	0.45	1.908	0.25	2.270
M 2.5	0.45	2.208	0.25	2.569
M 3	0.5	2.675	0.3	3.143
M 3.5	0.6	3.110	0.35	3.642
M 4	0.7	3.545	0.4	4.140
M 4.5	0.75	4.013	0.45	4.715
M 5	0.8	4.480	0.45	5.139
M 6	1	5.350	0.6	6.285
M 8	1.25	7.188	0.7	8.207
M 10	1.5	9.026	0.85	10.279
M 12	1.75	10.863	1.0	12.350
M 14	2	12.701	1.15	14.421
M 16	2	14.701	1.15	16.420
M 18	2.5	16.376	1.45	18.564
M 20	2.5	18.376	1.45	20.563
M 22	2.5	20.376	1.45	22.563
M 24	3	22.051	1.75	24.706
M 27	3	25.051	1.75	27.705
M 30	3.5	27.727	2.05	30.848

Selection of 'best wire' (Fig 7)

The best wire is the one which, when placed in the thread groove, will make contact at the nearest to the effective diameter. The selection of the wire is based on the type of thread and pitch to be measured.

The selection of the wire can be calculated and determined but readymade charts are available from which the selection can be made.

Fig 7

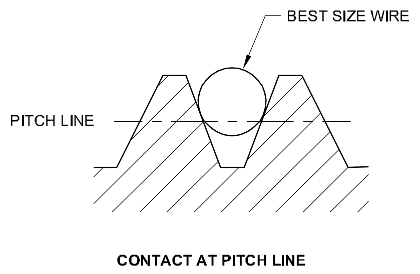


TABLE 2

Measurement with measuring wires. Metric threads with fine pitch (M)

Thread Dimension designation	Basic measurement d_2 mm	Measuring wire dia. mean W_1 mm	over wire M_1 mm
M 1 x 0.2	0.870	0.12	1.057
M 1.2 x 0.2	1.070	0.12	1.257
M 1.6 x 0.2	1.470	0.12	1.557
M 2 x 0.25	1.838	0.15	2.072
M 2.5 x 0.35	2.273	0.2	2.570
M 3 x 0.35	2.773	0.2	3.070
M 4 x 0.5	3.675	0.3	4.142
M 5 x 0.5	4.675	0.3	5.142
M 6 x 0.75	5.513	0.45	6.214
M 8 x 1	7.350	0.6	8.285
M 10 x 1.25	9.188	0.7	10.207
M 12 x 1.25	11.188	0.7	12.206
M 14 x 1.5	13.026	0.85	14.278
M 16 x 1.5	13.026	0.85	14.278
M 18 x 1.5	17.026	0.85	18.277
M 20 x 1.5	19.026	0.85	20.277
M 22 x 1.5	21.026	0.85	22.277
M 24 x 2	22.701	1.15	24.420
M 27 x 2	25.701	1.15	27.420
M 30 x 2	28.701	1.15	30.419

TABLE 3

Measurement with measuring wires. Unified fine threads (UNF)

Thread designation	Pitch mm	Basic measurement d_2 mm	Measuring wire dia. mean W_1 mm	Dimension over wire M_1 mm
Nr 0-80 UNC	0.317	1.318	0.2	1.644
Nr 0-72 UNC	0.353	6.25	0.2	1.920
Nr 2-64 UNF	0.397	1.927	0.25	2.334
Nr 3-56 UNF	0.454	2.220	0.25	2.578
Nr 4-48 UNF	0.529	2.501	0.3	2.944
Nr 5-44 UNF	0.577	2.800	0.35	3.351
Nr 6-40 UNF	0.635	3.093	0.35	3.594
Nr 8-36 UNF	0.706	3.708	0.4	4.298
Nr10-32 UNF	0.794	4.310	0.45	4.974
Nr 12-28 UNF	0.907	4.897	0.5	5.612
1/4"-28 UNF	0.907	5.761	0.5	6.477
5/16"-28 UNF	1.058	7.249	0.6	8.134
3/8"-24 UNF	1.058	8.837	0.6	9.721
1/2"-20 UNF	1.27	11.875	0.7	12.876
5/8"-18 UNF	1.411	14.958	0.85	16.287
3/4"-16 UNF	1.588	18.019	0.9	19.345
7/8"-14 UNF	1.814	21.046	1.0	22.476
1" -12 UNF	2.117	24.026	1.3	26.094

TABLE 4

Measurement with measuring wires. Unified coarse threads (UNC)

Thread designation	Pitch mm	Basic measurement d_2 mm	Measuring wire dia. mean W_1 mm	Dimensionover wire M_1 mm
Nr 1-64 UNC	0.397	1.596	0.22	1.913
Nr 2-56 UNC	0.454	2.25		2.249
Nr 3-48 UNC	0.529	2.171	0.3	2.614
Nr 4-40 UNC	0.635	2.433	0.35	2.935
Nr 5-40 UNC	0.635	2.763	0.35	2.265
Nr 6-32 UNC	0.794	2.990	0.45	3.654
Nr 8-32 UNC	0.794	3.650	0.45	4.314
Nr 10-24 UNC	1.058	4.139	0.6	5.026
Nr 12-24 UNC	1.058	4.799	0.6	5.685
1/4"-20 UNC	1.27	5.524	0.7	6.527
5/16"-18UNC	1.411	7.021	0.85	8.352
3/8"-16 UNC	1.587	8.494	0.9	9.822
1/2"-13 UNC	1.954	11.430	1.15	13.191
5/8"-11 UNC	2.309	14.376	1.3	16.279
3/4"-11 UNC	2.540	17.399	1.45	19.552
7/8"-9 UNC	2.822	20.391	1.6	22.750
1" -8 UNC	3.175	23.338	1.8	25.991
1 1/4"-7 UNC	3.629	29.393	2.05	32.403
1 1/2"-6 UNC	4.233	35.349	2.4	38.885
1 3/4"-5 UNC	5.08	41.151	3	45.755
2"–4 1/2 UNC	5.644	47.135	3.5	52.751

Calculation involving gear ratio metric thread cutting on inch lead screw lathe and vice versa

Objectives : At the end of this lesson you shall be able to
- **state the formula of the gear ratio for cutting metric thread on a British lathe**
- **state the formula of the gear ratio for cutting British thread on a metric lathe**
- **solve the problems involving cutting metric thread on British lathe and vice versa.**

Gear ratio for cutting metric thread on British lathe

The formula of the gear ratio for cutting metric thread on a metric lathe is

$$\frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead to be cut on the job}}{\text{Lead of lead screw}}$$

Now, for cutting metric thread on a British lathe, the lead of the work to be cut in mm is converted to inches by multiplying with the constant 5/127.

Because 25.4 mm = l"

1 mm = 1/25.4"

= 10/254

= 5/127"

Therefore,

Gear ratio

$$\frac{DR}{DN} = \frac{\text{Lead to be cut in mm on job x 1 x 5}}{\text{Lead of L.S. x 127}}$$

$$\frac{DR}{DN} = \frac{\text{Lead to be cut in mm x T.P.I. on L.S. x 5}}{127}$$

A translating gear of 127 teeth is provided for cutting metric thread on a British lathe. This gear wheel is used as the driven wheel. The worked out example illustrates this statement.

Gear ratio for cutting British thread on metric lathe

The general formula for cutting British thread on a British lathe is

$$\frac{DR}{DN} = \frac{\text{Lead to be cut on job}}{\text{Lead of lead screw}}$$

Now for cutting British thread on a metric lathe the lead of the screw in mm is converted into inches by multiplying with a constant of 5/127.

$$\frac{DR}{DN} = \frac{\text{Lead to be cut in inch on job}}{\text{lead of lead screw in mm x } \frac{5}{127}}$$

$$\frac{DR}{DN} = \frac{\text{Lead to be cut in inch on job x 1 x 127}}{\text{Lead of lead screw in mm x 5}}$$

$$\frac{DR}{DN} = \frac{1}{\text{T.P.I. to be cut}} \text{ x } \frac{1}{\text{Lead of lead screw}} \text{ x } \frac{127}{5}$$

As a practice, it is advisable to have a larger wheel as a driven gear as far as possible. But in this case the 127 teeth wheel has to be used as a DRIVER only.

Gear ratio for cutting metric thread on British lathe using 63 teeth as driver wheel.

Instead of taking the constant $\frac{5}{127}$

$\frac{63}{1600}$ is taken because 1 metre = 39.37".

1 metre = 39.375" (approx.)

1000 mm = 39.375" = 39 $\frac{3”}{8}$

1 mm = $\frac{315}{1000 \text{ x } 8}$

= $\frac{63}{1600}$

Gear ratio

$$\frac{DR}{DN} = \frac{\text{Lead to be cut in mm x TPI on LS x 63}}{1600}$$

Gear ratio for cutting British thread on metric lathe using the 63 teeth wheel as the driven wheel:

$$\frac{DR}{DN} = \frac{1}{\text{T.P.I. to be cut}} \text{ x } \frac{1}{\text{Lead of lead screw in mm}} \text{ x } \frac{1600}{63}$$

Lathe constant

Lathe constant is the number of threads per inch that can be cut when the change gear ratio is 1 and the ratio between the main spindle gear and the fixed stud gear is also 1.

On some machines the ratio of the spindle gear to the fixed stud gear is more than 1 in which case the lathe constant is equal to:

$$\frac{\text{spindle gear x T.P.I on lead screw}}{\text{fixed stud gear}}$$

When lathe constant is given

(Gear ratio for cutting thread) $\frac{DR}{DN} = \frac{\text{Lathe constant}}{\text{T.P.I. to be cut}}$

Find the gears required to cut 4.5 mm pitch in a lathe having a lead screw of 6 T.P.I. Gears available from 20 to 120 teeth by 5 teeth range with a conversion gear of 127 teeth.

DATA

Lead of work = 4.5 mm

T.P.I of L/s = 6 T.P.I

Lead of L/s = $\frac{1}{\text{T.P.I.}}$

Lead of L/s = $\frac{1}{6}$

Gear ratio = $\frac{DR}{DN} = \frac{5}{127} \times \frac{\text{Lead of work}}{\text{Lead of lead screw}}$

$= \frac{5}{127} \times \frac{4.5}{1/6}$

$= \frac{5 \times 6 \times 4.5}{127 \times 1}$

Now it is not possible to have a change gear train with a simple gear train. So a compound gear train is used,

i.e. $\frac{30}{127} \times \frac{4.5}{1}$

$\frac{30}{127} \times \frac{45}{10}$

$\frac{45 \times (30 \times 2)}{127 \times (10 \times 2)} = \frac{45}{127} \times \frac{60}{20}$

45 T & 60 T are drivers.

127 T & 20 T are driven.

Problems involving cutting metric threads on British lathe and vice versa

Find the gears required to cut a 3 mm pitch in a lathe having a lead screw of 6 T.P.I. Gears available from 20 to 120 teeth by 5 teeth with a special gear of 127 teeth.

DATA

Lead of work = 3 mm

T.P.I on L/s = 6 T.P.I

Lead of L/s = $\frac{1}{6}$

Gear ratio $= \frac{DR}{DN} = \frac{5 \times \text{Lead of work}}{127 \times \text{Lead of lead screw}}$

$= \frac{5}{127} \times \frac{3}{1/6}$

$= \frac{5}{127} \times \frac{3 \times 6}{1}$

$= \frac{90}{127}$

90 teeth gear is driver.

127 teeth gear is driven.

Problems involving cutting British threads on metric lathe

Find the gears required to cut 6 T.P.I on job in a lathe having a lead screw of 6 mm pitch.

Gears available from-20 T to 120 by 5 teeth range with a special gear of 127 teeth.

DATA

Lead of work = 1/6"

Lead of L/s = 6 mm

Gear ratio $= \frac{DR}{DN} = \frac{127}{5} \times \frac{\text{Lead of work}}{\text{Lead of L/s.}}$

$= \frac{127}{5} \times \frac{1/6}{6}$

$= \frac{127}{5} \times \frac{1}{6x6}$

$= \frac{127}{30} \times \frac{1}{6}$

$= \frac{127}{30} \times \frac{(1 \times 20)}{(6 \times 20)}$

$= \frac{127}{30} \times \frac{20}{120}$

127 T & 20 T are driver gears.

30 T & 120 T are driven gears.

Tool Life negative top rake

Objectives: At the end of this lesson you shall be able to
- **state the relationship between cutting speed and tool life**
- **explain tool life index equation**
- **determine the maximum cutting speed for a given tool life.**

Relationship between cutting speed and tool life

Duration of correct cutting to the anticipated surface finish between grinding is termed as tool life. In metal cutting, increase in cutting speed increases power requirement. Therefore, the mechanical energy is converted into heat energy at the cutting edge. Much of the heat is absorbed by the cutting tool with corresponding increase in temperature, resulting in softening of the cutting tool, which is the reason for inefficient cutting action. The effect of this reduction in tool life is largely present in high carbon steels. Hence, they have to be operated at lower cutting speeds.

Cutting materials such as high speed steel, metallic carbides and oxides can operate at much higher temperatures without reduction in hardness.

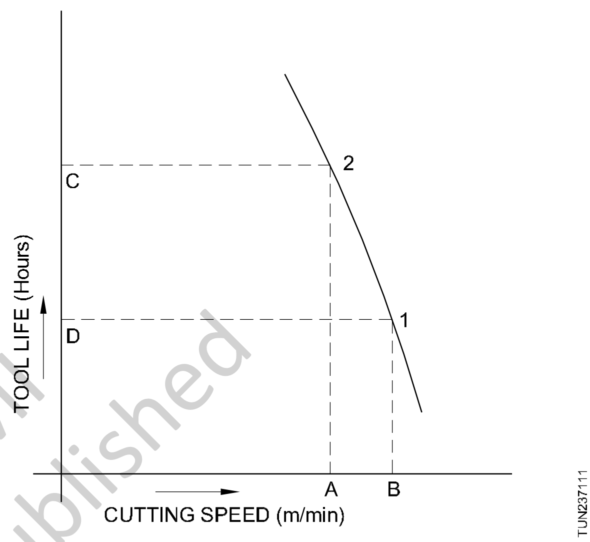
Fig 1 shows graphically the relationship between cutting speed and tool life curve in logarithmic form. A small increase in cutting speed from A to B causes large reduction in tool life from C to D, while small reduction in cutting speed causes a large increase in tool life.

Thus when the machine gearbox does not give the required cutting speed, it is better to use the next lower speed rather than the higher speed.

Tool life index

The relationship between tool life and cutting speed can be represented by the following equation for most practical purposes.

Fig 1



$Vt^n = C$

where V = cutting speed in m/min.

t = tool life in minutes

n and C are constants for a given set of conditions.

The value of n lies between 0.1 to 0.2 and typical values are given in the following table.

Table

Tool life index

Material and conditions	Tool material	n
3 1/2% nickel steel	Cemented carbide	0.2
3 1/2% nickel steel (roughing)	Highspeed steel	0.14
3 1/2% nickel steel (finishing)	Highspeed steel	0.125
High carbon, high chromium die steel	Cemented carbide	0.15
High carbon steel	Highspeed steel	0.2
Medium carbon steel	High-peed steel	0.15
Mild steel	Highspeed steel	0.125
Cast iron	Cemented carbide	0.1

The following example is shown to determine the maximum cutting speed for a given tool LIFE.

Example

The life of a lathe tool is 8 hours when operating at a cutting speed of 40 m/min. Given that $Vt^n = C$, find the highest cutting speed that will give a tool life of 16 hours. The value of n is 0.125.

(i) Determine the value of Log C from initial conditions.

$C = Vt_1^n$ where

$V = 40$ m/min.

$t^1 = 480$ min.

$n = 0.125$

Log C = Log V + n Log t1

= log40 + (0.125 Log480)

=1.6021 + (0.125 x 2.681)

=1.6021 + 0.3351

=1.9372

(ii) Determine Vmax for revised conditions

$$V_{max} = \frac{C}{t_2^n}$$

Where t_2 = 960 min.

Log Vmax = Log C – n Log t_2

= 1.9372 – (0.125 x log960)

= 1.9372 – (0.125 x 2.9823)

= 1.9372 – 0.3728

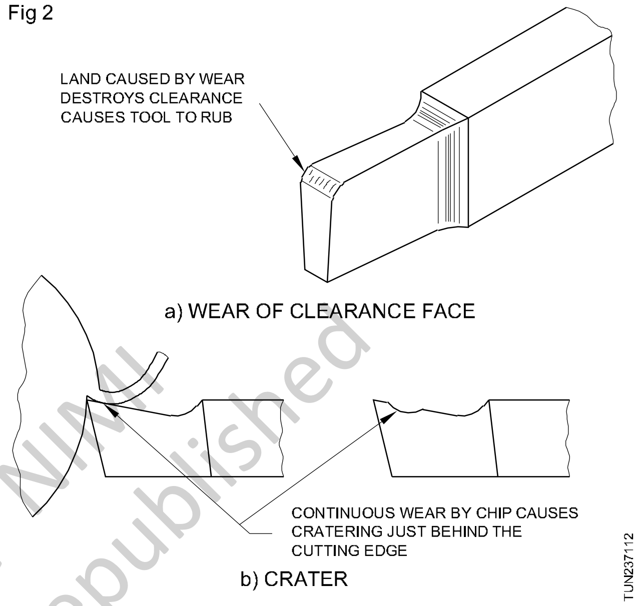
= 1.5644

Vmax = 36.68 m/min.

From the calculations, tool life is doubled by reduction of cutting speed by 8.3 percent, or reduction of tool life can be calculated for an increase of 8.3 percent in cutting speed. Hence, it is always important to select a lower cutting speed, rather than a higher cutting speed, if the machine controls do not give optimum value.

Tool life calculations are useful in achieving optimum operating conditions of cutting tools. Modern cutting tool materials are singularly resistant to softening under the heat of normal cutting and usually fail in two ways as shown in Fig 2.

Fig 2



a) Wear of clearance face

b) Crater of rake face

The above conditions can be corrected only by regrinding immediately for effective metal cutting.

Calculation involving tooth thickness, core dia, depth of cut of square thread

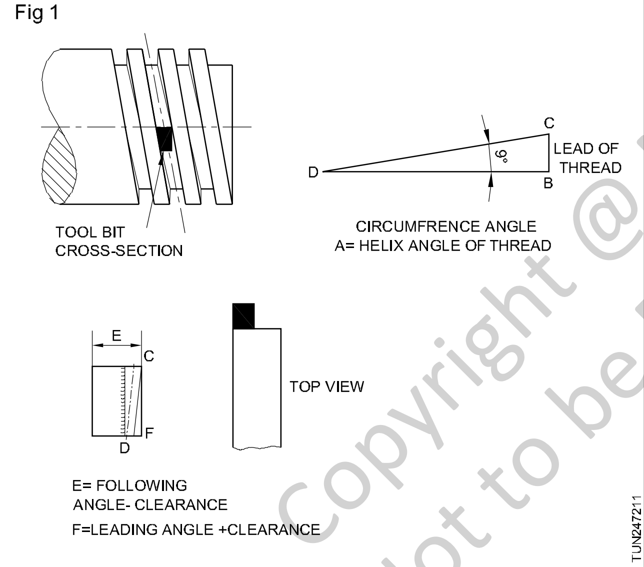
Objectives : At the end of this lesson you shall be able to
- **calculate the heleix angles of square tool**
- **brief the clearance angle in squrae threading tool**
- **read a standard thread chart.**

Square threads were often found in vise screws, jacks, and other devices where maximum power transmission was required. Because of the difficulty of cutting this thread with taps and dies, it is being replaced by Acme thread. With care, square threads can be readily cut on a lathe.

The shape of a square threading tool

The square threading tool looks like a short cutting - off tool. It differs from it in that both sides of the square threading tool must be ground at an angle to conform to the helix angle of the thread (Fig.1)

Fig 1



The helix angle of a thread, and therefore the angle of the square threading tool, depends on two factors:

1 The helix angle changes for each different lead on a given diameter. The greater the lead of the thread, the greater will be the helix angle.

2 The helix angle changes for each different diameter of thread for a given lead. The larger the diameter, the smaller will be the helix angle.

The helix angle of either the leading or following side of a square thread can be represented by a right-angle triangle (Fig. 1). The side opposite equals the lead of the thread, and the side adjacent equals the circumference of either the major or minor diameter of the thread. The angle between the hypotenuse and the side adjacent represent the helix angle of the thread.

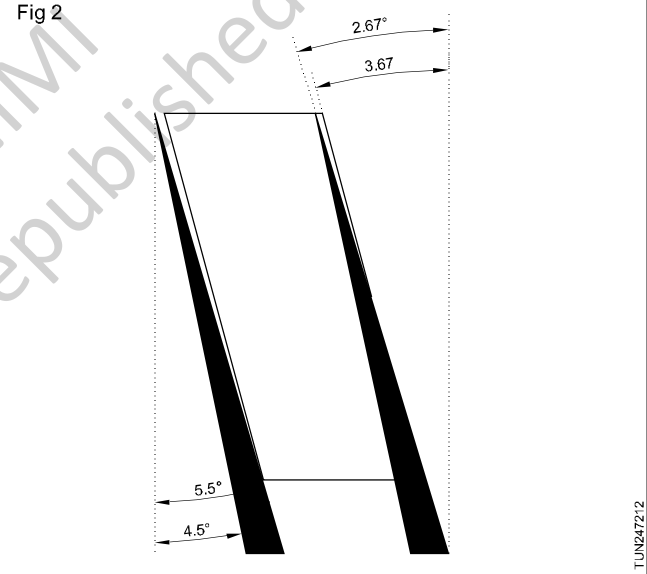
To calculate the helix angles of the leading and following sides of a square thread

$$\text{Tan loading angle} = \frac{\text{lead of thread}}{\text{circumference of minor diameter}}$$

$$\text{Tan following angle} = \frac{\text{lead of thread}}{\text{circumference of major diameter}}$$

Clearance

Fig 2



If a square tool bit is ground to the same helix angles as the leading and following sides of the thread, it would have no clearance and the sides would rub. To prevent the tool the tool from rubbing, it must be provided with approximately 1° clearance on each side, making it thinner at the bottom (Fig. 2). For the leading side of the tool, add 1° to the calculated helix angle. On the following side, subtract 1° from the calculated angle.

Example

To find the leading and following angles of a threading tool to cut a 11/4 in - square thread.

Solution

To cut a square thread

- Grind a threading tool to the proper leading and following angles. The width of the tool should be approximately 0.002 in. (0.05mm) wider than the thread groove. This will allow the completed screw to fit the nut readily. Depending on the size of the thread, it may be wise to grind two tools; a roughing tool 0.015in. (0.38mm) undersize, and a finishing tool 0.002 in. (0.05mm) oversize.

$\text{Lead} = 0.250 \text{ in}$

$\text{single depth} = \dfrac{0.500}{4}$

$= 0.125 \text{ in}$

$\text{Double depth} = 2\text{x}0.125$

$= 0.250 \text{ in}$

$\text{Minor diameter} = 1.250 - 0.250$

$= 1.000 \text{ in}$

$\text{Tan leading angle} = \dfrac{\text{lead}}{\text{minor dia. circumference}}$

$= \dfrac{0.250}{1.000 \text{ x } \pi}$

$= \dfrac{0.250}{3.1416} = 0.0795 \text{ in.}$

$\therefore$ the angle of the thread $= 4^{o}33'$

The toolbit angle $= 4^{o}33'$ plus 1^{o} clearance

$= 5^{o}33'$

$\text{Tan following angle} = \dfrac{\text{lead}}{\text{major dia. circumference}}$

$= \dfrac{0.250}{1.250\pi} = \dfrac{0.250}{3.927} = 0.0636 \text{ in}$

$\therefore$ the angle of the thread $= 3^{o}38'$

The toolbit angle $= 3^{o}38' - 1^{o}$ clearance

$= 2^{o}38'$

- Align the lathe centers and mount the work.
- Set the quick change gearbox for the required number of tpi.
- Set the compound rest at 30º to the right. This will provide side movement if it becomes necessary to reset the cutting tool.
- Set the threading tool square tool square with the work and on center.
- Cut the right - hand end of the work to the minor diameter for approximately 1/16 in. (1.58mm) long. This will indicate when the thread is cut to the full depth.
- If the work permits, cut a recess at the end of the thread to the minor diameter. This will provide room for the cutting tool to "run out" at the end of the thread.
- Calculate the single depth of the thread as

$$\frac{(0.500)}{N}$$

- Start the lathe and just touch the tool to the work diameter.
- Set the cross feed graduated collar to zero (0)
- Set a 0.003 - in. (0.08mm) depth of cut with the cross feed screw and take a trial cut.
- Check the thread with a thread pitch gage.
- Apply cutting fluid and cut the thread to depth, moving the crossfeed in from 0.002 to 0.010 in. (0.05 to 0.25mm) for each cut. The depth of the cut will depend on the thread size and the nature of the workpiece.

Since the thread sides are square, all cuts must be set using the crossfeed screw.

Standard threads

Standards of threads describe pitch core diameter and major diameter. The standard threads can be cut in standard machine tools with standard cutters and designer can use them for calculation of sizes and ensure interchangeability. We will see in illustrated examples how the standards are used by designer. Presently we describe Indian standard IS 4694-1968 for square threads in which a thread is identified by its nominal diameter which

Table 1 : Basic Dimensions of Square Thread, (mm)

Pitch, p		5		
Core Dia. d1	17	19	24	23
Major Dia. d	22	24	29	28
Pitch, p		6		
Core dia. d1	24	26	28	30
Major dia. d	30	32	34	36
Pitch p 7				
Core dia. d1	31	33	35	37
Major dia. d	38	40	42	44
Pitch, p		8		
Core dia. d1	38	40	42	44
Major dia. d	46	48	50	56
Pitch, p		9		
Core dia. d1,	46	49	51	53
Major dia. d	55	58	60	62
Pitch, p		10		
Core dia. d1	55 58	60 62	65 68	70 72
Major dia. d	65 68	70 72	75 78	80 82

is also the major diameter. According to standard the major diameter of nut is 0.5 mm greater then major diameter of the screw which will provide a clearance of 0.25 mm between the outer surface of screw and inner surface of nut thread. The basic dimensions of square threads are described in Table 1.

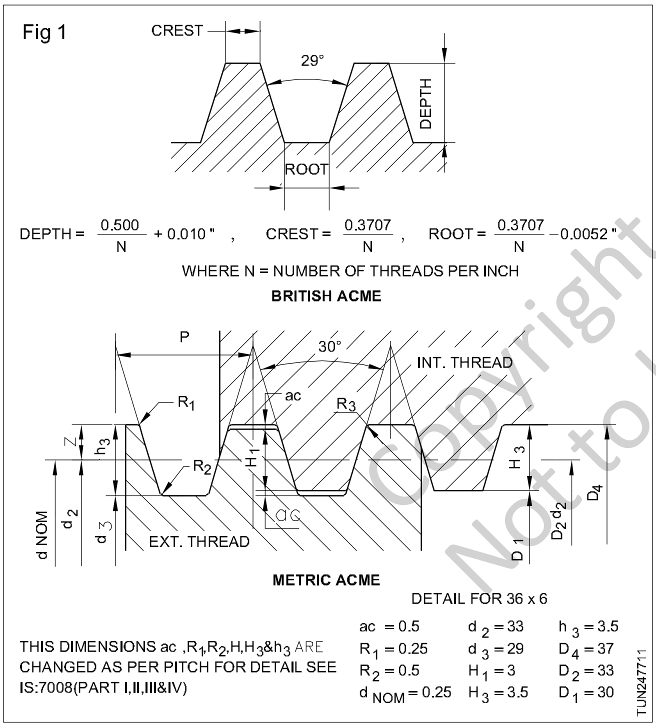
Calculation involves - depth,core dia, Pitch proportion etc of ACME thread & Buttress thread

Objectives : At the end of this lesson you shall be able to
- **claculation of ACME thread angle**
- **brief the clearance angle in threading tool**
- **read a standard thread chart.**

ACME Thread

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.

Acme thread (Fig 1)



Detail For 36X6

This dimensions ac, R1, R2, H, H3 & h3 are changed as per pitch for detail see I.S 7008 (Part I,II, III pic)

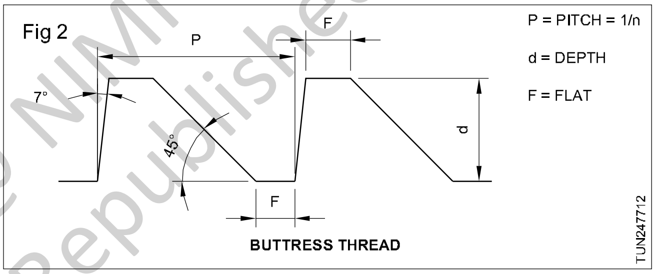
ac = 0.5 d_2 = 33 h_3 = 3.5

R_1 = 0.25 d_3 = 29 D_4 = 37

R_2 = 0.5 H_1 = 3 D_2 = 33

dNom = 0.25 H_3 = 3.5 D_1 = 30

Buttress thread (Fig 2)



The flanks have different angles.One of the flanks have an angle of 7º with respect to a line perpendicular to the axis. This flank can take heavy loads and is called the "pressure flank" of the thread. The other flank has an angle of 45º.

They are used where great pressures are to be applied in one direction only.

They are not used for translation motions.

Threads of buttress form

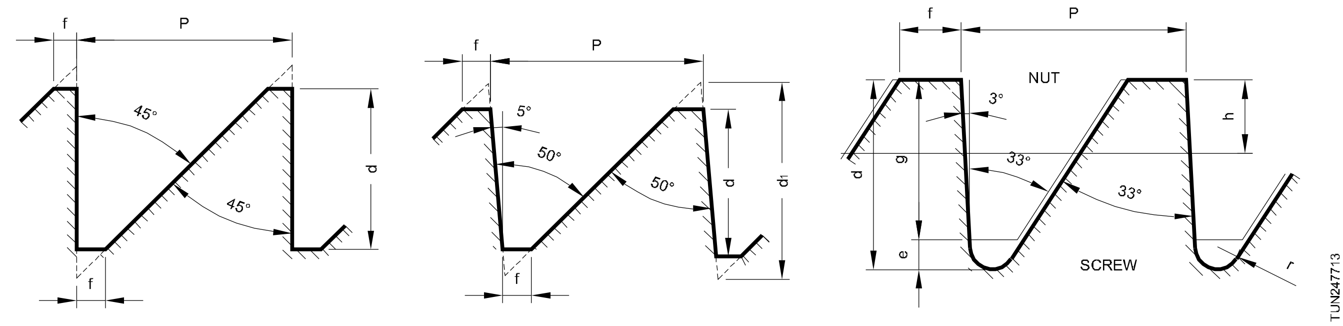
The buttress form of thread has certain advantages in applications involving exceptionally high stresses along the thread axis in one direction only. The contacting flank of the thread, which takes the thrust, is referred to as the pressure flank and is so nearly perpenticular to the thread axis that the radial component of the thrust is reduced to a minimum. Because of the small radial thrust, this form of thread is particularly applicable where tubular members are screwed together, as in the case of breech mechanisms of larger guns and airplane propeller hubs.

Fig. 1a shows a common form. The front or load-resisting face is perpendicular to the axis of the screw and the thread angle is 45 degrees. According to one rule, the pitch P=2 x screw diameter ÷ 15. The thread depth d may equal 3/4 x pitch, making the flat f=1/8 x pitch. Sometimes depth d is reduced to 2/3 x pitch, making f=1/6 x pitch.

The load - resisting side or flank may be inclined an amount ranging usually from 1 to 5 degrees to avoid cutter interference in milling the thread. With an angle of 5 degrees and an included thread angle of 50 degrees, if the width of the flat f at both crest and root equals 1/8 x pitch, then the thread depth equals 0.69 x pitch or 3/4 d_1.

The saw - tooth form of thread illustrated by Fig. 1c is known in Germany as the "Sagengewinde" and in Italy as the "Fillettatura a dente di Sega. "Pitches are standardized from 2 millimeters up to 48 millimeters in the german and Italian specifications. The front face inclines 3 degrees from the perpendicular and the included angle is 33 degrees.

Fig 3



The thread depth d for the screw =0.86777 x pitch P. The thread depth g for the nut=0.75 x pitch. Dimension h=0.341 x P. The width of flat at the crest of the thread on the screw =0.26384 x pitch. Radius r at the root = 0.12427 x pitch. The clearance space e=0.11777 x pitch.

British Standard Buttress Threads BS 1657:1950 - Specificiations for buttress threads in this standard are similar to those in the American Standard except: 1) A basic depth of thread of 0.4p is used instead of 0.6p; 2) Sizes below 1 inch are not included; 3) Tolerances on

Table 1 Dimensions of basic profile

All dimensions in millimeters

Pitch P	**H**	**H/2**	**H1**	**w**
	1.587 8 P	**0.793 9**	**0.75 P**	**0.263 84 P**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
2	3.175 6	1.587 8	1.50	0.527 68
3	4.763 4	2.381 7	2.25	0.791 52
4	6.351 2	3.175 6	3.00	1.055 36
5	7.939 0	3.969 5	3.75	1.319 20
6	9.526 8	4.763 4	4.50	1.583 04
7	11.114 6	5.557 3	5.25	1.846 880
8	12.7024	6.351 2	6.00	2.110 72
9	14.290 2	7.145 1	6.75	2.374 56
10	15.878 0	7.939 0	7.50	2.638 40
12	19.053 6	9.526 8	9.00	3.166 08
14	22.229 2	11.114 6	10.50	3.693 76
16	26.404 8	12.702 4	12.00	4.221 44
18	28.580 4	14.290 2	13.50	4.749 12
20	31.756 0	15.878 0	15.00	5.276 80
22	34.931 6	17.465 8	16.50	5.804 48
24	38.107 2	19.053 6	18.00	6.332 16
28	44.458 4	22.229 2	21.00	7.387 52
32	50.809 6	25.404 8	24.00	8.442 88
36	57.160 8	28.580 4	27.00	9.498 24
40	63.512 0	31.756 0	30.00	10.553 60
44	69.863 2	34.931 6	33.00	11.608 96

major and minor diameters are the smae as the pitch diameter tolerances, whereas in the American Standard separate tolerances are provided; how ever, provision is made for smaller major and minor diameter tolerances when crest surfaces of screws or nuts are used as datum surfaces, or when the resulting reduction in depth of engagement must be limited; and 4) Certain combinations of large diameters with fine pitches are provided that are not encouraged in the American Standard.

Lowenherz or lowenherz thread

The lowenherz thread is intended for the fine screws of instruments and is based on the metric system. The lowenherz thread has flats at the top and bottom the same as the U.S. standard buttress form, but the angle is 53 degrees 8 minutes. The depth equals 0.75 x the pitch, and the width of the flats at the top and bottom is equal to 0.125 x the pitch. The screw thread used for measuring instruments, optical apparatus, etc., especially in Germany.

The minor diameter clearance and the clearance between the non-stressed thread flank and the fundamental deviations of the pitch diameter of the stressed thread flank are related to these basic sizes.

Nominal profiles

The nominal profiles to which the deviations and tolerances are related have specified clearances on the minor diameter and between the non-load bearing thread flanks, relative to the basic profile.

The numerical threads data associated with the nominal profile is given in Table 2.

Table 2 Basic numerical threads data for nominal profile

All dimensions in millimeters

Pitch P (1)	a_e 0.117 77 P (2)	a $0.1\sqrt{P}$ (3)	e 0.263 84 P- $0.1\sqrt{P}$ (4)	h3 0.867 77 P (5)	R 0.124 27 (6)
2	0.236	0.141 4	0.386	1.736	0.249
3	0.353	0.173 2	0.618	2.603	0.373
4	0.471	0.2	0.855	3.471	0.497
5	0.589	0.223 6	1.096	4.339	0.621
6	0.707	0.244 9	1.338	5.207	0.746
7	0.824	0.264 6	1.582	6.074	0.870
8	0.942	0.282 8	1.828	6.942	0.994
9	1.060	0.3	2.075	7.810	1.118
10	1.178	0.316 2	2.322	8.678	1.243
12	1.413	0.346 4	2.820	10.413	1.491
14	1.649	0.374 2	3.320	12.149	1.740
16	1.884	0.4	3.821	13.884	1.988
18	2.120	0.424 3	4.325	15.620	2.237
20	2.355	0.447 2	4.830	17.355	2.485
22	2.591	0.469 0	5.335	19.091	2.734
24	2.826	0.489 9	5.842	20.826	2.982
28	3.298	0.529 2	6.858	24.298	3.480
32	3.769	0.565 7	7.877	27.769	3.977
36	4.240	0.6	8.898	31.240	4.474
40	4.711	0.632 5	9.921	34.711	4.971
44	5.182	0.663 3	10.946	38.182	5.468

Profiles of threads with clearance on the flank

The formulae associated with the dimensions indicated in Fig. 2 and Fig. 3 are given below:

H_1=0.75P

h_3=H_1+a_c=0.867 77 P

$a = 0.1\sqrt{P}$ (axial play)

a_c=0.117 77P

w=0.263 84 P

$$e = 0.263\,84\,P - 0.1\sqrt{P} = w - a$$

R=0.124 27P

D_1=d-2H1 = d-1.5P

d_3=d-2h3

d_2=d-0.75P

d_1=d-0.75P +3.175 8a

The profiles for external and internal threads with clearance on the non-load bearing flank on the minor diameter but with no clearance between the load bearing flanks or on the major diameter (nominal size) is indicated in Fig.2.

The profile for external and internal threads with clearances on the minor diameter and on the flank (standard nut system) but with no clearance on the major diameter is indicated in Fig. 3.

S=0.314 9 A_o

Where

A_o=fundamental deviation (upper deviation) for external thread on the pitch diameter.

Profile for multiple -start threads

The profile for multiple start threads is given in Fig. 4.

P_h=lead (axial advance at one turn), and

P=pitch (axial distance between two neighboring flanks being in the same direction).

Multiple start (n-start) threads have the same profile as single start threads with lead P_h=pitch P. For the pitch P of multiple start threads, only the values permitted for the lead P (which is equal to pitch P) of single start threads may be selected. However, the multiple of the pitch P of multiple start threads need not correspond to the value permitted for single start threads.

Fig 4

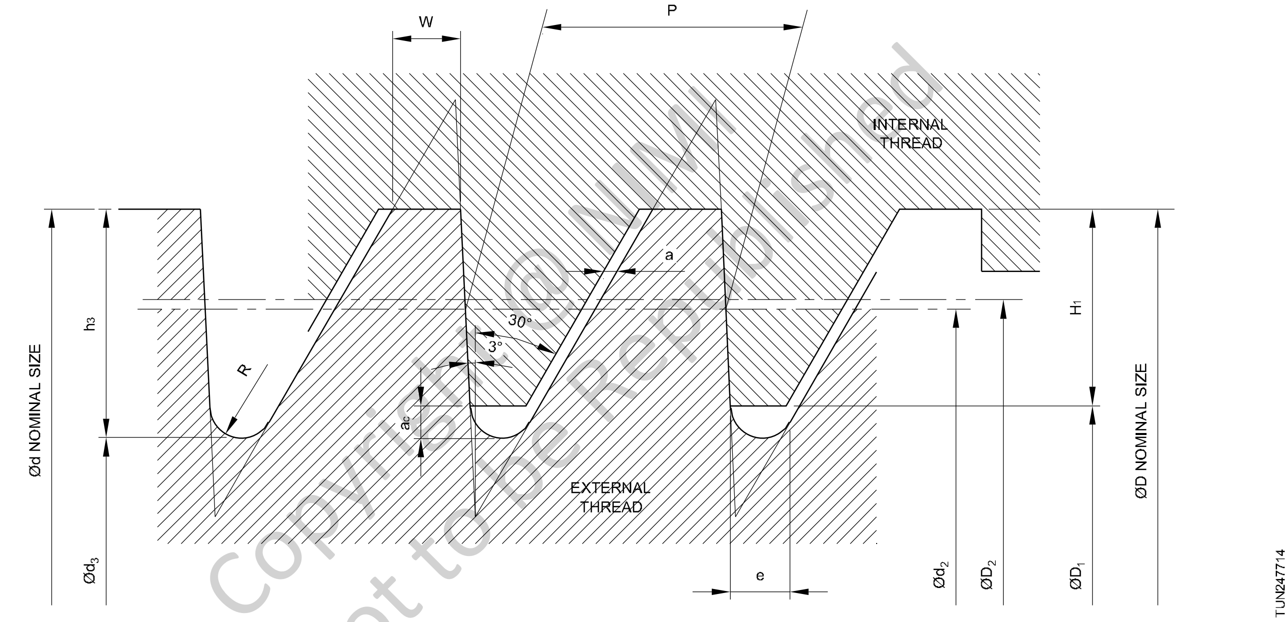


Fig 5

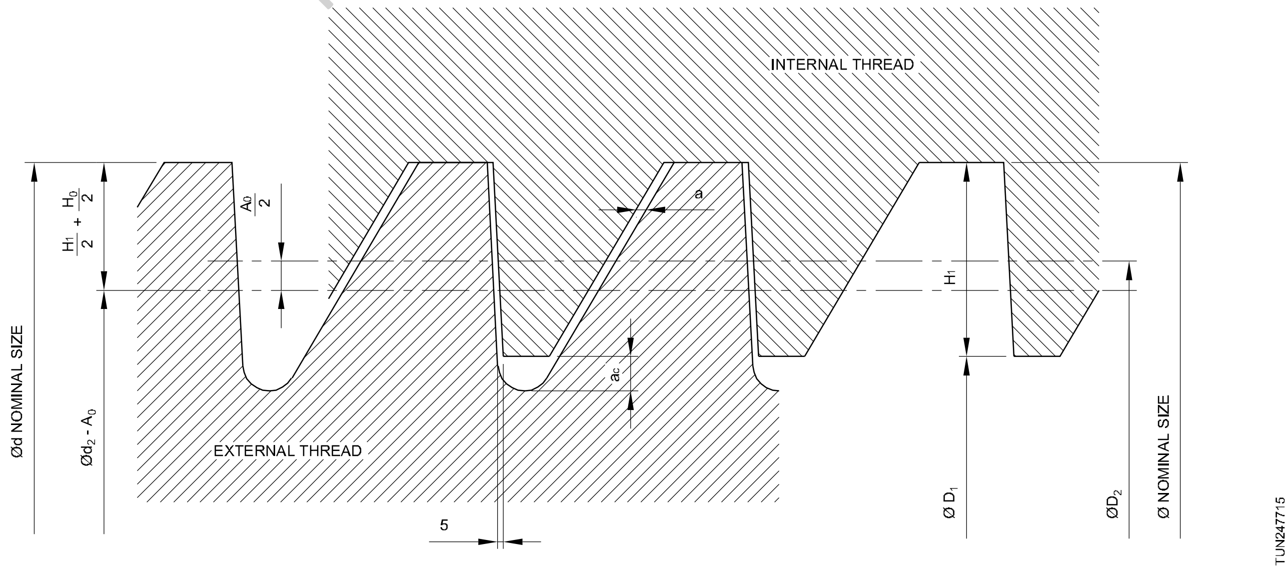
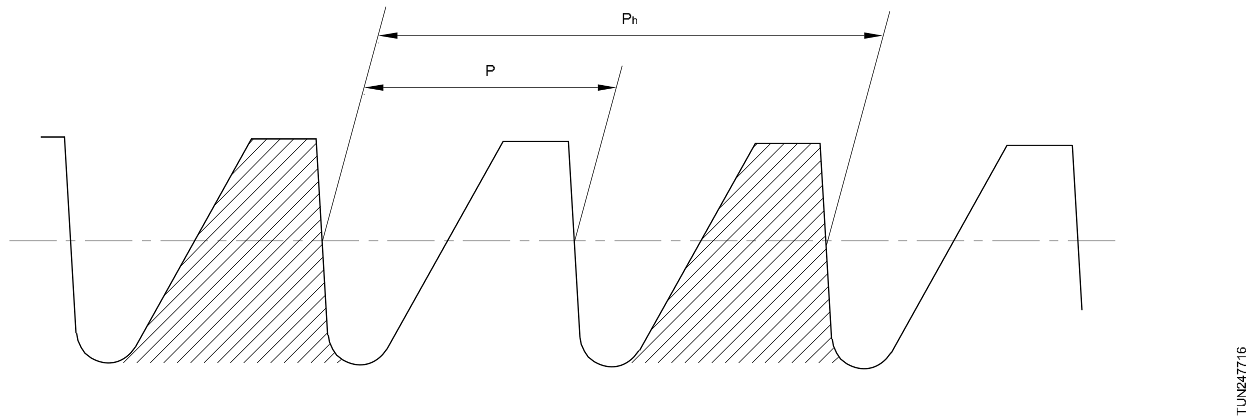


Fig 6

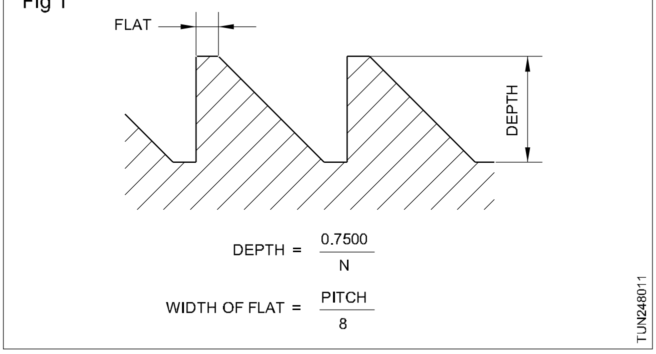


Buttress thread cutting (male & female) & tool grinding

Objectives : At the end of this lesson you shall be able to
- **grind buttress threading tool**
- **list the advantages of butters thread**
- **brief the thread proportion.**

Buttress thread (Fig 1)

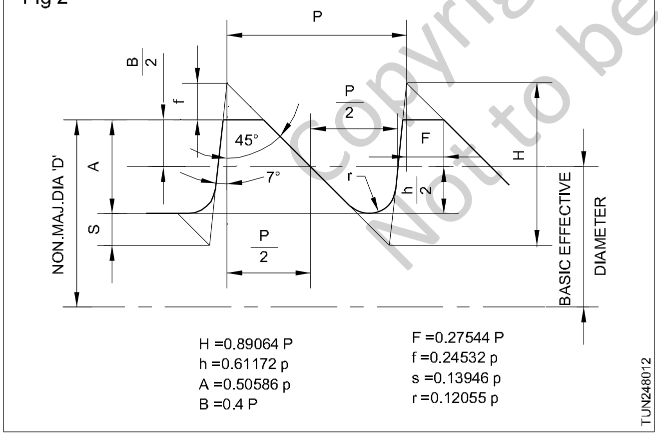
Fig 1



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 1 shows the various elements of a buttress thread. These threads are used in power press, carpentry vices, gun breeches, ratchets etc.

Buttress thread as per B.I.S. (Fig 2)

Fig 2

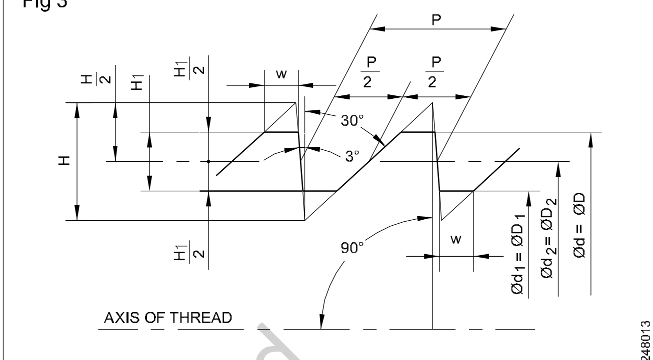


This is a modified form of the buttress thread. Figure 2 shows the various elements of the buttress thread. The bearing flank is inclined by 7° as per B.I.S. and the other flank has a 45° inclination.

Saw-tooth thread as per B.I.S. 4696

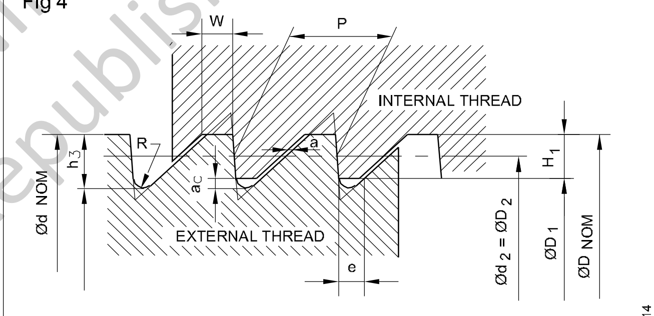
This is a modified form of buttress thread. In this thread, the flank taking the load is inclined at an angle of 3°, whereas the other flank is inclined at 30°. The basic profile of the thread illustrates this phenomenon. (Fig 3) The proportionate values of the dimensions with respect to the pitch are shown in Figs 4 and 5.

Fig 3



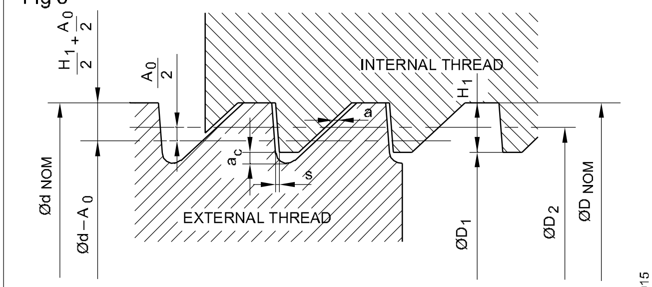
BASIC PROFILE FOR SAW TOOTH THREADS

Fig 4



DESIGN PROFILE FOR THREADS WITH CLEARANCE ON NON-BEARING FLANKS

Fig 5



DESIGN PROFILE FOR THREADS WITH CLEARANCE ON BEARING AND NON-BEARING FLANKS

The equations associated with the dimensions indicated in the two figures (Figs 5 and 6) are given below.

$H_1 = 0.75$ P

$h_3 = H_1 + a_c = 0.867\ 77$ P

a = 0.1 Ö P (axial play)

$a_c = 0.117\ 77$ P

W = 0.263 84 P

e = 0.263 84 P - 0.1 Ö P = W - a

R = 0.124 27 P

$D_1 = d - 2 H_1 = d - 1.5 P$

$d_3 = d - 2 h_3$

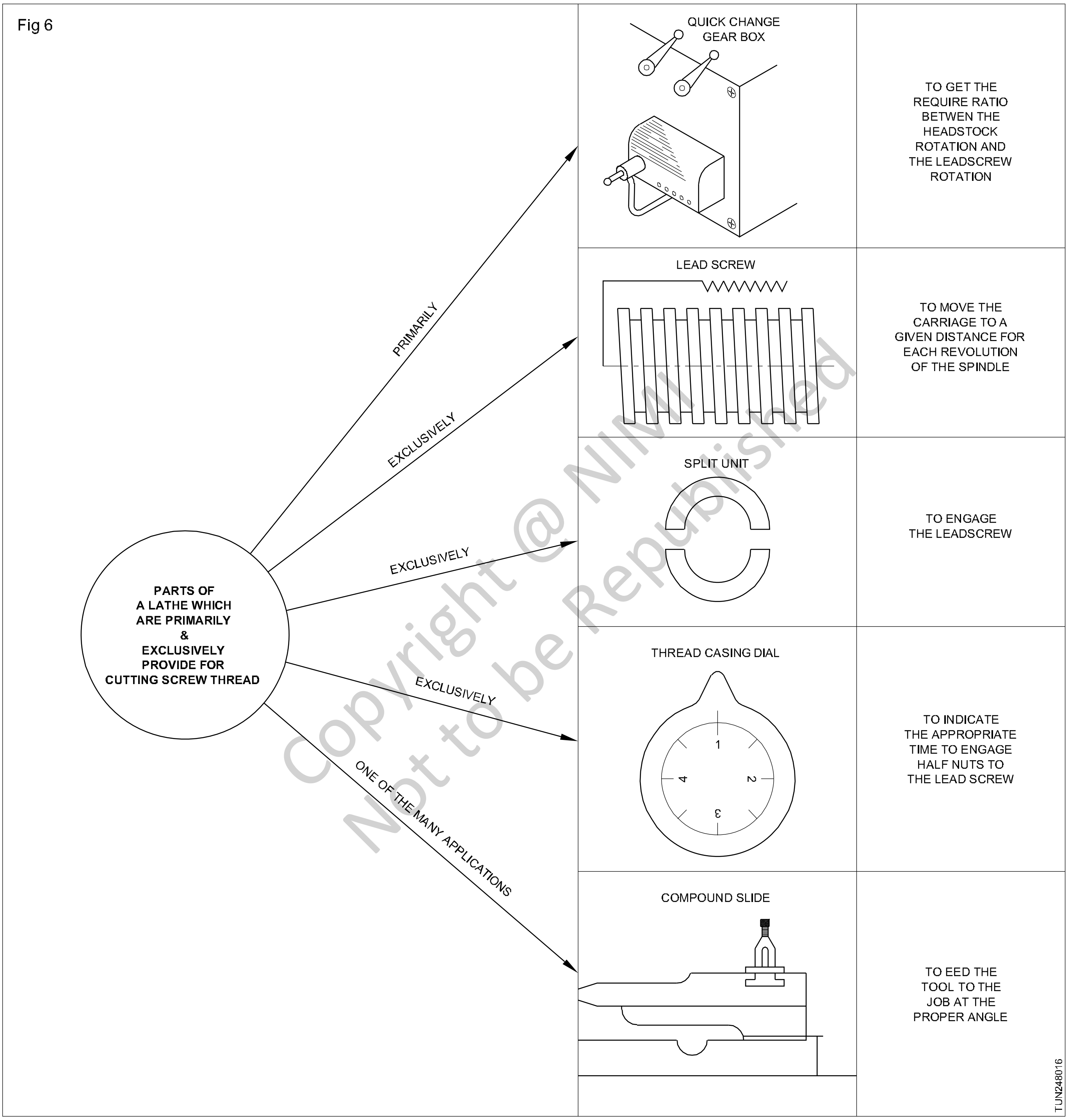
$d_2 = D_2 = d - 0.75 P$

S = 0.314 99 A_o, where A_o = basic deviation (= upper deviation) for external thread in the pitch diameter.

Diagram of CNC machine indicating thread cutting sequences

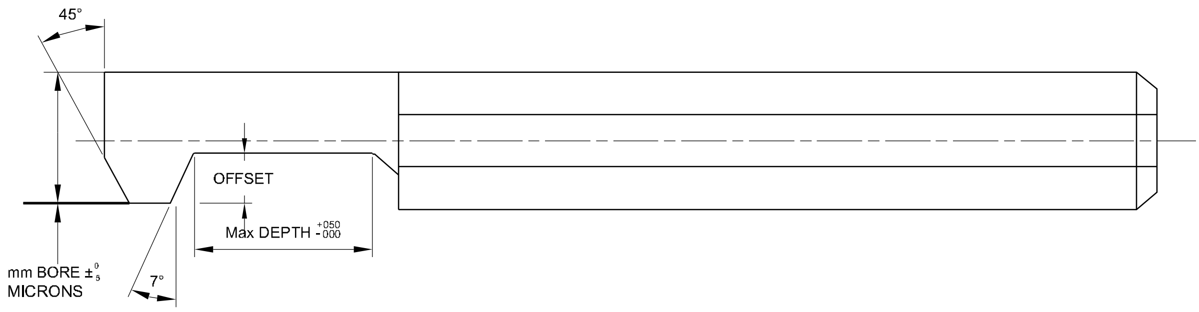
The sequence of thread cuttinng in CNC is explained in below

Fig 6



Internal Threading

Fig 1



BUTTRESS THREADING TOOL (FEMALE)

Buttress internal thread cutting is more demanding their external threading, due to threaded need to evacuate chips effectively. Chip evacuations especially in blind hole, os helped by used left hand tools for R.H. thread and vice versa (pull - threading) boring bar section has a strong influance on the quality of internal threading. Three types of bar can be used for internal threading.

Boring type	Max. overhang
Steel	2-3 x dW
Steel dampered	5 x dW
Carbide	5-7 x dW

dW = Borind bare dia

External threading can be produced in number of ways. The spindle can rotate clock wose or anticlock wise, with the tool fed towards or away from the chuck. The thread turining tool can be used in normal or upside down position (The later heeps in removal of clips). The internal and external thread cutting are indicated in the following sketches.

Important elements in tool grinding is the provision of flank clearance and radial clearance for precise and accurate threading.

Flank clearance

The cutting edge clearance between the sides of the inserts and thread flank a figure indicating side clearance and flank clearance is shown in the sketch.

Butters thread is designed to handle externally high axial thread in one direction. The lead bearing thread face is perpendicular to screw axis.

Buttress thread often used in the construction of artilary particularly with screw type breech block. They are also used in vices and in the form of pipe thread in oil fixed tubring. This thread gives a tight hydraulic seal.

Fig 3

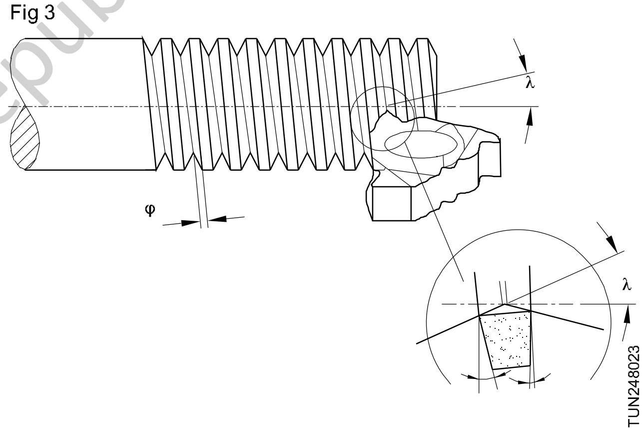
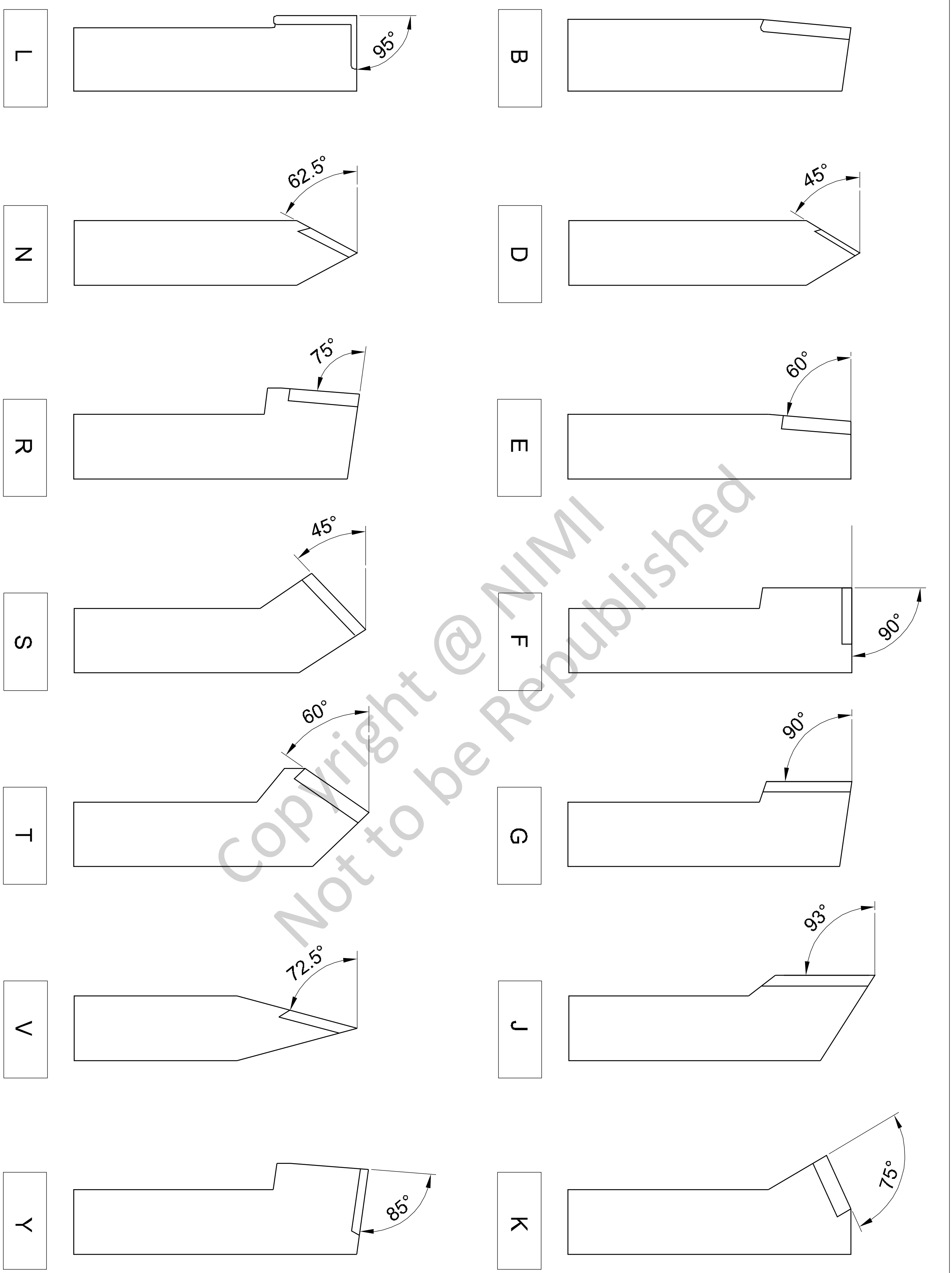


Fig 2



THREADING TOOL (MALE)

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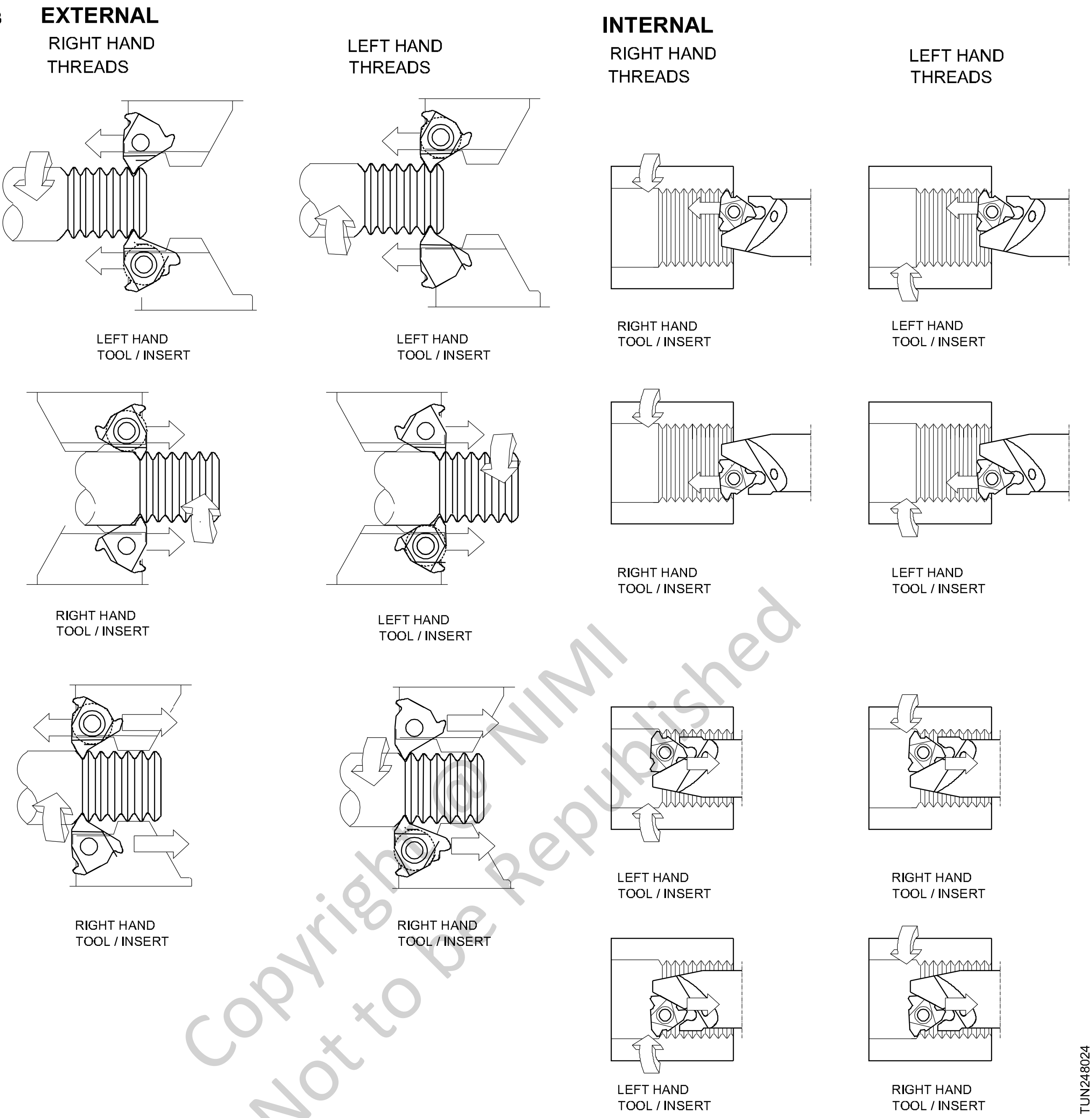
Fig 3


EXTERNAL
RIGHT HAND THREADS
LEFT HAND THREADS
INTERNAL
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LEFT HAND TOOL / INSERT
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Different lathe accessories - use and care

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 lull utilization of the lathe. The accessories can be grouped into:

- work-holding accessories
- work-supporting accessories.

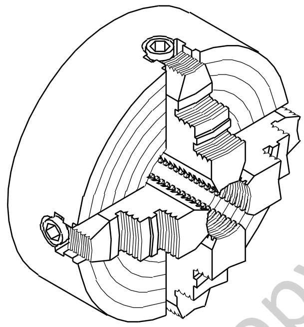
Work-holding accessories

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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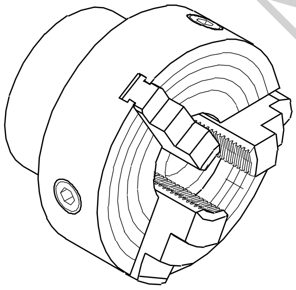
- three jaw self-centering chuck (Fig 2)

Fig 2



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- face plates (Fig 3)
- lathe mandrels. (Fig 4)

These accessories do not hold the work themselves.

They support the work. The following are the work sup-porting accessories.

- Catch plate (Fig 5)
- Driving plate (Fig 6)

Fig 3

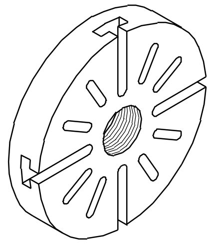

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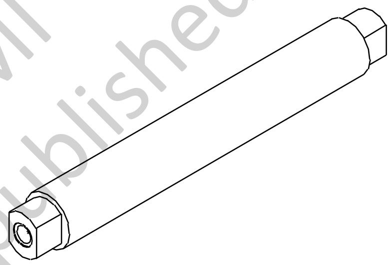
Fig 4



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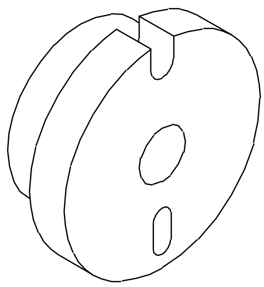
- Lathe centres (Fig 7)
- Lathe carriers (Fig 8)
- Lathe fixed steady (Fig 9)
- Lathe travelling steady (Fig 10)

Fig 5



CATCH PLATE

TUN258315

Accessories used for in-between centre work

The accessories used during turning work held in between centres are as follows.

Live centre, Dead centre, Catch plate, Driving plate, Lathe spindle sleeve and Lathe carriers.

Fig 6

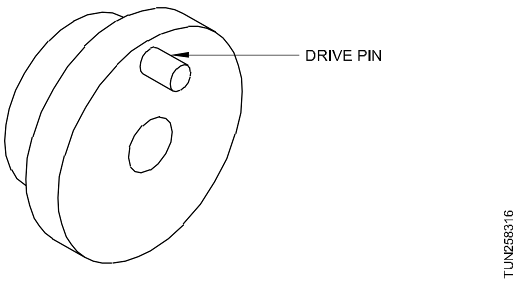
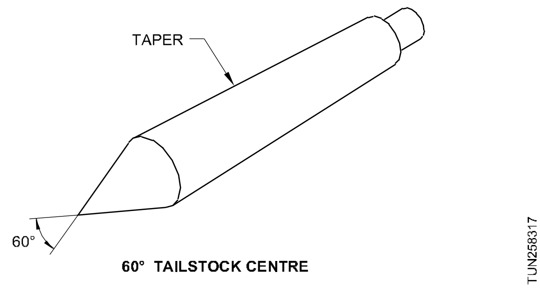
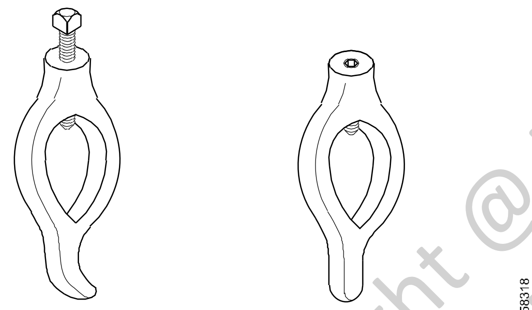


Fig 7



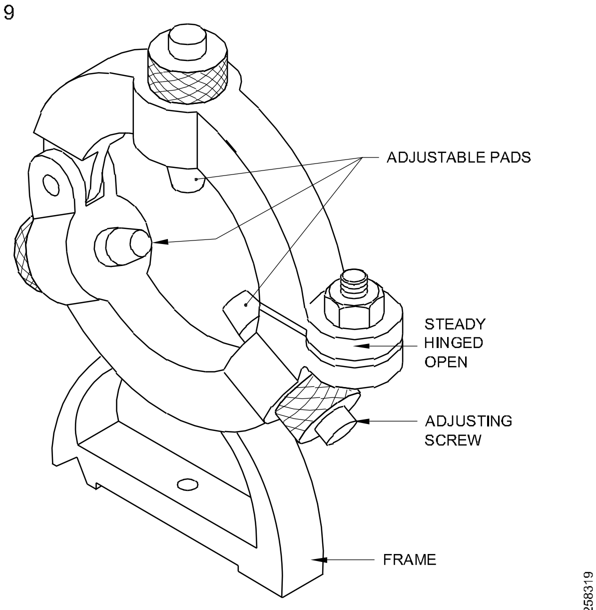
60° TAILSTOCK CENTRE

Fig 8



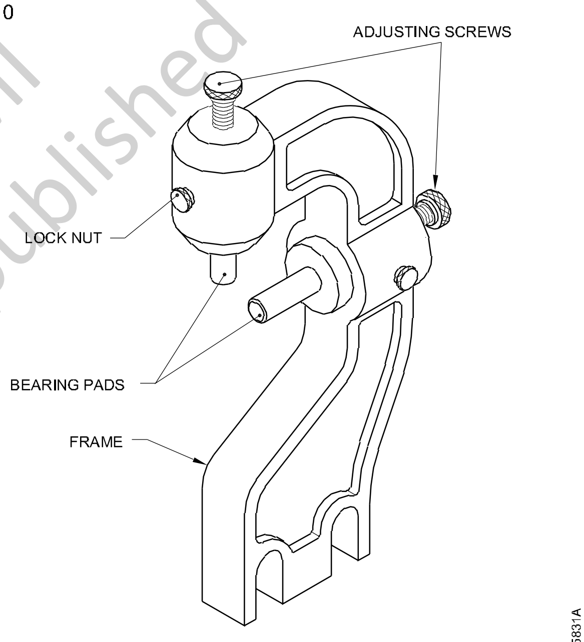
BENT TAIL STRAIGHT TAIL

Fig 9



FIXED STUDY

Fig 10



TRAVELLING STEADY

Lathe accessories - Lathe centres

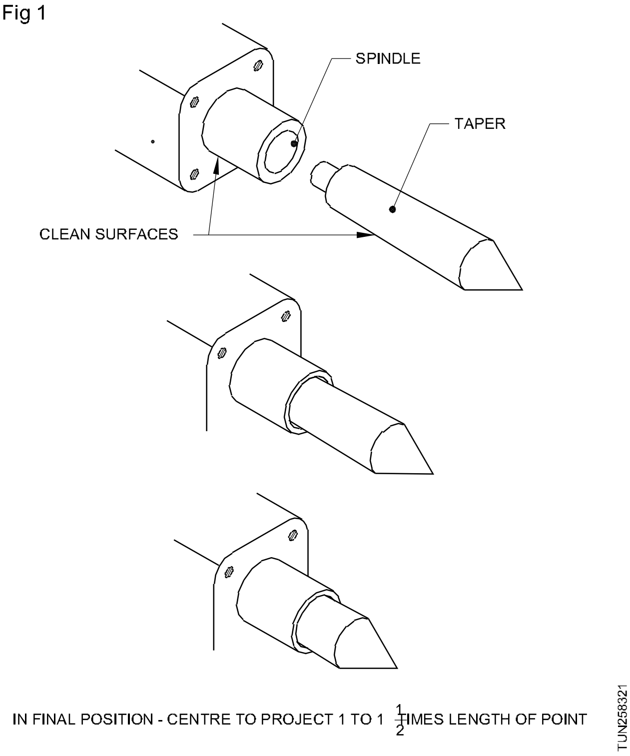
Objectives : At the end of this lesson you shall be able to
- **state what is a lathe centre**
- **distinguish between a live centre and a dead centre**
- **state the purpose of lathe centres**
- **identify and name the different types of centres**
- **indicate the specific uses of each type of centre.**

Lathe centre

It is a lathe accessory. It is used to support a lengthy work to carry out lathe operations. When a work is held in a chuck, the centre is assembled to the tailstock, and it supports the overhanging end of the work. The work is to be provided with a centre drilled hole on the face of the overhanging end. When the job is held in between centres to carry out the operation, it functions together with a driving plate and a suitable lathe carrier.

The centre, which is accommodated in the main spindle sleeve, is known as a 'live centre' and the centre fixed in the tailstock spindle is known as a dead centre. In construction, both centres are identical, made as one unit that consists of a conical point of 60° included angle, a body provided with a Morse taper shank and a tang.

Fig 1

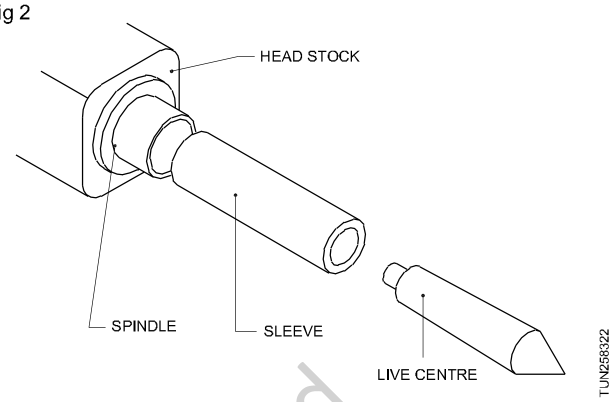


The dead centre is made out of high carbon steel, hardened and around whereas the live centre need not have its conical tip heardened as it revolves with the work. A good lubricant should be used for the dead centre.

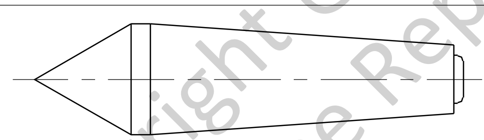
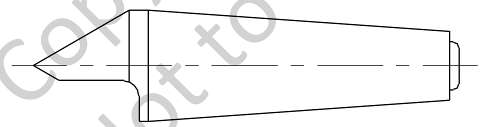
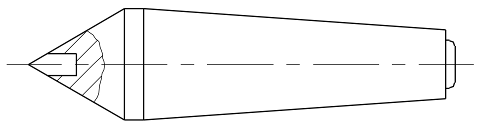
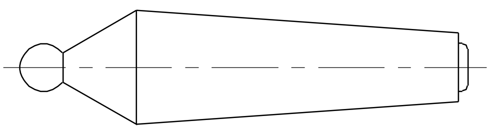
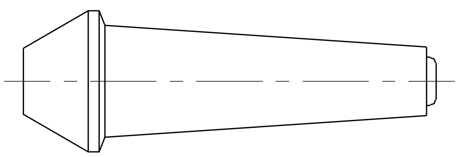
Types of centres and their uses

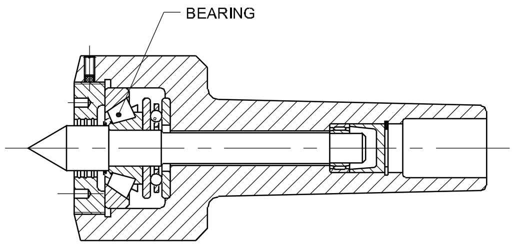
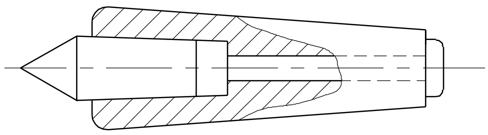
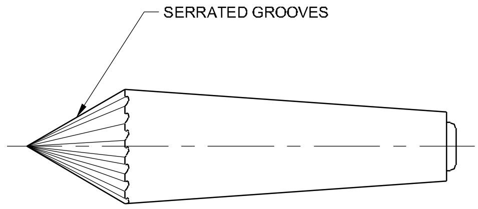
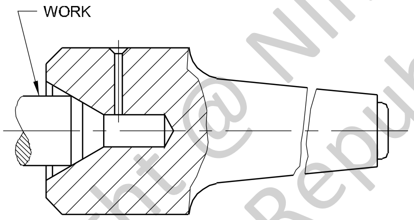
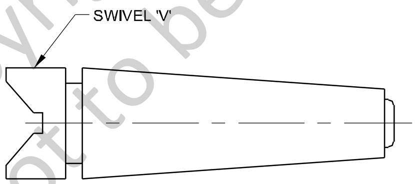
The following table gives the names of the most widely used types of lathe centres, their illustrations and their specific uses.

Fig 2



Various Types of Lathe Centres

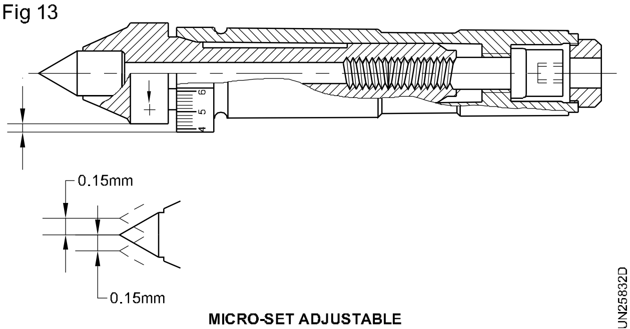
1	Ordinary centre-common type		Used for general purpose.
2	Half centre		Though it is termed as half centre, little less than half is relieved at the tip portion. Used while facing the job without disturbing the setting.
3	Tipped centre		A carbide or a hard alloy tip is brazed into an ordinary steel shank. The hard tip is wear-resistant.
4	Ball centre		Minimum wear and strain. Particularly suitable for taper turning.
5	Pipe centre		Used for supporting pipes, shells and hollow end jobs.

6 Revolving centre		Frictionless. Used for supporting heavy jobs and jobs revolving with high speeds. A high-speed steel inserted centre is supported by two bearings housed in a body. It is also called the revolving dead centre.
7 Insert-type centre		Economical. Only the small high-speed steel insert is replaced.
8 Self-driving live centre		Usually mounted on the head-stock spindle. Used while machining the entire length of the job in one setting. Grooves cut around the circumference of the centre point provide for good gripping of the job and for getting the drive. This centre can be used for only soft jobs and not for hardened jobs.
9 Female centre		the end of the job where no countersink hole is permitted.
10 Swivel 'V' centre		This centre is used to support a job in the `V' portion and to drill holes across the round job by using a drill bit in the head-stock spindle.

A micro-set adjustable centre fitted into the tailstock spindle provides a fast and accurate method of aligning lathe centres.(Fig 3)

Some of these centres contain an eccentric, others contain a dovetail slide which permits slight adjustment of the centre itself to correct alignment.

Fig 13



MICRO-SET ADJUSTABLE

Types of mandrels and their uses

Objectives : At the end of this lesson you shall be able to
- **define a mandrel**
- **state the constructional features of a solid mandrel**
- **identify and name the different types of mandrels**
- **enumerate the uses of different mandrels.**

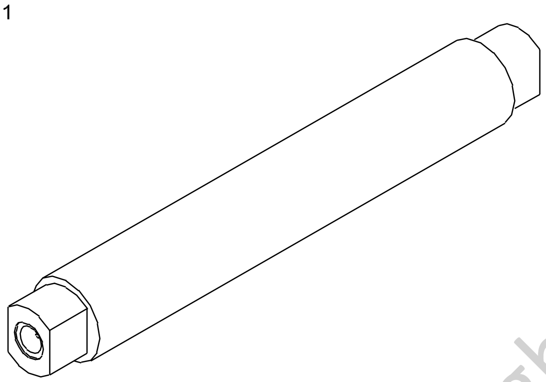
Types of mandrels and their uses

Sometimes it is necessary to machine the outer surfaces of cylindrical works accurately in relation to a hole concentric that has been previously bored in the centre of the work. In such cases the work is mounted on a device known as a mandrel.

Mandrel (Fig 1)

Lathe mandrels are devices used to hold the job for machining on lathes. They are mainly used for machining outside diameters with reference to bores which have been duly finished by either reaming or boring on a lathe.

Fig 1



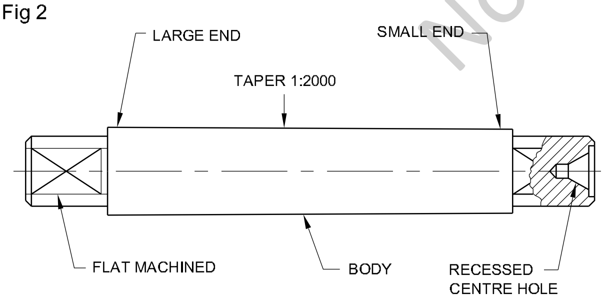
MANDREL

TUN258331

Constructional features of a solid mandrel (Fig 2)

The standard solid mandrel is generally made of tool steel which has been hardened and ground to a specific size and is ground with a taper of 1:2000.

Fig 2



DETAILS OF THE STANDARD SOLID MANDREL

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It is pressed or driven into a bored or reamed hole in a workpiece so that it can be mounted on a lathe. The ends of the mandrel are machined smaller than the body and and are provided with a flat for the clamping screw of the lathe carrier. This preserves accuracy and prevents damage to the mandrel when the lathe carrier is clamped on.

The centres made in these mandrels are 'B' type i.e. protected centres. In such centres the working portion is deep and does not get damaged while handling.

Types of mandrels

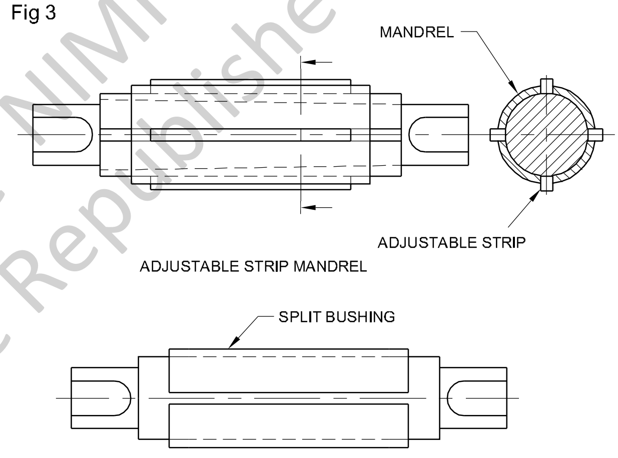
- Expansion mandrel
- Gang mandrel
- Stepped mandrel
- Screw or threaded mandrel
- Taper shank mandrel
- Cone mandrel

Expansion mandrel (Fig 3)

The two most common types of expansion mandrels are:

- split bushing mandrel
- adjustable strip mandrel.

Fig 3



EXPANSION MANDRELS

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Split bushing mandrel

A split bushing mandrel consists of a solid tapered mandrel, and a split bushing, which expands when forced on to the mandrel. The range of application of each solid mandrel is greatly increased by fitting any number of different sized bushings. As a result only a few mandrels are required.

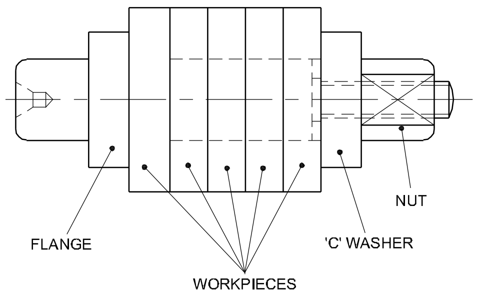
Adjustable strip mandrel

The adjustable strip mandrel consists of a cylindrical body with four tapered grooves cut along its length, and a sleeve, which is slotted to correspond with the tapered grooves. Four strips are fitted in the slots.

When the body is driven in,the strips are forced out by the tapering grooves and expanded radially. Sets of different sized strips greatly increase the range of each mandrel. This type of mandrel is not suitable for thin walled work, since the force applied by the strips may distort the workpiece.

Gang mandrel (Fig 4)

Fig 4



GANG MANDREL

A gang mandrel consists of a parallel body with a flange at one end and a threaded portion at the other end. The internal diameters of workpieces are larger than the mandrel body diameters by not more than 0.025 mm. A number of pieces can be mounted and held securely when the nut is tightened against the 'U' washer. The nut should not be over-tightened, otherwise inaccuracies will result.

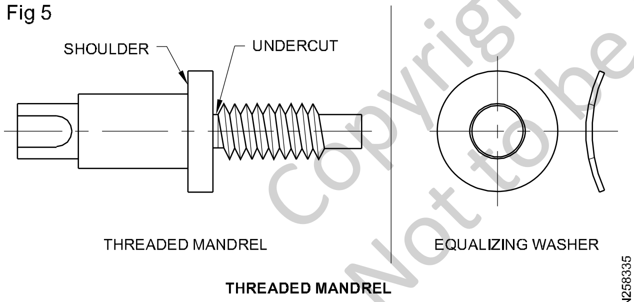
A gang mandrel is especially useful when machining operations have to be performed on a number of thin pieces which might easily be distorted, if held by any other method.

Stepped mandrel

The stepped mandrel is manufactured in order to reduce the number of mandrels. It differs from the plain mandrel in the fact that a number of steps are provided on it. Its use saves time in holding various bored works.

Screw or threaded mandrel (Fig 5)

Fig 5



THREADED MANDREL

A threaded mandrel is used when it is necessary to hold and machine workpieces having a threaded hole.

This mandrel has a threaded portion which corresponds to the internal thread of the work to be machined. An undercut at the shoulders ensures the work to fit snugly (tightly) against the flat shoulder.

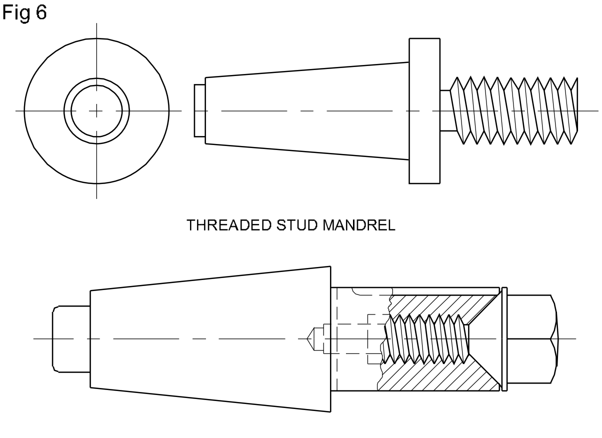
Taper shank mandrel (Fig 6)

Taper shank mandrels are not used between lathe centres. They are fitted to the internal taper of the headstock spindle. The extending portion can be machined to suit the workpiece to be turned. Taper shank mandrels are generally used to hold small workpieces.

Two common types of taper shank mandrels are:

- expansion stud mandrel
- threaded stud mandrel.

Fig 6



TAPER SHANK MANDRELS

Expansion stud mandrel

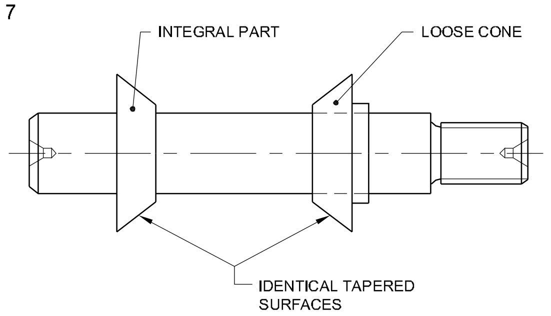
The expansion stud mandrel is slotted and has an internal thread. When a tapered screw is tightened, the outside diameter of the stud expands against the inside of the workpiece. This type of mandrel is useful when machining a number of similar parts whose internal diameters vary slightly.

Threaded stud mandrel

The threaded stud mandrel has a projecting portion which is threaded to suit the internal thread of the work to be machined. This type of mandrel is useful for holding workpieces which have blind holes.

Cone mandrel (Fig 7)

Fig 7



CONE MANDREL

A cone mandrel is a solid mandrel. It has a portion taper turned with a steep taper and integral with the body. One end of the mandrel is threaded. A loose cone slides over the plain turned portion of the body of the mandrel. It has the same steep taper as that of the tapered integral part. A job of large bore, can be held between these two tapers and tightly secured by means of nut, washer and spacing collars.

Chucks other than 3 Jaw and 4 Jaw types and their uses

Objectives : At the end of this lesson you shall be able to
- **list the name of the chucks other than the 3 jaw and 4 jaw types**
- **state their constructional features**
- **state the uses of each of these chucks.**

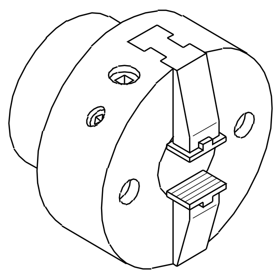
Apart from the four jaw independent chucks and self-centering chucks, other types of chucks are also used on a centre lathe. The choice depends upon the component, the nature of the operation, the number of components to be machined.

Some of the other types of chucks are:

- two jaw concentric chuck
- combination chuck
- collect chuck
- magnetic chuck
- hydraulic chuck or air operated chuck.

Two jaw concentric chuck (Fig 1)

Fig 1



TWO JAW CONCENTRIC CHUCK

TUN258341

The constructional features of this chuck are similar to those of 3 jaw and 4 jaw chucks.

Each jaw is an adjustable jaw which can be operated independently. In addition to this feature, both jaws may be operated concentric to the centre. Irregular shaped works can be held. The jaws may be specially machined to hold a particular type of job.

Combination chuck

The combination chuck is normally a four jaw chuck in which the jaws may be adjusted either independently as done in a 4 jaw chuck, or together, as done in a 3 jaw universal chuck.

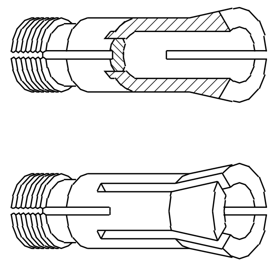
This kind of chuck is used in places where duplicate workpieces are to be machined. One piece is accurately set as done in a 4 jaw chuck, and the subsequent jobs are held by operating the centering arrangement.

Collet Chuck (Fig 2)

A collet is a hardened steel sleeve having slits cut partly along its length. It is held by a draw-bar which can be drawn in or out in the lathe spindle. The collet is guided in the collet sleeve, and held with the nose cap. It is possible to change the collet for different cross-sections depending on the cross-section of the raw material.

There are three most commonly used types of collet chucks.

Fig 2



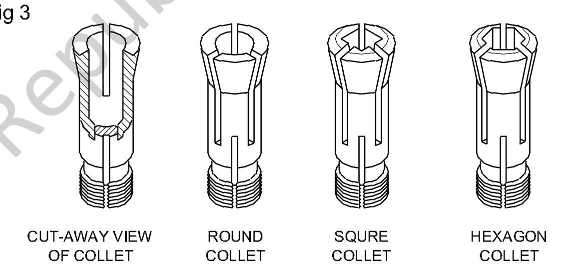
SPLIT COLLET

TUN258342

- Push-out chucks
- Draw-in chucks
- Dead length bar chucks

The operation of these chucks may be manual, pneumatic, hydraulic or electrical. They are mainly used to hold round, square, hexagonal or cast profile bars. (Fig 3)

Fig 3

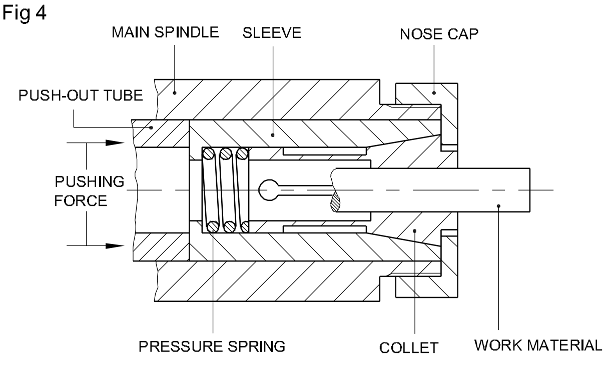


TUN258343

Push-out chucks (Fig 4)

the collet closes on the workpiece in a forward direction and consequently an end-wise movement of the work results. The cutting pressure tends to reduce the grip of the collet on the workpiece.

Fig 4



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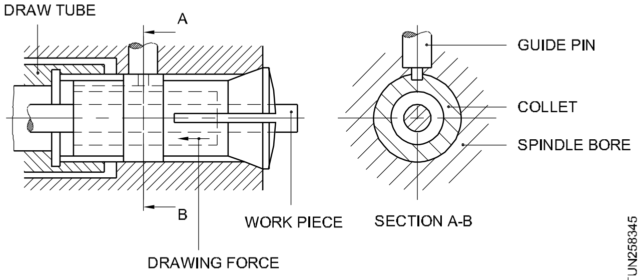
Draw-in chuck (Fig 5)

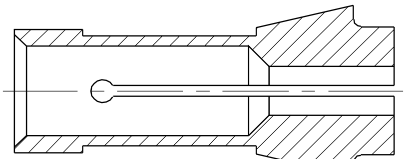
Fig 5



The collet closes on the workpiece in a backward direction and movement of the work. Take special care to avoid increases the grip of the collet on the workpiece.

Dead length bar chucks (Fig 6)

Fig 6



SPRING COLLET USED IN DEAD LENGTH BAR CHUCK

These chucks are widely used in modern machines as they provide an accurate end-wise location of the workpiece. The chuck does not move end-wise during gripping or closing operation. These chucks are made to hold round, hexagonal or square bars, and when they are not gripping, they maintain contact with the core thus preventing swarf and chips collecting between the collet and the core

The disadvantage with these chucks is that each collet cannot be made to grip bars which vary by more than about 0.08 mm without adjustment.

Magnetic chuck (Figs 7a & 7b)

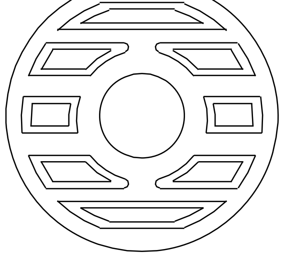
This chuck is designed to hold the job by means of magnetic force. The face of the chuck may be magnetized by inserting a key in the chuck and turning it to 180°. The amount of magnetic force may be controlled by reducing the angle of the key. The truing is done with a light magnetic force, and then the job is held firmly by using the full magnetic force.

Hydraulic chuck or air-operated chuck (Fig 8)

These chucks are mainly used for getting a very effective grip over the job. This mechanism consists of a hydraulic or an air cylinder which is mounted at the rear end of the headstock spindle, rotating along with it. In the case of a hydraulically operated chuck the fluid pressure is transmitted to the cylinder by operaring the valves. This mechanism may be operated manually or by power. The movement of the piston is transmitted to the jaws by means of connecting rods and links which enable them to provide a grip on the job.

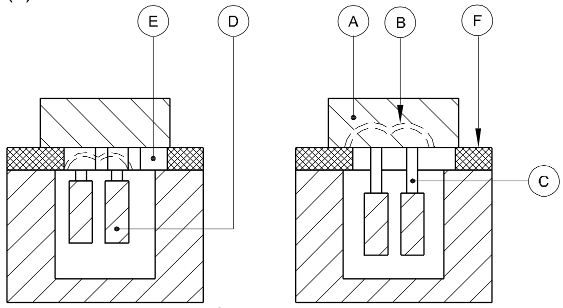
Fig 7

(a)



MAGNETIC CHUCK

(b)



INSIDE DETAILS OF MAGNETIC CHUCK

A WORKPIECE
B MAGNETIC FIELD
C CONNECTION
D MAGNETS
E KEEPERS
F FACE PLAT

TUN258347

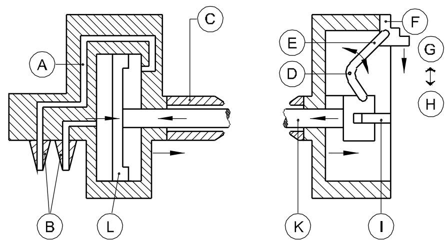
Uses of a two jaw concentric chuck

It is mainly employed to hold an irregularly shaped job. As the chuck is designed with two jaws, it can be used as a turning fixture.

Uses of a combination chuck

This chuck may be used both as a universal 3 jaw chuck and as a 4 jaw independent chuck. This chuck is very useful where duplicate workpieces are involved in the turning.

Fig 8



A. AIR PASSAGE
B. VALVES
C. HEADSTOCK
D. PIVOT HINGE
E. LINK
F. JAW
G. CHUCK OPENING
H. CHUCK CLOSING
I. GUIDE
K. PISTON ROD
L. PISTON

TUN258348

Uses of a collet chuck

It is mainly used for holding jobs within a comparatively small diameter. The main advantage of collets lies in their ability to centre work automatically and maintain accuracy for long periods. It also facilitates to hold the bar work.

Uses of a magnetic chuck

Magnetic chucks use the magnetic force from a permanent or electromagnet, or electro-permanent magnetic material to achieve chucking action on recent years magnetic chucks have replaced mechanical holding chucks. Magnetic chucks reduces set up time and increase access to all sides of workpiece. They are an valable tool for workholding.This type of a chuck is mainly used for holding thin jobs which cannot be held in an ordinary chuck. These are suitable for works where a light cut can be taken on the job.

Advantages of magnetic chucks

- They maintain constant & consisting pressure & no variation in clamping
- Full support of workpiece surface decreases cycle time
- Have shorter set-up time
- Non ferrous material can be held throw dawping in vice, attached to magnet.

Uses of hydraulic or air-operated chuck

These chucks are mainly used in mass production because of their speedy and effective gripping capacity.

Lubrication-function, types, source & method of lubrication

Objectives : At the end of this lesson you shall be able to
- **state the purpose of using lubricants**
- **state the properties of lubricants**
- **state the qualities of a good lubricant**

With the movement of two mating parts of the machine, heat is generated. it is not controlled the temperature may rise resulting in total damage of the mating parts. Therefore a film of cooling medium, with high viscocity is applied between the mating parts which is known as a lubricant.

A 'lubricant' is a subtance having an oily property available in the form of fluid. semi-fluid, semi-fluid, or solid state it is
the lifeblood of the machine, keeping the vital parts in perfect condition and prolinging the life of the machine. It saves the machine and its parts from corrosion, wear and tear, and it minimises friction.

Purposes of using lubricants

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

Properties of lubricants

Viscosity

It is the fluidity of an oil by which it can withstand high pressure or load without squeezing out from the bearing surface.

Oiliness

Oiliness refers to a combination of wet ability, surface tension and slipperiness. (The capacity of the oil to beave an oily skin on the metal.)

Flash point

It is the temperature at which the vapour is given off from the oil (it decomposes under pressure soon).

Fire point

Its is the temperature at which the oil catches fire and continues to be in flame.

Pour point

The temperature at which the lubricant is able to flow when poured.

Emulsification and de-emulsibility

Emulsification indicates the tendency of an oil to mix intimately with water to form a more or less stable emulsion. De-emulsibility indicates the readiness with which subsequent separation will occur.

Types of lubricant

Objectives : At the end of this lesson you shall be able to
- **state base of lubriant**
- **state sources of lubriant.**

Sources of lubricant:

Paraffin base has high lubricating oil content with high pour point with high viscosity index.

Asphalt base: this has a low lub-oil content with a low pour point and low viscosity index.

It is therefore important to subject lubricating oils refined from paraffin and asphalt base to various treatment to improve their properties suitable for blending produce wide range of lub-oils.

Mineral oils:

This is gotten by refining or through distillation of crude oil. (Paraffin or asphalt base). It most important property is viscosity and must have it is the lowest value for satis-factory under all conditions especially in load seed and temperature differences.

Synthetic oils:

Silicons possess the properties of synthetic oils. They are useful where. viscosity is almost independent of tem-perature. Example is gas turbine machine which is usu-ally very expensive.

Grease:

Greases are semisolid lubricant which has high viscosity with filler and metallic soap. The filler enable grease to with stand shock and heavy loads. The soap include metal base like calcium, sodium with fatty or vegetables oil fillers, lead, zine, graphite or molybdenum disulphide

Grease properties is seen as it act as a real lubricant useful is accessing difficult areas or parts and large clearance it has a continous lubricating ability.

Vegetable and Animal oils:

Fallow, whale, cod-liver, castor and olives oils belongs to this family but they are unsuitable at usual operating conditions especially temperature. They are used in grease and as additives to mineral oils to give improved boundary lubrication.

Solids:

Graphite, tale molybdenum disulphide are good source of the king of lubricant. They are difficult to apply may be suspended in a fluid when being used and are useful for high operating temperature.

Water:

They are used in steel, rubber or steel plastic bearings e.g. water.

Lubricated stern bearing with rubber bearing surfaces or impregnated plastic resin compounds.

Gases:

Gases like air and Co2 are used when liquids are not allowed. It has very low viscosity and more suitable for hydrostatic lubrication.

Classification of lubricants

Objectives : At the end of this lesson you shall be able to
- **state solid lubricants and their application**
- **state liquid and semi-liquid lubricants and their application**
- **state the classification of lubricants as per Indian Oil Corporation.**

Lubricants are classified in many ways. According to their state, lubricants are classified as:

- solid lubricants
- semi-solid or semi-liquid lubricants
- liquid lubricants.

Solid lubricants

These are useful in reducing friction where an oil film cannot be maintained because of pressure and temperature. Graphite, molybdenum disulphide, tale, wax, soap-stone, mica and French chalk are solid lubricants.

Semi-liquid or semi-solid lubricants

Greases are semi-liquid lubricants of higher viscosity than oil. Greases are employed where slow speed of heavy pressure exists. Another type of application is for high temperature components, which would not retain liquid lubricants.

Liquid lubricants

According to the nature of their origin, liquid lubricants are classified into:

- mineral oil
- animal oil
- synthetic oil.

According to the product line of Indian Oil Corporation the lubricants are classified as:

- automotive lubricating oils
- automotive special oils
- rail-road oils
- industrial lubrication oils
- metal working oils
- industrial special oils
- industrial greases
- mineral oils.

For industrial purposes the commonly used lubricants for machine tools are:

- turbine oils
- circulation and hydraulic oils (R & O Type)
- circulating and hydraulic oils (anti-wear type)
- circulating oil (anti-wear type)
- special purpose hydraulic oil (anti-wear type)
- fire-resistant hydraulic fluid
- spindle oil
- machinery oils
- textile oils
- gear oils

- straight mineral oils
- morgan bearing oils
- compressor oils.

In each type, there are different grades of viscosity and flash point. According to the suitability, lubricants are selected using the catalogue.

Example 1

Spindle oils are graded according to their viscosity and flash point.

Servospin - 2

Servospin - 5

Servospin - 12

Servospin - 22

Servospin oils are low viscosity lubricants containing anti-wear, anti-oxidant, anti-rust and anti-foam additives. These oils are recommended for lubrication of textile and machine tool spindle bearings, timing gear, positives displacement blowers, and for tracer mechanism and hydraulic system of certain high precision machine tools.

Example 2

Gear oils are graded according to their viscosity and flash point.

Servomesh - 68

Servomesh - 150

Servomesh - 257

Servomesh - 320

Servomesh - 460

Servomesh - 680

Servomesh oils are industrial gear oils blended with lead and sulphur compounds. These oils provide resistance to deposit formation, protect metal components against rust and corrosion, separate easily from water and are non-corrosive to ferrous and non-ferrous metals.

These oils are used for plain and anti-friction bearings subjected to shock and heavy loads, and should be used in system where the operating temperature does not exceed 90° C. These oils are not recommended for use in food processing units.

Servomest A-90 is a litumenous product which contains sulphur-lead type and anti-wear additive. It is specially suitable for lubrication of heavily leaded low-speed open gears.

Servomesh - SP 68

Servomesh - SP 150

Servomesh - SP 220

Servomesh - SP 257

Servomesh - SP 320

Servomesh - SP 460

Servomesh - SP 680

Servomesh SP oils are extreme pressure type industrial gear oils, which contain sulphur-phosporous compounds and have better thermal stability and higher oxidation resistance compared to conventional lead-napthenate gear oils.

These oils have good de-emulsibilty, now foaming tendency and provide rust and corrosion protection to metal surfaces. These oils are recommended for all heavy duty enclosed gear drives with circulation or splash lubrication system operating under heavy or shock load conditions up to a temperature of 110° C.

Lubricating System

Objective : At the end of this lesson you shall be able to
- **state the methods of applying a lubricant.**

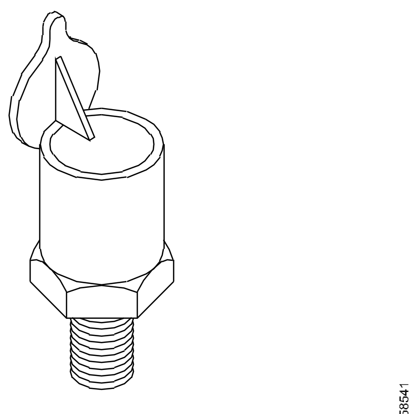
There are 3 systems of lubrication.

- Gravity feed system
- Force feed system
- Splash feed system

Gravity feed

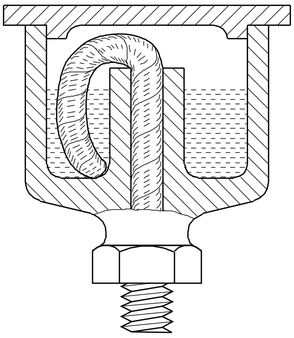
The gravity feed principle is employed in oil holes, oil cups and wick feed lubricators provided on the machines. (Fig 1 & 2)

Fig 1



OIL CUP

Fig 2



WICK FEED

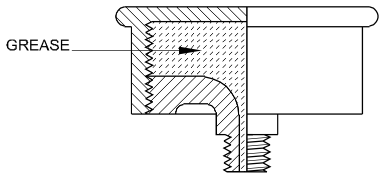
TUN258512

Force Feed/Pressure Feed

Oil, grease gun and grease cups

The oil hole or grease point leading to each bearing is fitted with a nipple, and by pressing the nose of the gun against this, the lubricant is forced to the bearing. Greases are also force fed using grease cup. (Fig 3)

Fig 3

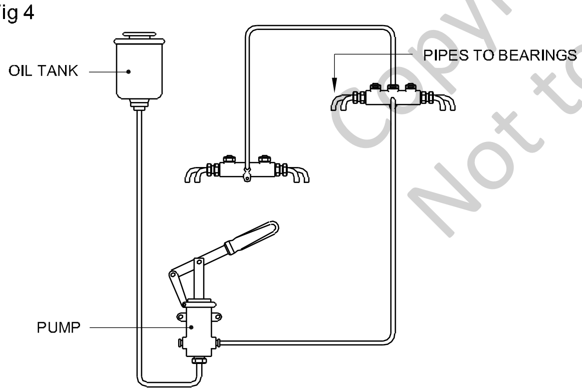


MANUAL SCREW DOWN GREASER

TUN258513

Oil is also pressure fed by hand pump and a charge of oil is delivered to each bearing at intervals once or twice a day by operating a lever provided with some machines. (Fig 4) This is also known as shot lubricator.

Fig 4



HAND PRESSURE FEED (ONE SHOT)

TUN258514

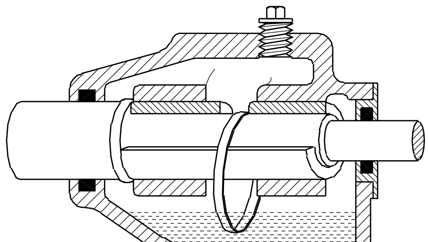
Oil pump method

In this method an oil pump driven by the machine delivers oil to the bearings continuously, and the oil afterwards drains from the bearings to a sump from which it is drawn by the pump again for lubrication.

Splash lubrication

In this method a ring oiler is attached to the shaft and it dips into the oil and a stream of lubricant continuously splashes around the parts, as the shaft rotates. The rotation of the shaft causes the ring to turn and the oil adhering to it is brought up and fed into the bearing, and the oil is then led back into the reservoir. (Fig 5) This is as known as ring oiling.

Fig 5

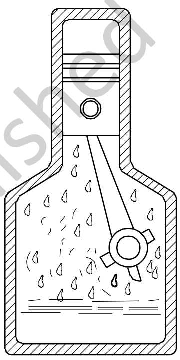


RING OILING

TUN258515

In other systems one of the rotating elements comes in contact with that of the oil level and splash the whole system with lubricating oil while working. (Fig 6) Such systems can be found in the headstock of a lathe machine and oil engine cylinder.

Fig 6



SPLASH-LUBRICATING SYSTEM

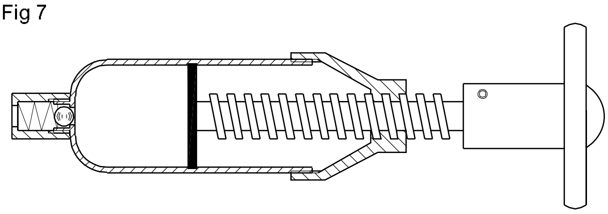
TUN258516

Types of grease guns

The following types of grease guns are used for lubricating machines.

- 'T' handle pressure gun (Fig 7)

Fig 7



T-HANDLE PRESSURE GUN

TUN258517

- Automatic and hydraulic type pressure gun (Fig 8)
- Lever-type pressure gun (Fig 9)

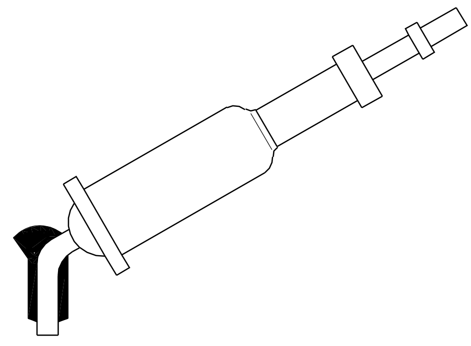
Lubrication to exposed slideways

The moving parts experience some kind of resistance even when the surface of the parts seems to be very smooth.

The resistance is caused by irregularities which cannot be detected by the naked eyes.

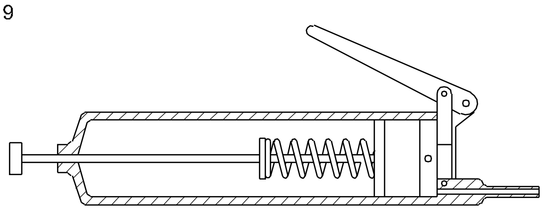
Without a lubricant the irregularities grip each other as shown in the diagram. (Fig 10)

Fig 8



AUTOMATIC HYDRAULIC-TYPE PRESSURE GUN

Fig 9



PRESSURE GREASE GUN

Fig 10

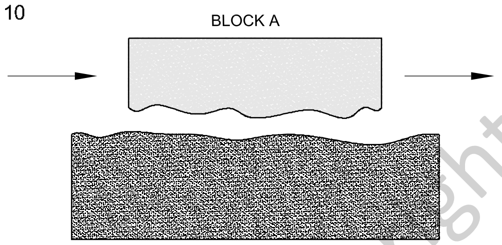
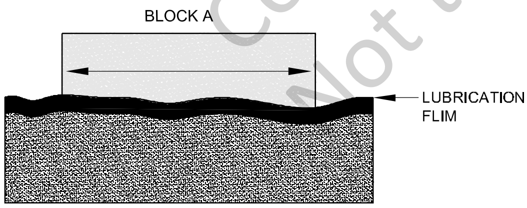


Fig 11



With a lubricant the gap between the irregularities fills up and a film of lubricant is formed in between the mating components which eases the movement. (Fig 11)

Hints for lubricating machines

- identify the oiling and greasing points
- select the right lubricants and lubricating devices
- apply the lubricants.

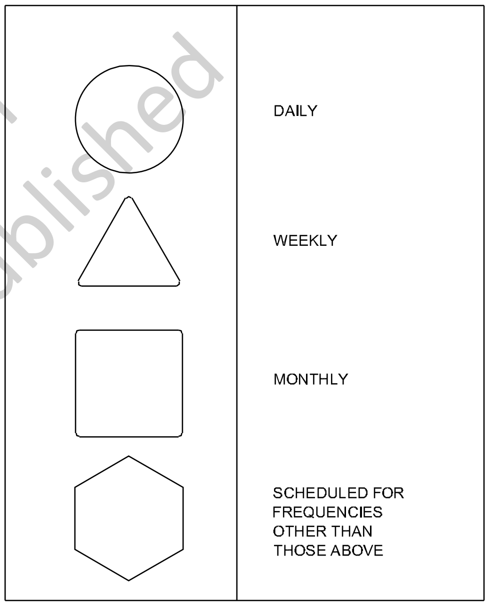
The manufacturer's manual contains all the necessary details for lubrication of parts in machine tools. Lubricants are to be applied daily, weekly, monthly or at regular intervals at different points or parts as stipulated in the manufacturer's manual.

These places are indicated in the maintenance manuals with symbols as shown in Fig 12.

The best guarantee for good maintenance is to follow the manufacturer's directives for the use of lubricants and greases. Refer to the Indian Oil Corporation chart for guidance. The commonly used oils in the workshop is given in Annexure I.

Fig 12

FREQUENCY CLASSIFICATION SYMBOLS



The lubricant containers should be clearly labelled. The label must indicate the type of oil or grease and the code number and other details. Oil containers must be kept in the horizontal position while the grease container should be in the vertical position.

Industrial lubrication oils

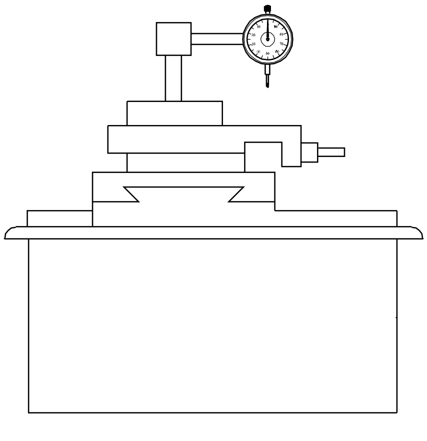
Product	Kinematic viscosity Cst at 40°C	VI	Flash poin COC°C	Description/Application
General Purpose Machinery Oils Lubrex 57 Lubrex 68	 54.60 64.72	 - -	 160 160	Lubrex oils are low viscosity index straight mineral lubricants having good inherent oxidation stability; they protect machine elements from excessive wear and provide economical lubrication. These oils are recommended for lubrication of bearings, open gears, lightly loaded slides and guideways of machine tools.
Flushing Oil Lubrex Flush 22	 19.22	 -	 150	Lubrex Flush 22 is a light coloured, low viscosity, straight mineral oil specially developed for slushing of automotive and industrial equipment. The characteristics of Lubrex Flush 22 make it possible to easily clean all inacessible internal surfaces of various equipments.
Circulating and Hydraulics Oils (Anti-wear Type) Servosystem 32 Servosystem 57 Servosystem 68 Servosystem 81 Servosystem 100 Servosystem 150	 29.33 55.60 64.72 78-86 95-105 145-155	 95 95 95 90 90 90	 196 210 210 210 210 230	Servosystem oils are blended from highly refined base stocks and carefully selected anti-oxidant, anti-wear, anti-rust and anti-foam additives. These oils have long service life, and are recommended for hydaulic systems and a wid of circulation systems of industrial and automotive equipment. These oils are also used for compressor crank case lubrication, but are not recommended for lubrication of turbines and equipment having silver coated components.
Spindle Oils Servospin 2 Servospin 5 Servospin 12	 2.0-2.4 4.5-5.0 11-14	 - - 90	 70 70 144	Servospin oils are low viscosity lubricants containing anti-wear, anti-oxidant, anti-rust and anti-foam additives. These oils are recommended for lubrication of textile and machine tool spindle bearings, timing gears, positive displacement blowers, and for tracer mechanism and hydraulic systems of certain high precision machine tools.
Machinery Oils Servoline 32 Servoline 46 Servoline 68	 29.33 42.50 64.-72	 - - -	 152 164 176	Servoline oils provide good oiliness for general lubrication even under boundary lubrication conditions, protect parts gaingst rust and corrosion and maintain thin film strength and anti-rust additives. Servoline oils are general purpose lubricants for all loss lubrication systems of textile mills, paper mills, machine tools.
Gear OIls Servomesh 68 Servomesh 150 Servomesh 257	 64-72 145-155 250-280	 90 90 90	 204 204 232	Servomesh oils are industrial gear oils blended with lead and sulphur compounds. These oils provide resistance to desposit formation, protect metal components against rust and corrosion, separate easily from water and are non-corrosive to ferrous and non-ferrous metals. Servomesh oils are recommended for lubrication of industrial gears, plain and anti-friction bearings subjected to shock and heavy loads and should be used in systems were operating temperature does not exceed

Dial Test indicator use for parallelism and concentricity

Objectives: At the end of this lesson you shall be able to
- **checking will movement of fail stock & alingment of the spindle**
- **test the coil stock sleeve movement relative to the carrrige giveing**
- **parallelism of bed and carriage movement.**

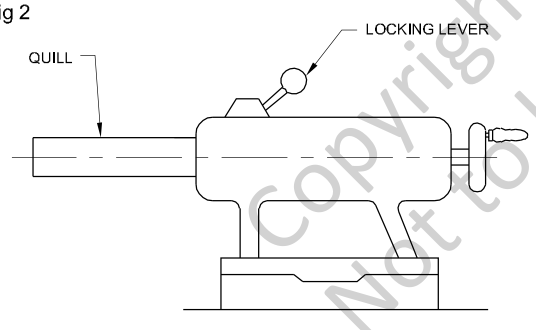
Fix the dial gauge on the carriage. (Fig 1)

Fig 1



Project the quill of the tailstock to the maximum extent possible and lock it. (Fig 2) Check the quill in the vertical and horizontal positions by a dial test indicator.

Fig 2



Clamp the quill during each measurement. If it is not clamped it will affect the measurement.

Place the dial plunger to contact over the free end of the quill in the vertical plane. (Fig 3)

Ensure that the dial is set at the topmost point of the quill.

Set the dial at the zero position. (Fig 4)

Move the carriage slowly towards the entire length of the quill. (Fig 5)

Note the dial reading at the extreme end of the quill.

Verify the deflection of the dial reading and compare the value with the test chart supplied. (IS: 6040)

For checking in the horizontal plane, set the dial horizontally and repeat the above procedure. (Fig 6)

Fig 3

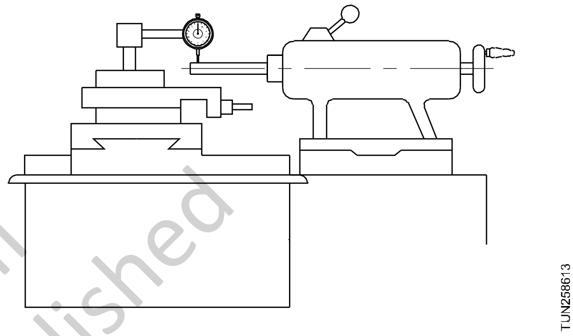


Fig 4

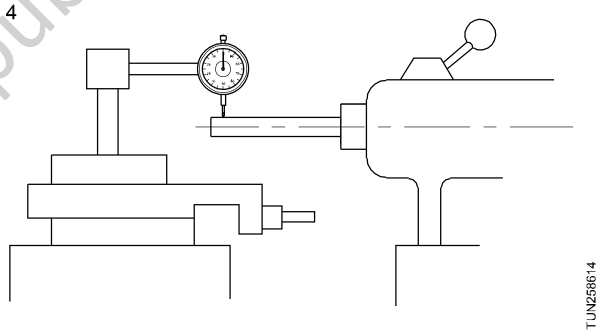
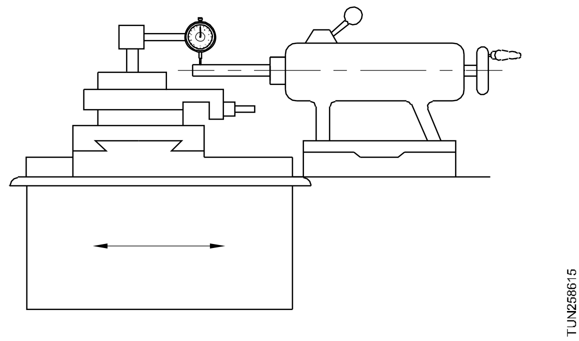


Fig 5



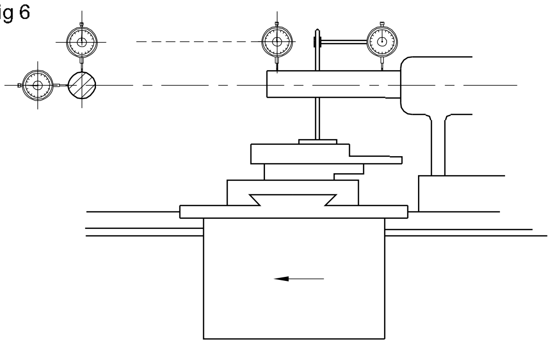
Fix the test mandrel into the tailstock spindle. Repeat the same procedure to test the accuracy of the tailstock spindle bore in the vertical and horizontal positions as shown in the figure.

Insert a hollow test mandrel (300 to 500 mm long) in between the centres. (Fig 6)

Ensure that the spindle bearing is at its working temperature.

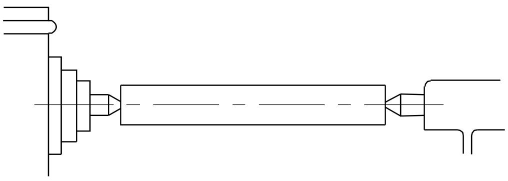
Fix the dial gauge on the saddle, the plunger touching a position of the mandrel and set it to zero.(Fig 7)

Fig 6



TUN258616

Fig 7



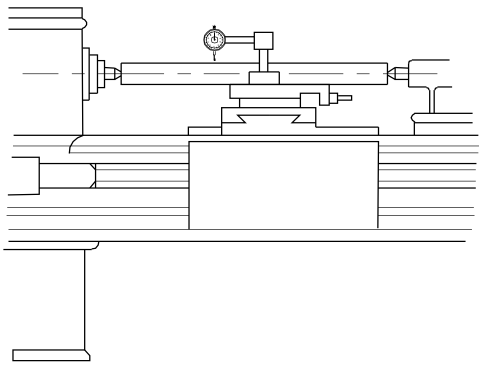
TUN258617

Move the carriage from one end to the other end of the mandrel to check the mandrel is in correct alignment in the horizontal position.

Rest the dial plunger at right angles (radially) to the surfaces to be tested.

Set the dial plunger at the top of the mandrel and move the saddle along the bed slowly to the entire length of the mandrel. (Fig 8)

Fig 8



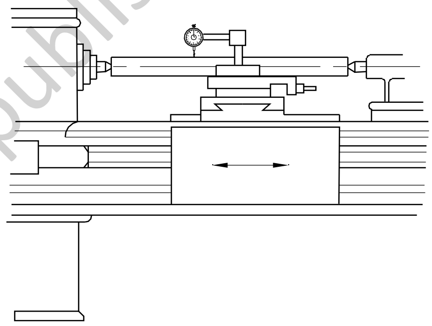
TUN258618

Observe the reading of the dial as the saddle moves along the beds and note for variation, if any.

The tailstock centre must be higher than the spindle centre within the permissible limit.

Verify the deflection of the dial gauge reading and compare the value with the test chart. (IS: 6040)

Fig 9



TUN258619

Checking the true running of a spindle

Objective: This shall help you to

- **test the true running of a lathe spindle with a test mandrel.**

Locate the taper shank of the test mandrel in the spindle taper.

Hold a dial gauge, stationary in the carriage, its plunger contacting the mandrel near its free end (Fig 1) and set it to '0' position.

Rest the dial gauge plunger at right angles (radially) to the surface to be tested.

Rotate the spindle along with the mandrel slowly by hand.

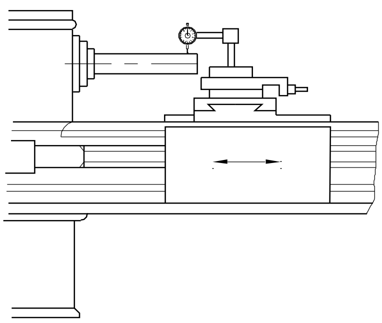
Observe and note the reading of the dial gauge.

Move the dial gauge near the spindle nose. Rotate the spindle along with the mandrel slowly by hand and note the reading.

Take readings of the dial gauge while the spindle is slowly rotated. Verify the deflection of the dial reading and compare the value with the test chart. (IS: 6040)

Adjustment of the spirit level with the plane surface

Fig 1



TUN258621

Grinding wheel - abrassive, grit, grade and bond

Objectives: At the end of this lesson you shall be able to
- **name the two abrasives used to manufacture grinding wheels**
- **identify and name the bonds used during the manufacture of grinding wheels**
- **state the cutting action of an abrasive wheel**
- **specify a grinding wheel as per B.I.S.**
- **state the factors which affect the selection of abrasive wheels.**

Satisfactory results can be obtained only by having the right type of abrasive wheel rotating at the correct speed for the kind of work that is to be ground.

Abrasive wheels are made from manufactured abrasive grains, held together by a suitable binding material called the bond.

The two abrasives used in the manufacture of grinding wheels are:

- aluminium oxide

- silicon carbide.

The aluminium oxide grinding wheels are suitable for grinding high tensile, tough materials, and all types of steels.

The silicon carbide grinding wheels are used to grind hard materials, such as, stone or ceramics, non-ferrous metals and other non-ferrous materials.

The type of the abrasive is clearly marked on an abrasive wheel by the manufacturer.

The bond

Abrasive particles in a grinding wheel are held together by a material called the bond.

The bond may be:

- vitrified
- silicate
- organic.

Vitrified bonds produce strong rigid grinding wheels that are not affected by water, acid or normal temperature changes. Most of the abrasive wheels are produced with vitrified bonds.

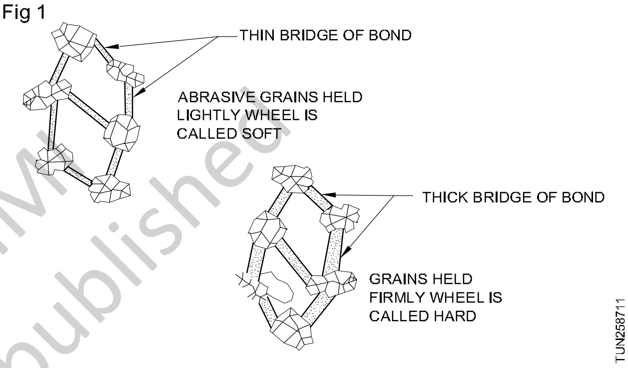
A silicate bond produces a wheel with a milder cutting action than a vitrified bonded wheel. Large diameter wheels have a silicate bond.

The organic bonds may be made of:

- resinoid
- bakelite
- rubber
- shellac.

The organic bonded wheels have a safe higher operating speed. They are better able to withstand rough usage. They are used on portable grinders and for rough foundry work. Thin cut-off wheels are made with an organic bond. (Fig 1)

Fig 1



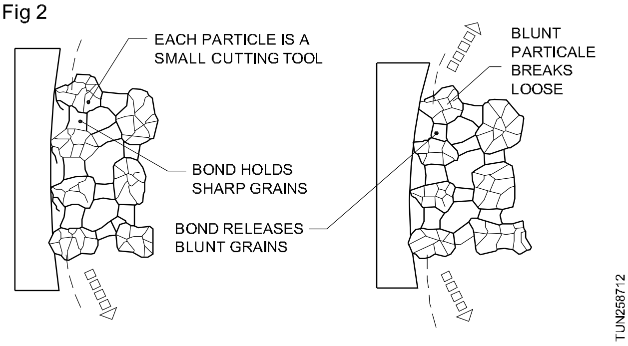
Degree of bond

The bond holds the abrasive particles together and supports them while they cut. The degree of bond determines whether the abrasive grains are held lightly or firmly.

A wheel is said to be ‘soft’ only when a thin bridge of bond holds the abrasive grains together so that the grains break away. A wheel is said to be ‘hard’ when a thick bridge of bond holds the grains firmly.

> **It is the amount or grade of bond that determines the ‘hardness’ or ‘softness’ of an abrasive wheel.**

Fig 2



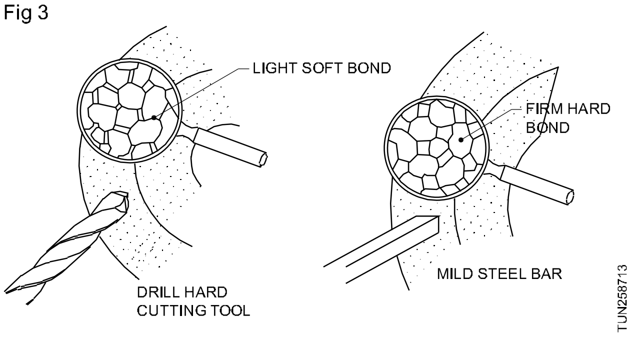
Cutting action of an abrasive wheel

The cutting action of a grinding wheel depends to a large extent on the grade of bond of the wheel. The principle is that the individual abrasive grains are small cutting tools.

The bond must be such that it must hold the grinding particles together when they are sharp, and must release them when they become blunt so that new sharp grains take their place to continue the cutting. This continuous process is known as the cutting action of the wheel. (Fig 2)

Use 'soft' light bond wheels to grind hard materials, and 'hard' firm bond wheels to grind soft materials. (Fig 3)

Fig 3



Abrasive wheel specification

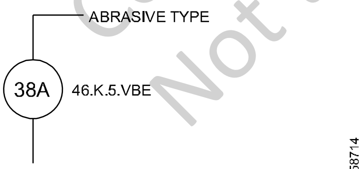
A standard marking system is used to specify and identify grinding wheels.

The following is the sequence of arrangement.

- Abrasive type
- Structure
- Grain size
- Bond type
- Grade of bond

Abrasive type (Fig 4)

Fig 4



ALUMINIUM OXIDE FOR GRINDING HSS CUTTING TOOLS

Letters are used to identify each of the two types of abrasives.

They are:

- 'A' for aluminium oxide
- 'C' for silicon carbide.

The manufacturer may use a number in front of this letter to designate a particular variation of each type.

Examples

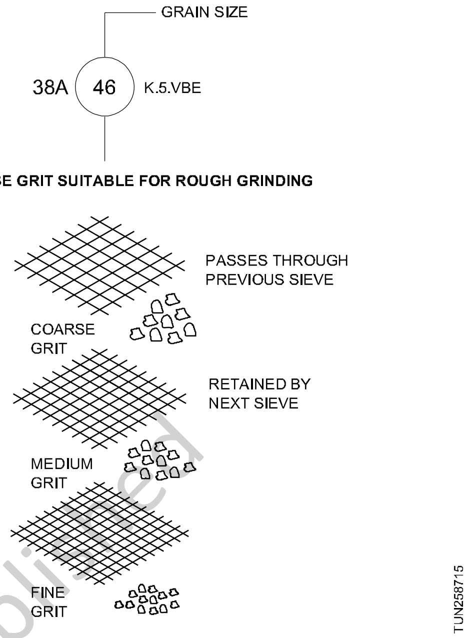
38 A is an aluminium oxide abrasive designed for grinding high speed steel cutting tools.

39C is a silicon carbide abrasive designed for grinding cemented carbide tools.

Grain size (Fig 5)

Grain or grit size is the actual size of the abrasive grain. The abrasive particles are graded by passing through sieves of various sizes. They are indicated by a number ranging from 10 (coarse) up to 600 (very fine). Generally a fine grit wheel gives a smooth surface and is used for finishing work.

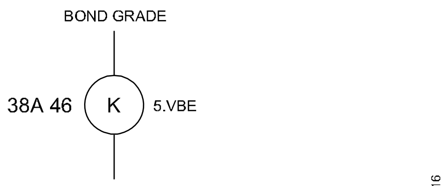
Fig 5



Grade of bond (Fig 6)

The grade or amount of bond in an abrasive wheel is indicated by a letter of the alphabet. The grades range from 'A' indicating a light or 'soft' bond to 'Z' indicating a firm or 'hard' bond. The grade of bond selected for a particular job would be one that produces the most satisfactory cutting action from the wheel.

Fig 6



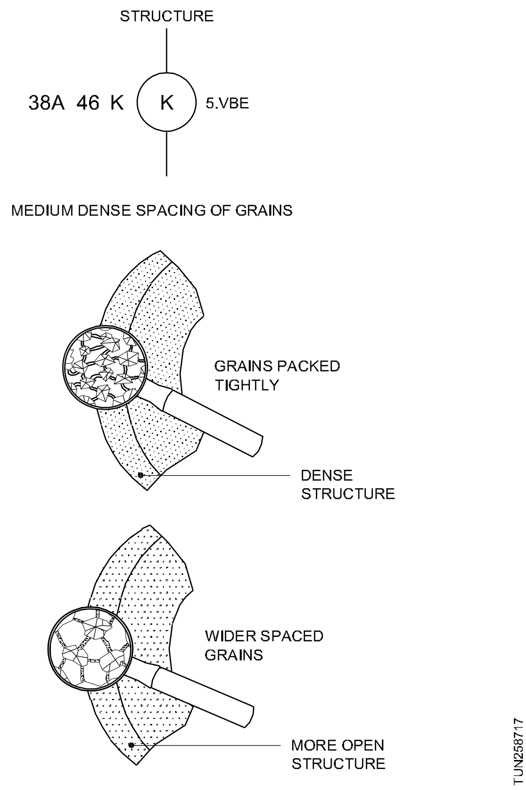
MEDIUM SOFT BOND TO ALLOW BLUNT PARTICLES TO BREAK OUT READLY (SOFT WHEEL)

Structure

The structure of an abrasive wheel is the spacing of the abrasive grains. An abrasive wheel can be manufactured with the abrasive grains tightly packed together or widely spaced. This structure is indicated by a number from 1 to 12. The higher numbers indicate a progressively more open structure.

The structure number need not be shown on the wheel markings. (Fig 7)

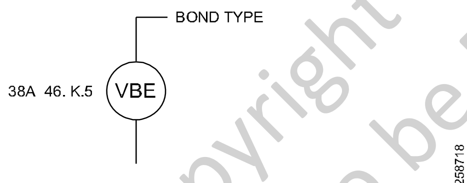
Fig 7



Bond type

A letter is used to indicate the type of material or the process used for the bond of the wheel. (Fig 8)

Fig 8



VITRIFIED TYPE OF BOND WITH A BOND VARIATION

V Vitrified

S Silicate

B Resinoid

R Rubber

E Shellac

O Oxychloride

Wheel marking

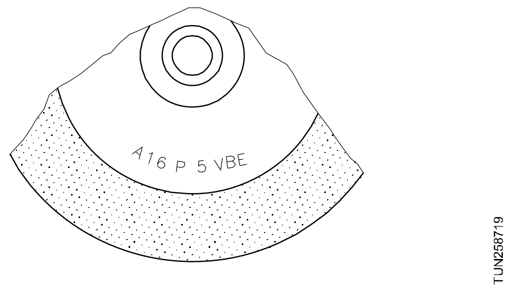
An abrasive wheel suitable for the rough grinding of a steel casting would be marked

A 16 P.5 V BE.

The expansion of the separate components would be:

A	Aluminium oxide abrasive
16	Coarse grain size
P	Medium to hard grade of bond
5	Medium to dense structure
V	Vitrified bond
BE	Manufacturer's particular bond characteristic. (Fig 9)

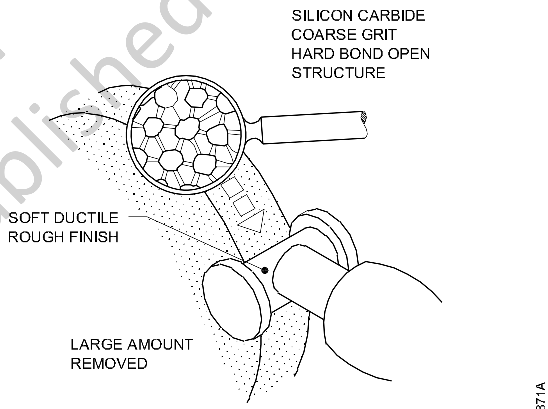
Fig 9



Factors for selecting an abrasive wheel for a particular job

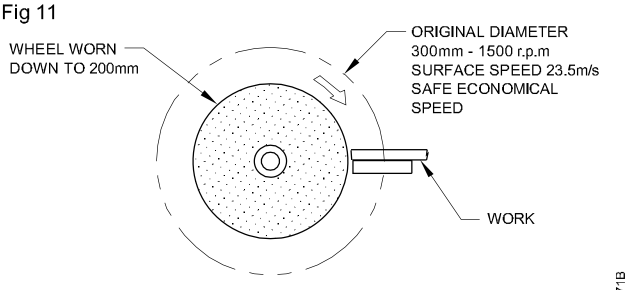
- The kind of material to be ground. (Fig 10)
- The amount of material to be removed. (Fig 10)
- The surface finish required.
- The type and condition of the machine.
- The wheel speed.(Fig 11)

Fig 10



DRESSING A BRASS CASTING

Fig 11



1500R.P.M - SURFACE SPEED NOW 15.7m/s
SPEED TOO SLOW WHEEL WEARS RAPIDLY

Defects in grinding wheel

Objectives: At the end of this lesson you shall be able to
- **state the problems which may arise relating to the surface of the wheel**
- **identify each one of the problems and state the effects.**

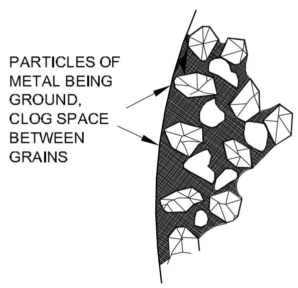
The problems which may arise relating to the surface of the grinding wheels by grinding are:

- loading
- glazing
- grooving
- out-of-round.

Loading

Small particles of the material being ground become embedded in the space between the grains of the wheel. The surface of the wheel becomes clogged or loaded. This reduces the cutting efficiency of the wheel. (Fig 1)

Fig 1



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A loaded wheel can be easily recognized, and the first indications will be:

- a rapid reduction of the cutting action of the wheel
- normal pressure of the work against the wheel has little effect
- the volume of sparks produced by the wheel is reduced.

An increased pressure of the work against the wheel results in:

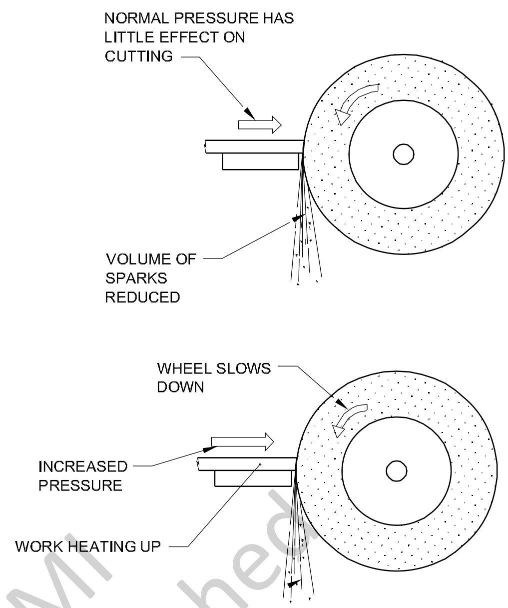
- the work heating up
- a slowing down of the wheel, particularly on the smaller machines. (Fig 2)

When these symptoms become apparent stop grinding and switch off the machine.

When the wheel has stopped rotating by itself, look at the wheel face. See whether the surface is dotted and streaked with metallic particles. Often these particles will have built up on the surface, and will protrude above the wheel face. This accounts for the sudden loss of cutting action of the wheel. (Fig 3)

> **'Loading' is the result of using the wrong type of wheel for the material being ground.**
>
> **Refer to the manufacturer's reference handbook which gives the recommendations for wheel selection.**

Fig 2



EFFECTS OF LOADING

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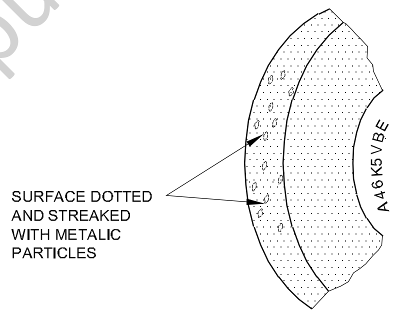
Fig 3



SELECT A MORE OPEN STRUCTURE WHEEL (8)

LOADED WHEEL

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Glazing

Glazing is caused by grinding hard materials on a wheel that has too hard a grade of bond. The abrasive particles become dull owing to cutting the hard material. The bond is too firm to allow them to break out. The wheel loses its cutting efficiency. The symptoms of a glazed wheel are very similar to those of a loaded wheel. The inspection of the wheel face shows a smooth glassy appearance.

Glazing may be prevented by selecting a wheel with a softer grade of bond.

The manufacturer's handbook may be referred to for wheel selection for the job in hand. (Fig 4)

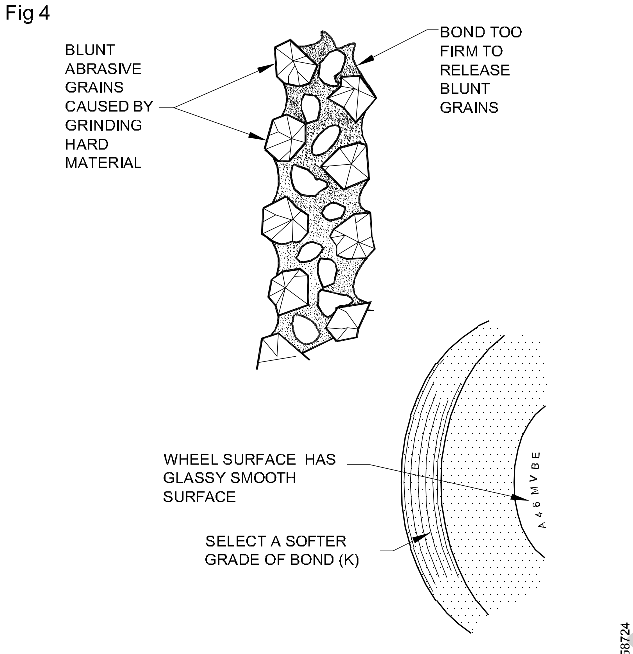
Grooving

Grooves are formed on the surface of the wheel by the wearing away of the wheel by the pressure that is being applied in one position.

Grooving may be prevented by moving the work across the full face of the wheel.

Avoid grinding on the outside edges of the wheel; otherwise,it results in rapid wear and causes a curved surface on the wheel. (Fig 5)

Fig 4



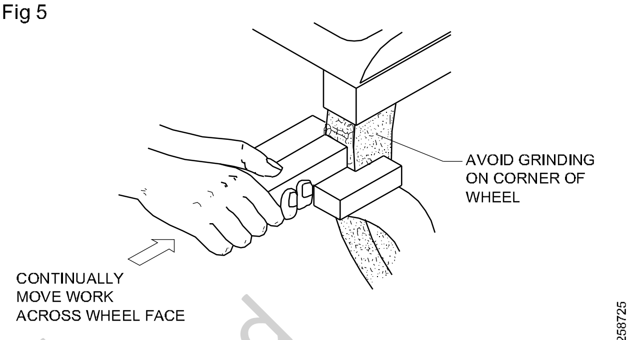
GLAZED WHEEL

Out-of-round

Uneven application, bumping or vibration of the work against the wheel will cause the wheel to wear out-of-round. It will lead to an out of balance condition. Applying even pressure and having the work well supported by the work-rest will help in preventing the wheel from becoming out-of-round.

Never attempt to perform heavy, rough grinding on a small bench grinder set-up for the sharpening of cutting tools.

Fig 5



MAINTAIN FIRM CONSTANT PRESSURE