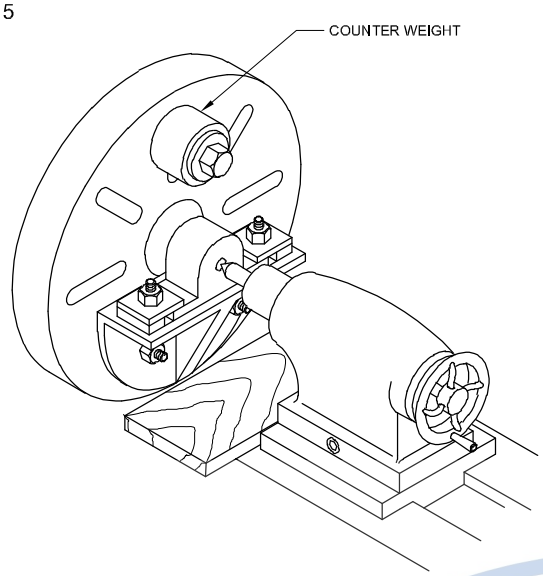
Fig 5



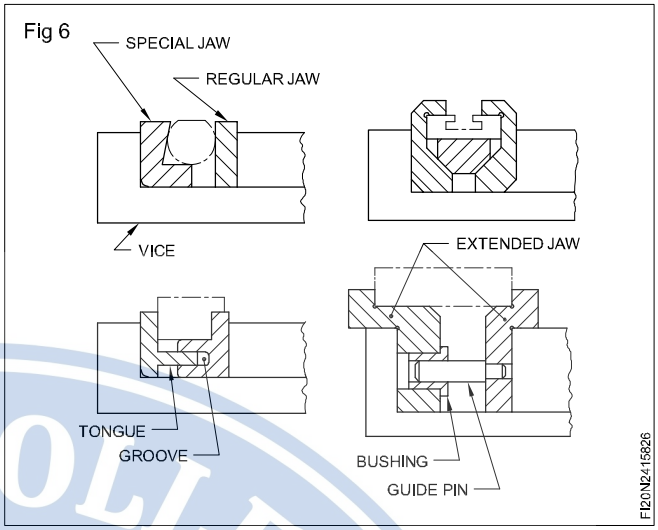
Vice fixture

Standard machine vices, attached with special jaws, provide an easy method of holding parts for machining. (Fig 6)

Other types of tooling used for positioning parts relative to each other for fabricating purposes are also commonly referred to as fixtures. Bending fixtures, assembly fixtures and welding fixtures are examples of this type.

The construction of a fixture depends upon the machining and fabricating methods employed.

Fig 6



Difference between jigs and fixtures

Jigs	Fixtures
jig holds and positions the work piece, guides the cutting tool	Fixture only hold and position the work piece, does not guide the cutting tool
Jig is not fixed to the machine table	Fixture is usually fixed to the machine table
Jigs are used in drilling machine for drilling, tapping, counter boring, and countersinking etc.	Fixtures are used in grinding, milling, turning, bending and assembling.

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Aluminium and its alloys

Objectives : At the end of this lesson you shall be able to
- **state the properties and uses of aluminium**
- **name the commonly used aluminium alloys and their uses**
- **name the ores from which aluminium is produced, and differentiate aluminium vs steel.**

Aluminium is a non-ferrous metal which is extracted from 'BAUXITE'. Aluminium is white or whitish grey in colour. It has a melting point of 660°C. Aluminium has high electrical and thermal conductivity. It is soft and ductile, and has low tensile strength. Aluminium is very widely used in aircraft industry and fabrication work because of its lightness. Its application in the electrical industry is also on the increase. It is also very much in use in household heating appliances. Some typical aluminium alloys, their composition and applications are given in the table that follows.

Aluminium alloys - Composition - Uses

Composition(%) (Only the percentage of alloying elements is shown. The remaining is aluminium)						Category	Applications
Copper	Silicon	Iron	Manganese	Magnesium	Other elements		
0.1 max.	0.5 max.	0.7 max.	0.1 max.	-	-	Wrought. Not heat treatable.	Fabricated assemblies, Electrical conductors. Food and brewing, processing plants. Architectural decorations.
0.15 max.	0.6 max.	0.75 max.	1.0 max.	4.5 to 5.5	0.5 Chromium	Wrought. Not heat treatable.	High strength ship building and engineering products. Good corrosion resistance.
1.6	10.0	-	-	-	-	Cast, not heat treatable.	General purpose alloy for moderately stressed pressure die-castings.
-	10.0 to 13.0	-	-	-	-	Cast, not h eat treatable.	One of the most widely used alloys. Suitable for sand,gravity and pressure die castings. Excellent foundry characteristics. Used for large marine, automotive and general engineering castings.
4.2	0.7	0.7	0.7	0.7	0.3 Titanium (option)	Wrought. Heat treatable.	Traditional 'Duralumin'. General machining alloy. Widely used for stressed components in aircraft.
-	0.5	-	-	0.6	-	Wrought. Heat treatable.	Corrosion-resistant alloy for lightly stressed components such as glazing bars, window sections and automotive body components.
1.8	2.5	1.0	-	0.2	0.15 Titanium 1.2 nickel	Cast. Heat treatable.	Suitable for sand and gravity die casting. High rigidity with moderate strength and shock resistance. A general purpose alloy
-	-	-	-	10.5	0.2 Titanium	Cast. Heat treatable.	A strong, ductile and highlycorrosion-resistant alloy used for air craft and marine castings, both large and small.

Advantages of using aluminium over steel

Advantages

- lighter
- strength comparable to steel
- corrosion resistance
- good machinability
- can be anodized
- better thermal and electrical conductivity

Disadvantages

- less strength (compared to the higher strength steel alloys)
- not good for threaded fasteners
- more difficult to paint
- weldments require post welding heat treat to recover mechanical properties
- more difficult to weld
- fatigues
- high cost
- lower modulus of elasticity,therefore,increased deformation
- low elongation values

Aluminium and aluminium alloys

Aluminium is one of the most widely used metals in the world. It possesses an exciting range of properties. Moreover,aluminium combines with alloying elements like copper. manganese,silicon,magnesium and zinc,and forms a very useful series of alloys.

Important properties

- Aluminium is a light weight metal. Its density is about 2.7 gm/cm^3. It is about one third as light as steel.
- While pure aluminium has a low strength of 7 kgf/mm^2, the alloys are moderately strong Some alloys have strength as high as 45 kgt/mm^2 in the heat - treated condition.
- The above two properties together provide it with high strength to weight ratio,which makes it suitable for aerospace application.
- Some of the alloys have excellent toughness at low temperatures,making them suitable for cryogenic (below 0° C) application.
- Some alloys have excellent corrosion resistance.
- Aluminium and its alloys have high thermal conductivity.
- Aluminium and its alloys also have high electrical conductivity.

Applications

- Household furniture and utensils.
- Containers,tanks and vessels.
- Automobile structures,bus bodies,road and railway tankers and wagons.
- Buildings and other architectural structures.
- Portable bridges.
- Aircraft,missiles and other aerospace components.
- Radiators and other heat exchangers.
- Electrical conductor cables and bus bars.

Aluminium alloy system

Aluminium alloys are classified on the basis of the principal alloying element present in a particular alloy.

Aluminium vs steel

Steel and aluminium are two of the most widely used materials on the planet.

Aluminium is the second-most abundant metallic element on Earth after silicon, while steel is the world's most popular alloy.

While both metals have countless uses, there are a few key factors that can help you one is best for the job.

Corrosion resistance

Aluminium oxidizes via the same type of chemical reaction that causes iron to rust. But unlike iron oxide, aluminium oxide sticks to the metal, shielding it from decay. As a result, it requires no paint or other coating to keep it from rusting.

Steel or carbon (not stainless) steel, to be specific-typically needs to be painted after being spun in order to protect it from rust and corrosion. Zinc is often used to protect against corrosion through the galvanizing process.

Malleability

While steel is extremely durable and resilient, aluminium is considerably more flexible and elastic.

Aluminium's malleability and smooth fabrication allow it to form deep intricate, and precise spinnings giving handlers significant design freedom. Steel is more rigid and will crack or rip if pushed too far during the spinning process.

Strength

Despite being at risk for corrosion, steel is still harder than aluminium.

While aluminium does increase in strength in colder environments, it is generally more prone to dents and scratches than steel.

Steel is less likely to warp or bend from weight, force, or heat. These resistant properties make it one of the most durable industrial materials.

Weight

Steel's superior strength also comes with a weight/density that is 2.5 times that of aluminium. It weighs approximately 60 percent less than concrete, however, making it easier to transport and use in various construction and fabrication applications.

With that said, shape and structural rigidity can contribute significantly to the strength of a structure, and when those two factors are optimized, aluminium can provide similar reliability to a comparable steel structure at half the weight.

For example, there is a rule of thumb in boat building that aluminium is roughly half the strength of steel at one-third the weight. This means that an aluminium vessel can be built at a given strength that is two-thirds the weight of a comparable steel boat.

Cost

The cost of aluminium and steel is constantly in flux based on global supply and demand, related fuel costs, and the iron and bauxite ore market. Even with that fluctuation, however, steel is typically cheaper than aluminium.

Lead and its alloys

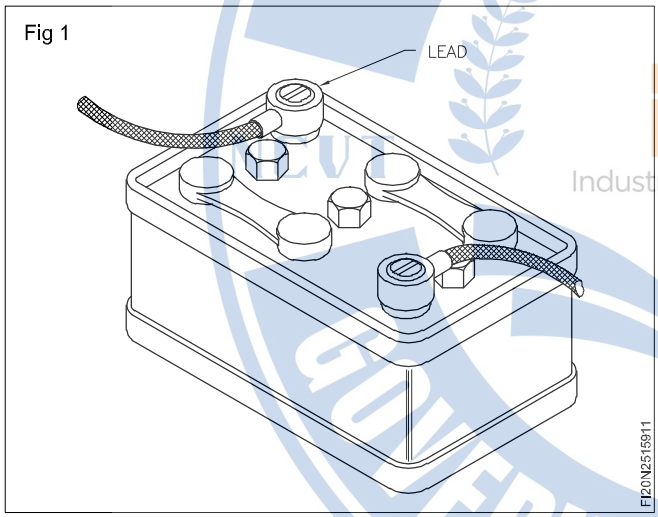
Objectives : At the end of this lesson you shall be able to
- **state the properties of lead**
- **state the various uses of lead**
- **state the uses of babbit metal.**

Lead is a very commonly used non-ferrous metal and has a variety of industrial applications.

Lead is produced from its ore 'GALENA'. Lead is a heavy metal that is silvery in colour when molten. It is soft and malleable and has good resistance to corrosion. It is a good insulator against nuclear radiation. Lead is resistant to many acids like sulphuric acid and hydrochloric acid.

It is used in car batteries, in the preparation of solders etc. It is also used in the preparation of paints.(Fig 1)

Fig 1



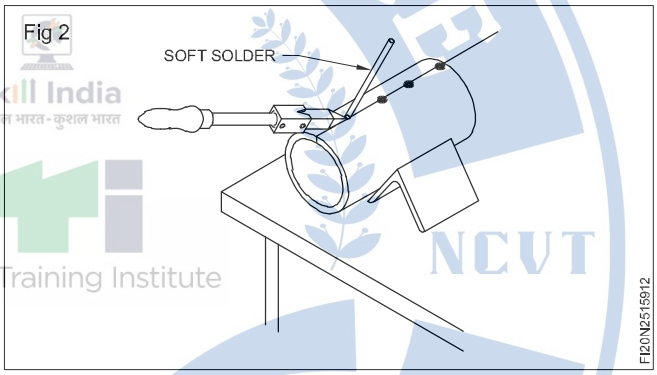
Lead Alloys

Babbit metal

Babbit metal is an alloy of lead, tin, copper and antimony. It is a soft, anti-friction alloy, often used as bearings.

An alloy of lead and tin is used as 'soft solder'.(Fig 2)

Fig 2



Zinc

Objectives : At the end of this lesson you shall be able to
- **state the properties and uses of zinc**
- **state the uses of zinc alloys.**

Zinc is a commonly used metal for coating on steel to prevent corrosion. Examples are steel buckets, galvanized roofing sheets, etc.

Zinc is obtained from the ore-calamine or blende.

Its melting point is 420°C.

It is brittle and softens on heating; it is also corrosion resistant. Due to this reason it is used for battery containers and is coated on roofing sheets etc.

Galvanized iron sheets are coated with zinc.

Tin and its alloys

Objectives : At the end of this lesson you shall be able to
- **state the properties and uses of tin**
- **name the common tin alloys and state their uses.**

Tin

Tin is produced from cassiterite or tinstone. It is silvery white in appearance, and the melting point is 231°C. It is soft and highly corrosion-resistant.

It is mainly used as a coating on steel sheets for the production of food containers. It is also used with other metals, to form alloys.

Eg. Tin with copper to form bronze. Tin with lead to form solder. Tin with copper, lead and antimony to form babbit metal.

Copper and its alloys

Objectives : At the end of this lesson you shall be able to
- **name the commonly used copper alloys**
- **state the properties and uses of copper**
- **state the composition and uses of different types of brasses**
- **state the composition and uses of different types of bronze.**

Metals without iron (Ferrum) are called non-ferrous metals. Eg. Copper, Aluminium, Zinc, Lead and Tin.

Copper

This is extracted from its ores 'MALACHITE' which contains about 55% copper and 'PYRITES' which contains about 32% copper.

Properties

Reddish in colour. Copper is easily distinguishable because of its colour.

The structure when fractured is granular, but when forged or rolled it is fibrous.

It is very malleable and ductile and can be made into sheets or wires.

It is a conductor of electricity. Copper is extensively used as electrical cables and parts of electrical apparatus which conduct electric current. (Fig 1)

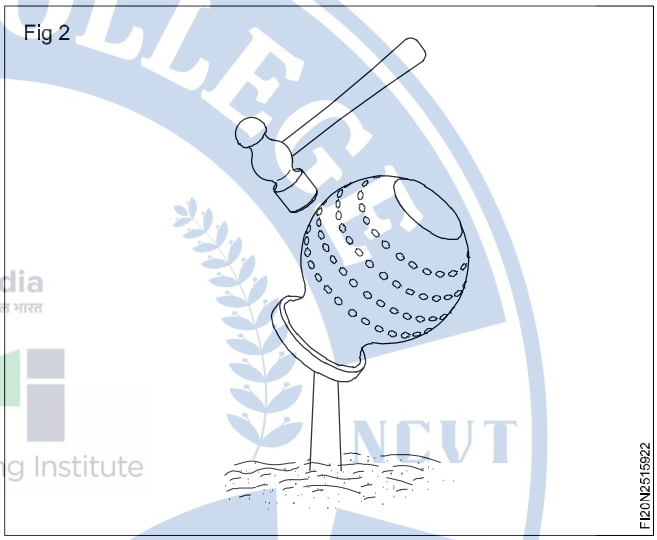
Fig 1

Copper is a good conductor of heat and also highly resistant to corrosion. For this reason it is used for boiler fire boxes, water heating apparatus, water pipes and vessels in brewery and chemical plants. Also used for making soldering iron.

The melting temperature of copper is 1083°C.

The tensile strength of copper can be increased by hammering or rolling. (Fig 2)

Fig 2



Copper alloys

Brass

It is an alloy of copper and zinc. For certain types of brass small quantities of tin or lead are added. The colour of brass depends on the percentage of the alloying elements. The colour is yellow or light yellow, or nearly white. It can be easily machined. Brass is also corrosion-resistant.

Brass is widely used for making motor car radiator core and water taps etc. It is also used in gas welding for hard soldering/brazing. The melting point of brass ranges from 880 to 930°C.

Brasses of different composition are made for various applications. The following table-1 gives the commonly used brass alloy compositions and their application.

Bronze

Bronze is basically an alloy of copper and tin. Sometimes zinc is also added for achieving certain special properties. Its colour ranges from red to yellow. The melting point of bronze is about 1005°C. It is harder than brass. It can be easily machined with sharp tools. The chip produced is

granular. Special bronze alloys are used as brazing rods. Bronze of different compositions are available for various applications. Table-2 gives the type compositions and applications Table 1 - Composition of different types of brass.

Table 1 - Composition of different types of brass

Name	Composition (%)			Applications
	Copper	Zinc	Other elements	
Cartridge brass	70	30	-	Most ductile of the copper/zinc alloys. Widely used in sheet metal pressing for severe deep drawing operations. Originally developed for making cartridge cases, hence its name.
Standard brass	65	35	-	Cheaper than cartridge brass and less ductile. Suitable for most engineering processes.
Basic brass	63	37	-	The cheapest of the cold working brasses. It lacks ductility and is only capable of withstanding simple forming operations.
Muntz metal	60	40	-	Not suitable for cold working, but suitable for hot-working. Relatively cheap due to its high zinc content. It is widely used for extrusion and hot-stamping processes.
Free-cutting brass	58	39	3% lead	Not suitable for cold working but excellent for hot working and high speed machining of low strength components.
Admirality brass	70	29	1% tin	This is virtually cartridge brass plus a little tin to prevent corrosion in the presence of salt water.
Naval brass	62	37	1% tin	This is virtually Muntz metal plus a little tin to prevent corrosion in the presence of salt water.
Gilding metal	9	5	-	Used for jewellery.

Table 2 - Composition of different types of bronze

Name	Composition (%)				Applications
	Copper	Zinc	Phosphorus	Tin	
Low tin bronze	96	-	0.1 to 0.25	3.9 to 3.75	This alloy can be severely cold-worked to harden it so that it can be used for springs where good elastic properties must be combined with corrosion resistance,fatigue-resistance and electrical conductivity. Eg.Contact blades
Drawn phosphor/ bronze	94	-	0.1 to 0.5	5.9 to 5.5	This alloy is used for turned components requiring strength and corrosion resistance, such as valve spindles.
Cast phosphor/ bronze	89.75 to 89.97		0.03 to 0.25	10	Usually cast into rods and tubes for making bearing bushes and worm wheels. It has excellent anti-friction properties.
Admirality gun-metal	88	2	-	10	This alloy is suitable for sand casting where fine-grained, pressure-tight components such as pump and valve bodies are required.
Leaded gun-metal (free cutting)	85	5 (5%lead)	-	5	Also known as 'red brass' this alloy is used for the same purposes as standard, admirality gun-metal. It is rather less strong but has improved toughness and machining properties.
Leaded (plastic) bronze	74	(24%lead)	-	2	This alloy is used for lightly loaded bearings where alignment is difficult. Due to its softness, bearings made from this alloy 'bed in' easily.

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Power Transmission Elements

Objectives : At the end of this lesson you shall be able to
- **name the different types of belts**
- **name the different types of belt fasteners.**

Introduction

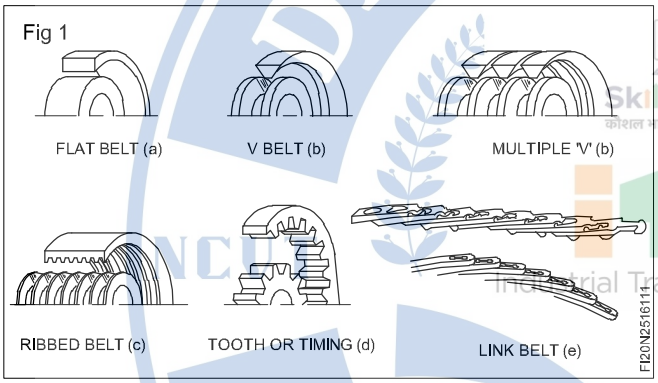
Power transmission is a process of transmit motion from one shaff to another by using some connection between them like belt, rope, chain and gears. Main types of power transmission elements are describe d below

Types of belts

Basically five types of belts are used for the transmission of power.

- Flat belt (Fig 1a)
- V-belt and multiple V-belt (Fig 1b)
- Ribbed belt (Fig 1c)
- Toothed or timing belt (Fig 1d)
- Link belt (Fig 1e)

Fig 1



The choice of a particular belt depends upon speed ratio, centre distance, flexibility, strength, economy and maintenance consideration of the driving system.

V-belts

'V'belt drives are generally used when the distance between the shafts is too short for flat belt drives. Owing to the wedge action between the belt and the sides of the groove

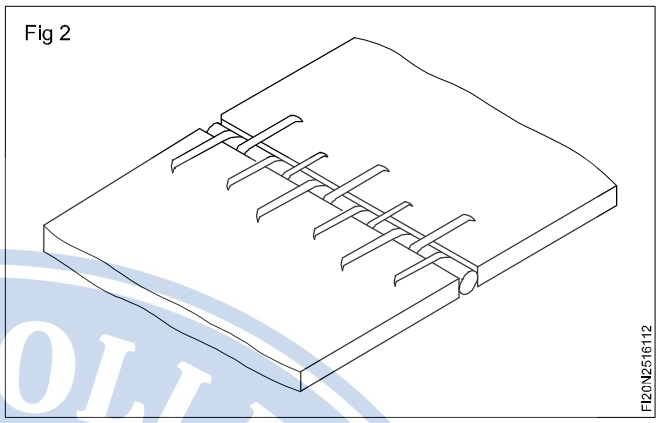
Types of fasteners

The belt fasteners commonly used in addition to the alligator type are as follows.

Wire type belt fastener

Fig 2 shows the wire type fastener generally used on light duty machines.

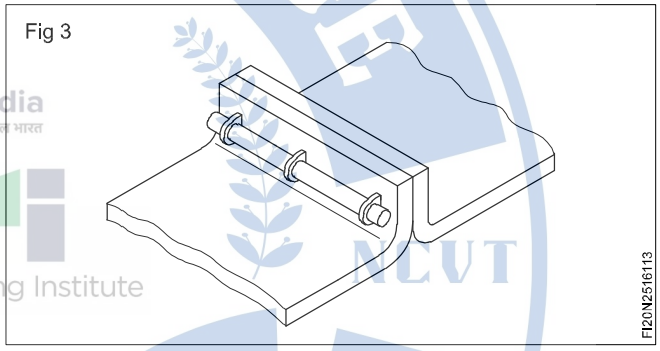
Fig 2



'Lagrelle' type belt fastener

Fig 3 shows a lagrelle type fastener used on heavy duty machines.

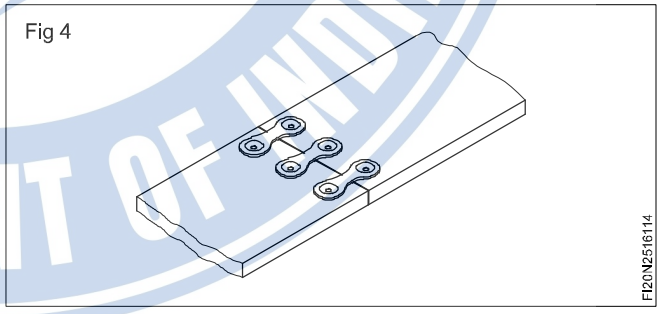
Fig 3



Jackson-type belt fastener

The Jackson-type fastener illustrated in Fig 4 is used on medium duty machines.

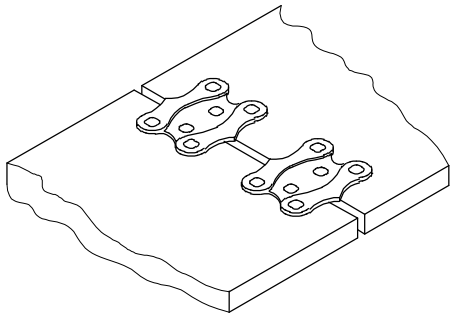
Fig 4



Crescent plate belt fastener

Fig 5 shows a mechanical type belt fastner which is used on medium duty machines.

Fig 5



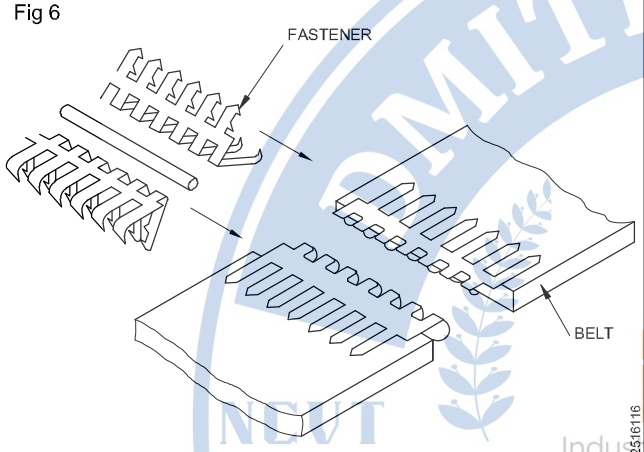
"CRESCENT" - PLATE BELT FASTENER

FI20N2516115

Belt fasteners (Alligator type)

Alligator type fasteners are used in joining belting for industrial purposes. The belt fastener is made of steel sheets conforming to IS:513-1973. The pins shall be made from mild steel wire conforming to IS: 280-1972. Belt fasteners are shown in Fig 6 and the position of the pin in a joint is illustrated in Fig 7.

Fig 6



ALLIGATOR TYPE BELT FASTENER

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Specification

The fastener designation and pin size, thickness of belt and other dimensions are given in the table as per IS: 5593-1980.

Fig 7

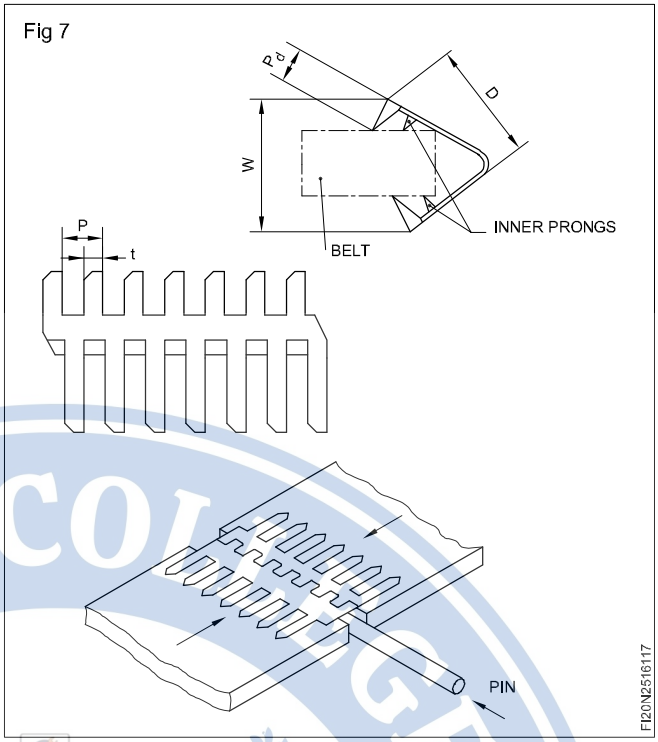

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Table - 1

Fastener Designation	Thickness of belt	Metal thickness (Sheet)	Point depth P_d	Approx overall width W	Approx overall depth t_1 Min D	Width of bar prong P	Pitch of prong
15	3 to 4	1.0	5.0	18	13	2.5	6
20	4 to 5	1.1	6.5	22	17	3	8
25	5 to 5.5	1.2	7.0	25	21	3	8
27	5.5 to 7	1.2	8.0	29	24	3	8
35	7 to 8	1.8	9.5	32	30	4	10
45	8 to 9.5	1.8	11.0	38	31	5	12
55	9.5 to 11	2.0	14.0	48	40	6.5	16
65	11 to 13	2.0	16.0	54	41	6.5	16

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Fastener designation	Pin in size mm
15,20,25 27,35 45,55,65	2.64 3.25 4.06

Belts tension

Objectives : At the end of this lesson you shall be able to
- **state the need for tensioning belts**
- **state the methods of adjusting belt tension**
- **state the importance of the arc of contact in a belt drive**
- **state the important factors for improving the efficiency in a belt drive**
- **calculate the deflection force necessary for a belt drive**
- **state the care and maintenance of belts.**

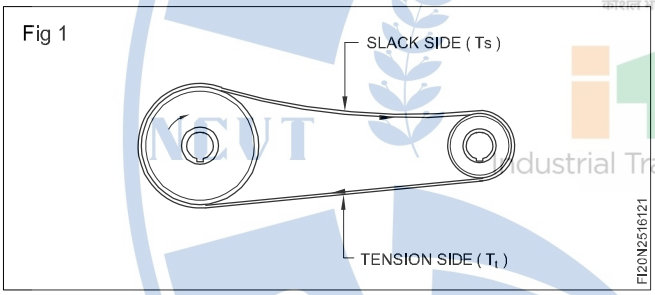
Belt tension

Belts must be tensioned correctly to transfer the torque from the driving pulley to the driven pulley to prevent unnecessary wear.

Too much of belt tension curtails belt and bearing life. As the belts stretch in use, it is necessary to check and adjust the belt drive tension.

When a drive is transmitting power the belt pulls or the belt tensions. There is the tight side tension (Tt) and a slack side tension (Ts). (Fig 1)

Fig 1



Tension ratio

The ratio of the tight side to the slack side tension is commonly referred to as the tension ratio. A higher ratio between the tight side and slack side tension makes the belt loose and slip.

This causes lack of effective pull for transmitting the required power.

Adjustment of tension

When the distance between two pulleys is fixed, the tension of a belt is adjusted by an idler. (Fig 2)

When the distance between two pulleys is not fixed, the tension of the belt is adjusted by the adjustment screw. (Fig 3)

Arc of contact

Tension is necessary to create friction between the pulleys and the belt. Torque transmission depends on the contact area of the belt over the pulleys. (Fig 4)

Fig 2

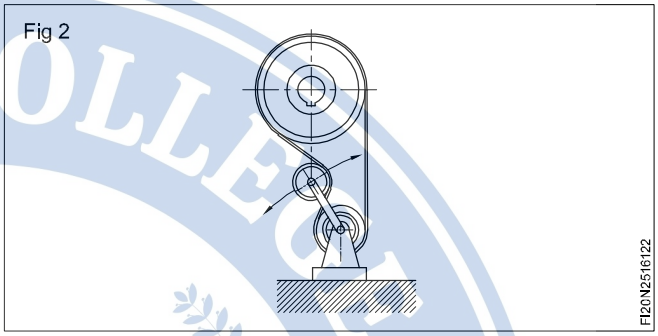


Fig 3

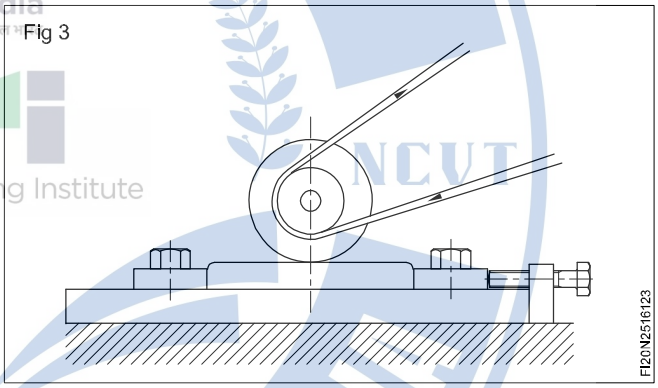
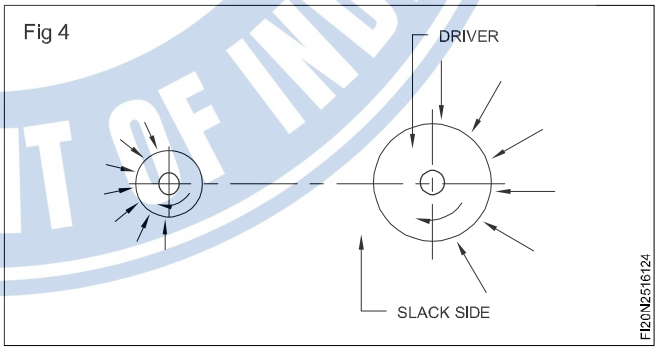


Fig 4



If the wrapping angle is big, the pulley can transmit high torque. (Fig 5)

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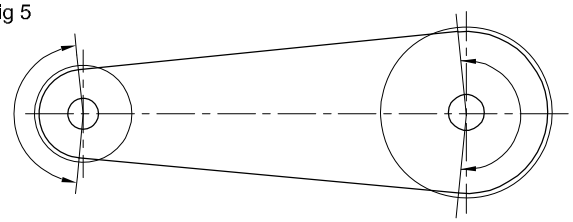
Fig 5



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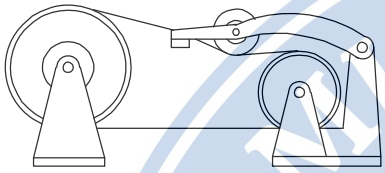
Belt efficiency

To provide maximum arc of contact the following points should be considered.

- Heavy belts of multi ply construction should not be used on small diameter pulleys.
- If the arc of contact is insufficient because of the short centre distance between the pulleys, a jockey pulley should be introduced as near to the small pulley as possible. (Fig 6)

Fig 6



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THE USE OF A JOCKEY PULLEY TO MAINTAIN CORRECT BELT TENSION

Excessive tension in the belt reduces the arc of contact, and introduces additional stresses which drastically reduce the life of the belt and bearings. (Fig 7)

Fig 7

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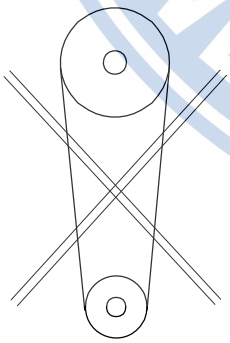
Vertical drives should definitely be avoided because the belt tension necessary to withstand gravitational pull (Fig 8) and accompanying slippage would result in adverse effects.

Fig 8



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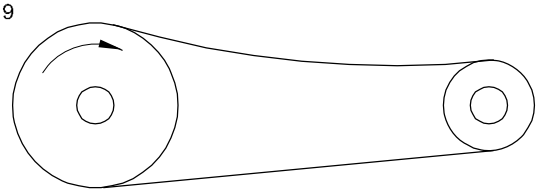
THE EFFECT OF GRAVITY ON A VERTICAL BELT

On the open belt drive, the slack side (Fig 9) must be at the top and the centre distance between the pulleys should be the maximum.

Fig 9



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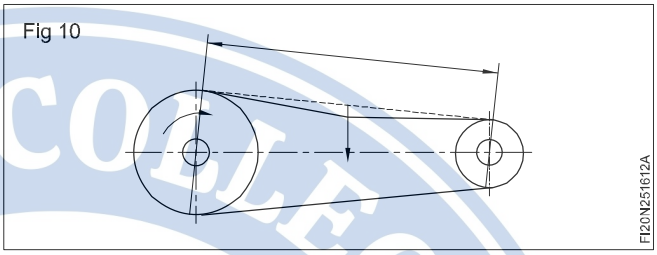
To measure tension of V-belt drives

To determine the force required to deflect one belt per 25 mm span length, apply a force perpendicular to the span at the centre of the belt large enough to deflect one belt to 0.5 mm span from its normal position. (Fig 10)

Fig 10



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- Compare this deflection force with the range of forces given in Table 1.
- If it is less than the minimum recommended deflection force, the belts should be tightened.
- If it is more than the maximum recommended deflection force, the drive is tighter than it need be.

Care and maintenance

- Keep the pulley faces and belts free from foreign material which may cause slips.
- When the 'V' belts begin to show signs of wear they should be replaced. Replace all the belts in a multiple 'V' belt drive rather than a single one.
- Check and adjust drive tension periodically.
- Store belts in a cool, dark and dry place.

The belt tension should be adjusted in such a way that the deflection force is in between the maximum and minimum.

TABLE 1

Recommended deflection force per belt for classical 'V' belts

V-Belt cross-section	Small sheave dia. range cm	Speed ratio range	Recommended deflection force Kg	
			Min.	Max.
A	7.62 - 8.13 8.64 - 9.14 9.65 - 10.67 11.68 - 17.78	2.0 - 4.0	1.08 1.14 1.32 1.59	1.54 1.68 1.91 2.26
B	11.68 12.67 - 13.71 14.22 - 16.25 17.27 - 23.87	2.0 - 4.0	2.00 2.22 2.45 2.81	2.86 3.22 3.53 4.08
C	17.78 19.05 - 20.32 21.59 - 25.4 26.67 - 40.64	2.0 - 4.0	3.4 3.81 4.30 5.00	5.00 5.44 6.36 7.72
D	30.48 - 33.02 34.29 - 39.37 40.64 - 55.88	2.0 - 4.0	7.71 8.6 10.00	10.91 12.27 14.09
E	54.86 - 60.96	2.0 - 4.0	14.54	21.36

Maintenance features of the Vee belt

Trouble	Cause	Remedy recommended
Belt Slips	Less tension. Overload. Oilness in the groove of the pulley or belt.	Increases the tension. Reduce the load. Degrease.
Frequent belt spoilage	Excessive heat. Shock load. Misalignment. Damaged sheave. Foreign particles. Drive overloaded.	Provide ventilation or use neoprane jacket type belt. Avoid shock load as far as possible and increase the belt tension. Align the pulleys. Change the damaged pulley. Provide belt guards. Check that all the belts in the drive have the same tension. If not, provide matching belts.
Belt whips excessively	Centre distance between the pulleys is more. Pulsating load.	Provide an idler. Introduce a fly wheel in the drive system.
Belt squeals.	Drive overloaded. Inadequate arc of contact. High starting torque.	Check that all the belts in the drive are evenly loaded. Provide an idler. Increase the belt tension.

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Vee belts and their advantages, disadvantages

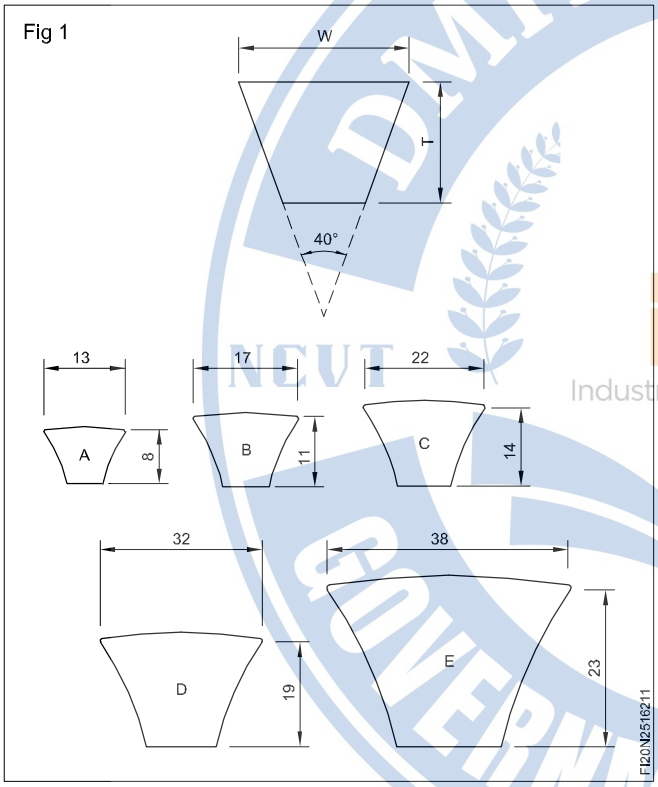
Objectives : At the end of this lesson you shall be able to
- **name of different types of belt**
- **state the advantages of 'V' belt**
- **state the classification of 'V'belt**
- **state the designation of V- belt.**

V- belts

'V' belt drives are generally used when the distance between the shafts is too short for flat belt drives. Owing to the wedge action between the belt and the sides of the groove in the pulley,the V belt is less likely to slip,hence more power can be transmitted.

The endless V belt is shaped roughly like a trapezium in cross- section,and is made of cord and fabric,and is treated with rubber and moulded together in a uniform manner and shape. The cross-sectional symbol of a V - belt is shown in Fig 1.

Fig 1



Advantages of V-belt drive

- It is compact, so installation is possible in limited space.
- It is used when the centre distance between the driver and the driven pulleys is short.
- Less vibration and noise.
- Cushions the motor and bearing against load fluctuation.
- Easy replacement and maintenance.

Classification of 'V'belts

The 'V' belts are classified into 5 groups as per IS.2494-1974 namely A,B,C,D and E. The nominal included angle of the V-belt shall be 40°.

Table 1 given below lists the standard sizes of V-belts from Section A to E.

TABLE - 1

Cross-section Symbol	Nominal Top Width W (mm)	Nominal Thickness (T)
A	13	8
B	17	11
C	22	14
D	32	19
E	38	23

Individual manufacturer's belts may deviate slightly from these dimensions for various constructional reasons. Crowning, if any, in belts should be disregarded for the measurement of thickness.

Designation of V-belt as per IS.2494

The V belts conforming to this standard shall be designated by the cross-section symbol, nominal inside length and the number of IS: standard.

Example

C 3048 IS: 2494

C = V-belt cross-section

3048 = Nominal inside length in mm. in untensioned state.

'V' belts creep, slip

Objectives : At the end of this lesson you shall be able to
- **list the use of commercial 'V' belt**
- **brief the term creep and slip**
- **explain the purpose of belt dressing**
- **calculate length of open belt.**

Use of commercial belt

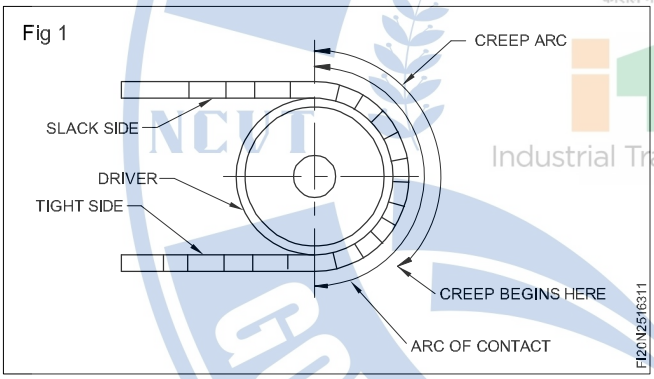
A belt is a loop of flexible material used to link two or more rotating shafts mechanically,most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points.

Commercial belts are mainly used in home appliances like,grinder,mixie and washing machine etc.

Creep and slip of belt (Fig 1)

Fig 1



As the belt turns on a pulley it tends to strech on the contact area of the driving pulley and shorten on the driven pulley. This localised movement of the belt is a direct result of the elastic stretch and is known as creep, Greater the load more will be the creep. The figure shows the condition of belt as a result of creep.

Slip is the actual difference caused between the surface speed of the belt and pulley. The effect of slip may be reduced by decreasing the pulley ratio and maintaining proper alignment. Creep, being the physical characteristic of the belt, cannot itself be controlled. Slip and creep jointly cause power loss.

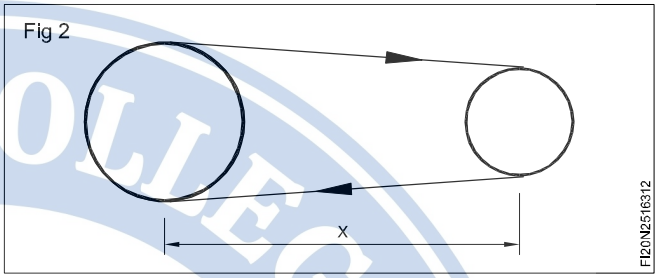
Belt dressing

Due to the continuous rubbing of the belt on the surface of the pulley the belt gets dried up due to friction, and heat is generated. This causes the belt to slip.

To keep the belt supple and free from cracks, belt dressing is applied. Tallow or powdered resin are good dressing materials which are applied on the inner face of the belt. This improves the gripping property of the belt.

Open belting (Fig 2) calculation

Fig 2

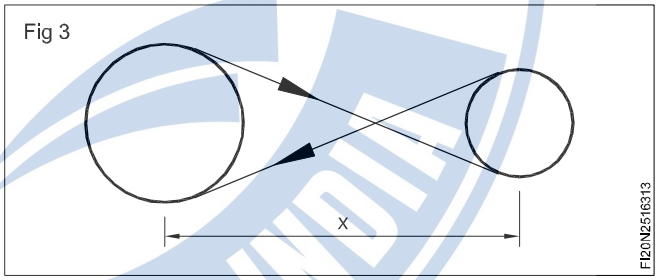


If L = length of open belting
D = dia. of larger pulley
d = diameter of smaller pulley
x = centre distance between the pulleys

then, $L = \frac{D + d}{2} \times 3\frac{1}{7} + 2x$

Cross-belting (Fig 3)

Fig 3



If L_C = length of cross-belting
C = circumference of larger pulley
c = circumference of smaller pulley
R = radius of larger pulley
r = radius of smaller pulley
x = centre distance between the pulleys

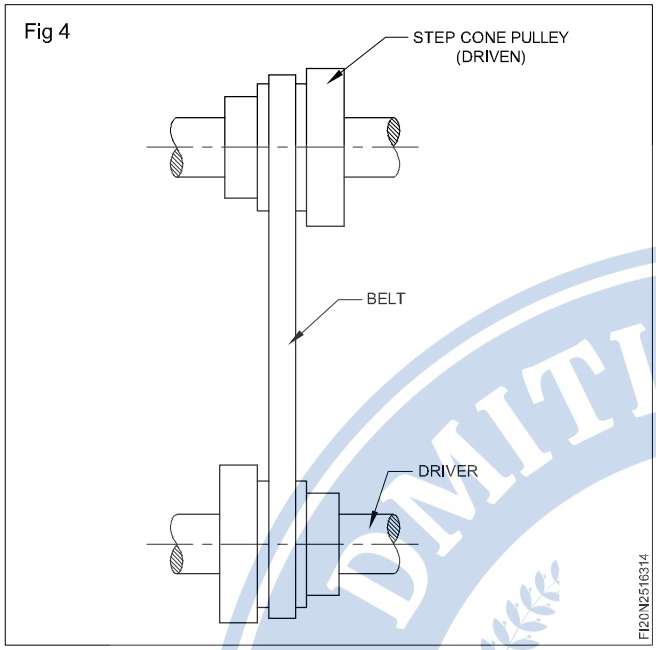
then, $L_c = \frac{C}{2}+\frac{c}{2}+2\sqrt{x^2+(R+r)^2}$

stepped drives (Fig 4)

Stepped drives are used to obtain different speed ratios. Pulleys of different sizes are employed.

Three different speeds can be obtained by changing the belt position from one step to another.

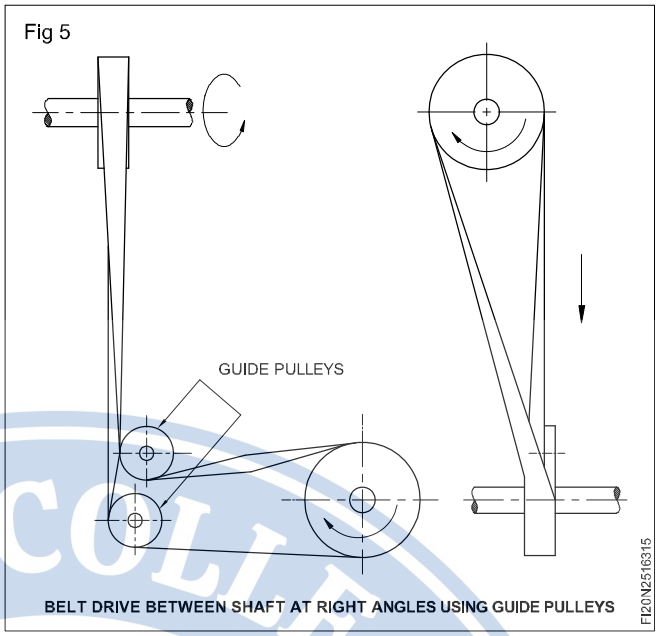
Fig 4



Right angled drive (Fig 5)

This drive is employed between shafts at right angles using tide pulleys. In this the horizontal drive is converted into vertical drive with the help of the guide pulleys.

Fig 5



BELT DRIVE BETWEEN SHAFT AT RIGHT ANGLES USING GUIDE PULLEYS

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Couplings - Types of couplings

Objectives : At the end of this lesson you shall be able to
- **state the types of couplings**
- **state the purpose of couplings.**

Introduction

Power is transmitted from one end to the other com monly by means of shafts

If the distance between the two ends is large (say 8- 10 m), it would be inconvenient and expensive to have one such long length of shaft both from manufacturing and transport point of views.

Hence, it is recommended to connect a number of pieces by means of suitable couplings to transmit power from on end to the other.

Types

Shaft couplings may be broadly classified as:

1 Rigid or fast coupling
2 muff coupling
3 Flange coupling
4 Flexible coupling
5 Pin bush coupling
6 Chain coupling
7 Gear coupling
8 Spider coupling
9 Tyre coupling
10 Grid coupling
11 Old ham coupling
12 Fluid coupling
13 Universal coupling

1 Rigid or fast coupling

This type of couplings provide rigid connection between the two shafts without permitting any relative motion between them.

The important types of rigid couplings are

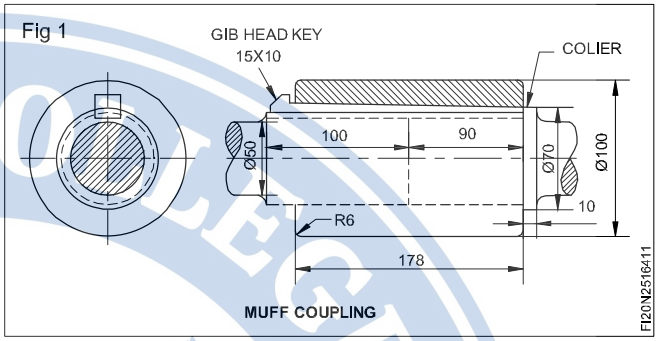
- unprotected type flanged coupling
- protected type flanged coupling
- Solid or forged flanged coupling
- Muff couplings
- Compression coupling

2 Muff coupling

In muff or sleeve coupling shown in fig 1, the ends of the two shafts to be coupled butt against each other and a cast iron muff or sleeve envelops them.

A gib - headed sunk key is provided to hold the sleeve and the shafts together, thus forming a rigid coupling.

Fig 1



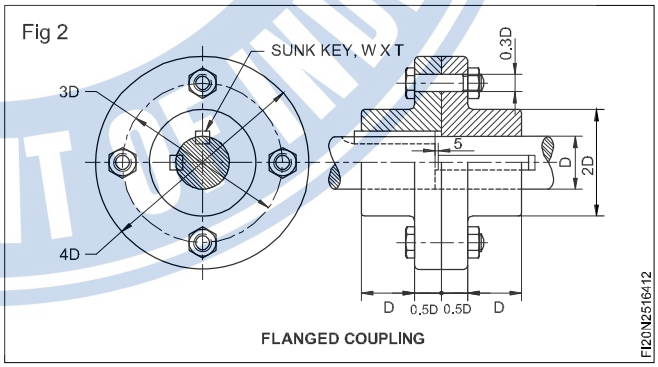
3 Flanged coupling

These are the standard forms of couplings, most extensively used. In a flanged coupling, flanges are either fitted or provided at the ends of shafts. The flanges are fastened together by means of a number of bolts and nuts. The number and size of the bolts depend upon the power to be transmitted and hence, the shaft diameter.

3.1. Flanged coupling with detachable flanges

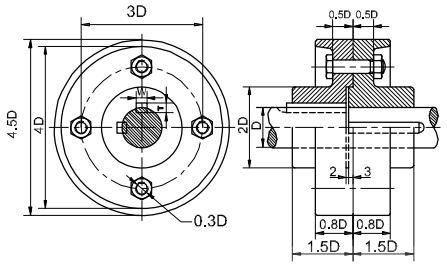
In this, two flanges are keyed, one at the end of each shaft, by means of sunk keys (Fig 2) For ensuring correct alignment. a cylindrical projection may be provided on one flange which fits into the corresponding recess in the other.

Fig 2



In the design shown in figure, the bolt heads and nuts are exposed and liable to cause injury to the workman. Hence, as a protection, the bolt heads and nuts may be covered by providing an annular projection on each flange. A flanged coupling, using these flanges is called a protected flanged coupling (Fig 3).

Fig 3

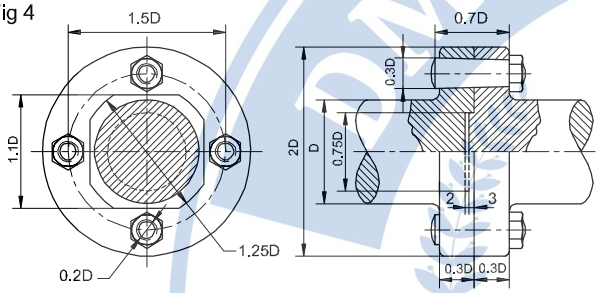


PROJECTIVE FLANGED COUPLING

3.2. Solid flanged coupling

Couplings for marine or automotive propeller shafts demand greater strength and reliability. For these applications, flanges are forged integral with the shafts. The flanges are joined together by means of a number of headless taper bolts (Fig 4)

Fig 4

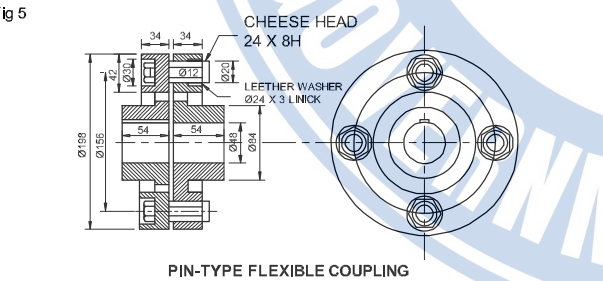


SOLID FLANGED COUPLING

4 Flexible Coupling (Fig 5)

- Flexible couplings are used where slight relative movement is required or the axis of shafts run slightly out of line.

Fig 5



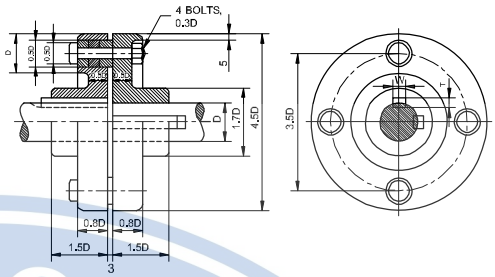
PIN-TYPE FLEXIBLE COUPLING

- Here the motion from one half of the coupling to the other half is imparted with the help of driving pins rigidly bolted to one flange and loosely fitting corresponding holes in the other.
- Brass bush and rubber covering is provided on the driving pins for absorbing shocks and as insulators.

5 Bushed Pin type Flanged Couping (Fig 6)

It is the modified version of a protected flanged coupling. In this, bolts are replaced by bushed pins. The smaller ends of the pins are rigidly fastened by nuts to one of the flanges, while the enlarged ends are covered with flexible material like leather or rubber bushes, in the other flange. The flexible medium takes care of mis - alignment, if any, and acts as a shock absorber. These couplings are used to connect prime mover or an electric motor and a centrifugal pump.

Fig 6

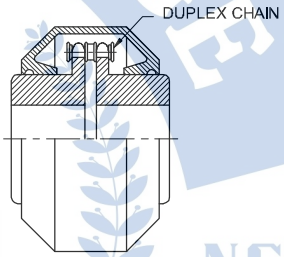


BUSHED PIN TYPE FLANGED COUPLING

6 Chain Coupling (Fig 7)

Flanges replaced a sprocket on each shaft. The coupling is by a duplex chain wrapped over both adjacent coupling.

Fig 7

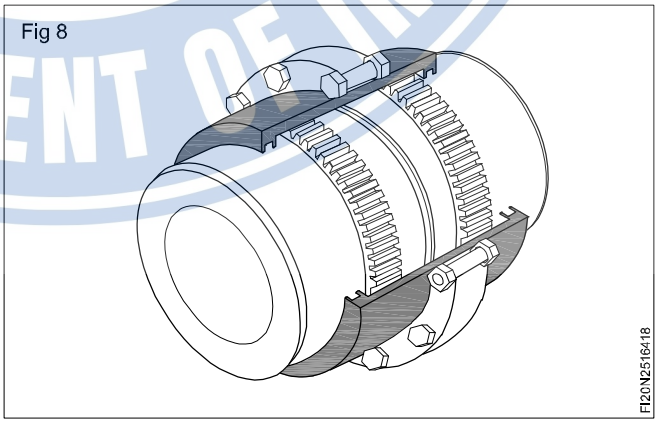


CHAIN COUPLING

7 Gear Coupling (Fig 8)

Both coupling halves have a raised rim machined as an external gear. The sleeve which couples the two shafts comprises two halves bolted together, each half having a machine internal gear. This coupling requires lubrication. The coupling is capable of hgh speeds and high power capacity.

Fig 8



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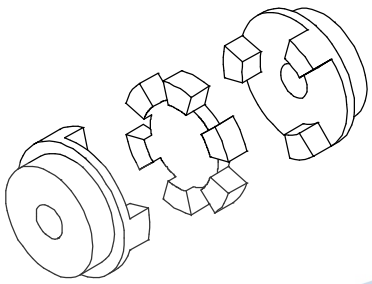
8 Spider (Fig 9)

Both half of the couplings have three shaped lugs. When the coupling halves are fitted together the lugs on one half fit inside the spaces between the lugs on the other side. A rubber insert with six legs fits within the spaces between the lugs. The drive is by the lugs transmitting the torque through the rubber spider spacer. This coupling is only used for low power drives.

Fig 9



SPIDER COUPLING

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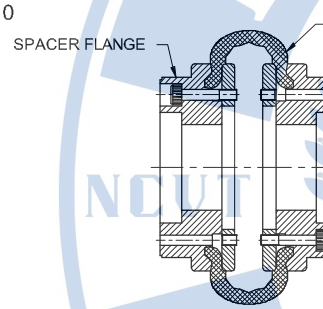
9 Tyre Coupling (Fig 10)

Tyre coupling device is used to reduce vibration in engines and also reduces the torque oscilation. It is available in different versions such as F or H type. And customers can find tyre coupling in various dimensions and in taper lock fitting models. It is applicable in compressors, pumps, blowers. etc.,

Fig 10



TYRE COUPLING

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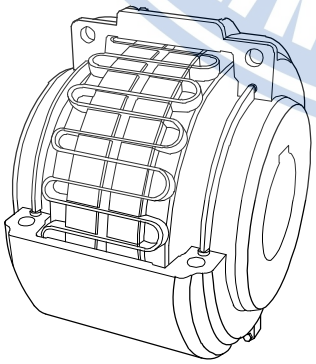
10 **Grid Coupling** (Fig 11)

Metal coupling that provides positive protection against the damaging effects of shock loads and vibration. Both Grid couplings are an excellent choice where torsional flexibility /vibration damping are primary concerns.

Fig 11



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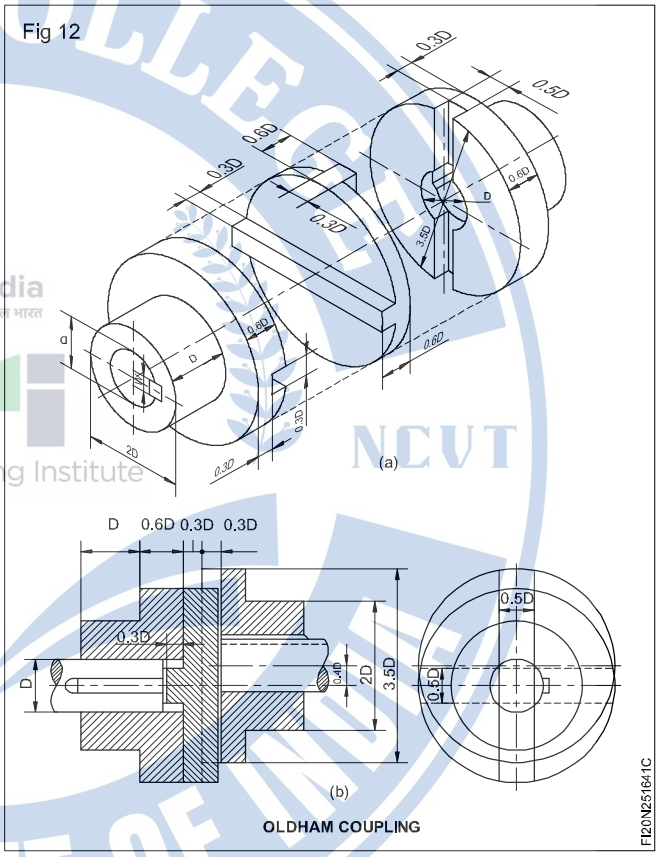
- Easy to assemble/replace
- Part - for - part interchangeable with industry standard grid coupling designs.
- Coupling sizes 2020 through 2140 in - stock in a range of standard bore sizes.
- Shot - peened tapered grid flex element for long llife.

Typical Applications:

- Pumps
- Gear Boxes
- Electric Motors
- Fans/Blowers
- Conveyors
- Compressors

11 Oldham Coupling (Fig12)

Fig 12



OLDHAM COUPLING

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It is used to connect two parallel shafts whose axes are at a small distance apart. Two flanges, each having a rectangular slot,are keyed, one on each shaft. The two flanges are positioned such that, the slot in one is at right angle to the slot in the other.

To make the coupling, a circular disc with two rectangular projections on either side and at right angle to each other, is placed between the two flanges. During motion, the central disc, while turning, slides in the slots of the flanges. Power transmission takes place between the shafts, because of the positive connection between the flanges and the central disc.

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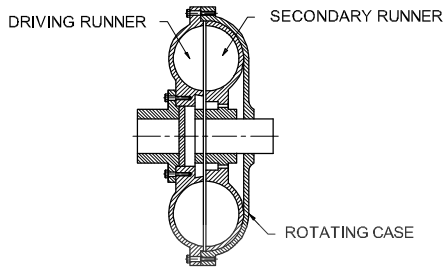
12 Fluid Coupling (Fig 13)

Based on both coupling halves having vanes within a housing (case) containing viscous fluid which rotates with the driving shaft. The rotation is transmitted from one side (Driving) to the other (secondary) via the viscous fluid. The coupling provides a soft start.

Fig 13



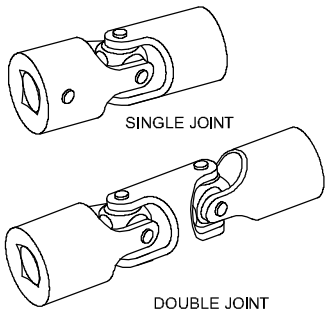
FLUID OUPLING

13 Universal Coupling (Fig 14) (Hooks Coupling)

Coupling which allows large angle between drive halves (20-30°) . Generally based on a yoke mounted on each shaft. Between to yokes in mounted a trunnion cross.

Needle bearings are used at the bearing points between the cross and the yokes. These type or units are used in pairs on carden shafts. Uses widely on rear wheel drive vehicle propshafts.

Fig 14

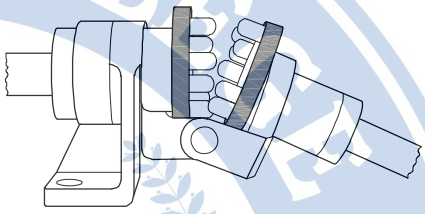


UNIVERSAL COUPLING

14 Universal Coupling - Uni - Joint (Fig 15)

The other name of universal coupling is hook coupling.Simplest type of coupling which allows large angle between drive halves. Each side of coupling includes protruding pins. The halves of the coupling are fastened in a pivotting assembly. At all angles up to about 40° the pins interlock with each other and rotation on one half forces the other half to rotate. Low power use only. Not smooth. Not reliable. Really only suitable for remote manual operations.

Fig 15



COUPLING U-JOINT

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Pulleys - types - solid - split and 'V' belt pulleys

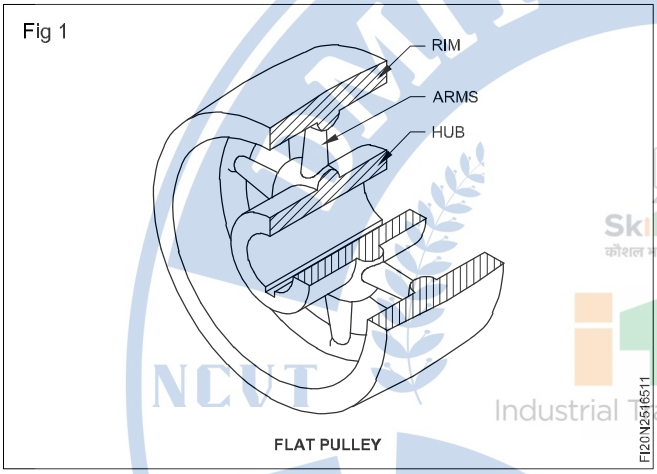
Objectives : At the end of this lesson you shall be able to
- **state the different types of pulleys and their uses**
- **state the purpose of crowning of a pulley**
- **state the importance of wrapping angles in a belt drive**
- **state the maintenance aspects of V belts**
- **state the advantages of a chain drive.**

Pulley for flat belt

Pulleys for flat belts are made from cast iron or mild steel and are available in solid or split form.

The flat pulleys have a wide rim with a crowned surface for retention of the belt. The hub is strongly designed and provides the means of securing the pulley to the shaft. The arms unite the hub and rim into a rigid assembly. The arms of a pulley may be of circular or elliptical cross-section, but larger at the hub than at the rim. (Fig 1)

Fig 1



Crowned face of pulley

The rim of a pulley for flat belt is generally made convex and this is called the crowned face of the pulley. The crown faced pulley will keep the belt centralised even if there is any slight tendency to run off. Shifting the belt from the fast pulley to the 'loose' pulley will be quick and easy. Excessive crowning will be injurious to belting.

'V' groove pulley

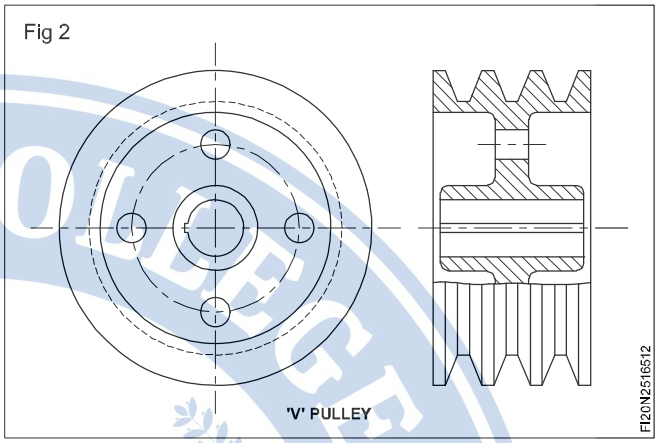
These pulleys have one or more 'V' grooves to carry the V belts. Fig 2 shows a V belt pulley having three V grooves. These pulleys are widely used in transmission of motion in machine tools and are made from cast iron, wrought iron, mild steel or wood.

Fast and loose pulley

Pulleys are usually secured to their shafts by means of a key or grub screw. The function of the pulley keyed to the shaft is to convey rotation from the driving to the driven pulley by means of a belt. This is called a fast pulley.

The loose pulley is not keyed to the shaft and is free to rotate on the shaft.

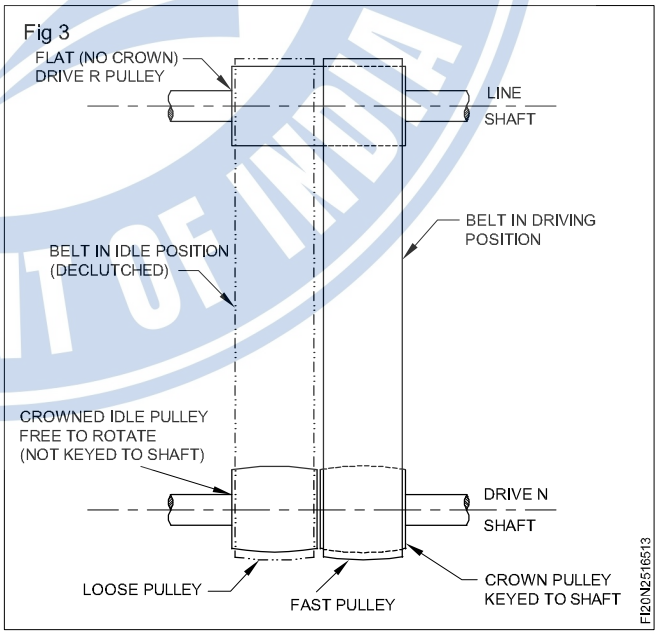
Fig 2



Function

A machine can be easily stopped or started whenever required by the use of a pair of fast and loose pulleys. This pair is mounted on a counter- shaft near the machine to be operated. When the driving belt from the main shaft is on the fast pulley, the countershaft is in motion. If the belt is shifted from the fast pulley on to the loose pulley, the countershaft will stop rotation. Fig 3 shows the position of the fast and loose pulleys in a driving system.

Fig 3

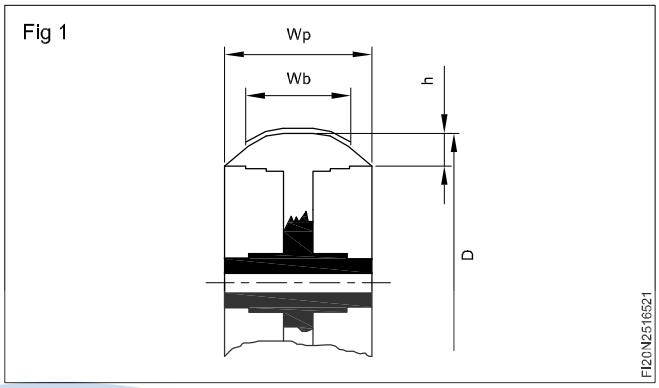


Determining the size of crowning faces of pulley

Objectives: This shall help you to
- **define the importance of crowning**
- **state the specification of standard pulleys.**

Crowning one or several pulleys in belt system is the most common way of tracking a belt. For flat power transmission belts and narrow conveyor belts(up to 8 in.), a radius crown is used. For wider conveyor belts, a trapezoidal crown is typically applied. Note: Never utilize an apex crown!

Fig 1



Radius Crown Specifications for Flat Belt Pulleys

A radius crown represents a great way to track a belt. Dimensionally, it does not take a big crown height in order for the belt to track properly, and exceeding the seemingly small amounts below will actually do more harm than good!

In a system with multiple pulleys, crown the pulleys that turn the same way.

The min. pulley face width

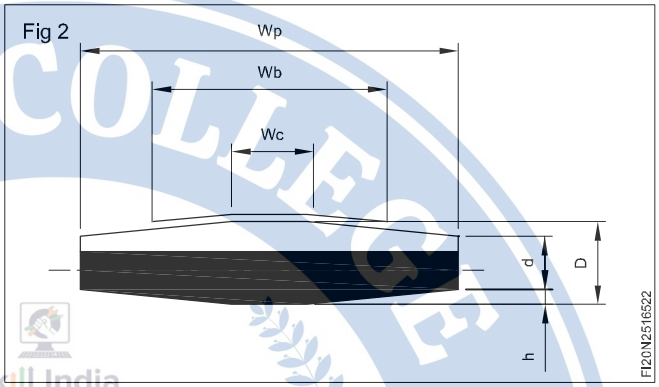
W_p = (belt width W_b x 1.1) + 0.5 in.

The max. belt width

W_b = (pulley face width W_p - 0.5 in) / 1.10

Note:

Fig 2



Standard Radius crown heights h						
Pulley Face Width W_P	Pulley Diameter D					
	1 - 6	6 - 12	12 - 18	28 - 40	40 - 60	> 60
in	in	in	in	in	in	in
1 - 5	0.031	0.047	0.051	0.067	0.078	0.098
5 - 10	0.039	0.051	0.059	0.078	0.090	0.110
10 - 16	0.043	0.055	0.063	0.087	0.098	0.118
> 16	0.047	0.059	0.078	0.098	0.118	0.137

Convert to metric units

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pulley Diameter D	Crown Height h
1 to 2.75	0.012
2.75 to 4	0.017
4 to 6	0.022
6 to 8	0.026
8 to 11	0.034
11 to 14	0.042
> 14	0.045

The cylindrical part of the pulley W_c is half of the belt width W_b. Also, it is recommended for the pulley width w_b for the pulley crown to function properly. For pulley widths less than 8 in., use a radius crown and refer to the flat belt pulley specifications above.

Belt length

Objective: At the end of this lesson you shall be able to
- **Calculate the length of the belt for open belt drive.**

In belting technology, there are a few special expressions and technical data which need a brief explanation.

Belt length

The length of power transmission flat belts can be expressed in three ways:

- Geometric belt lenght (l_g)
- Effective belt length (l_{eff})
- Shortened belt lenght (l_s)

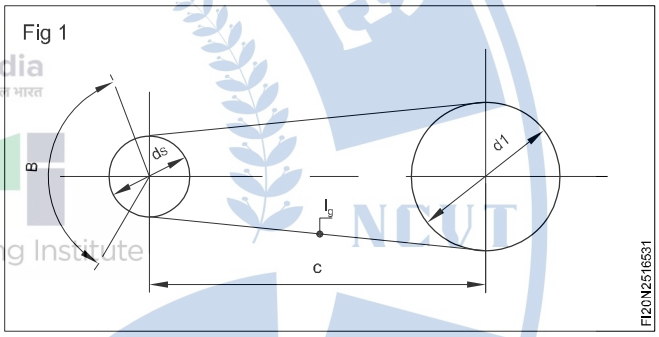
For common two pulley drives, the difference between geometric and effective belt length is negliglble. However, in specific applications, e.g. short centre distance and / or relatively thick belts, limited take -up etc., greater calculation accuracy is necessary.

Please note that the theoretical considerations below are automatically taken into consideration when using the POWER - SeleCalc calculation program.

Geometric belt length (l_g)

The geometric belt length means the inner circumference of an un-tensioned belt drive on the assumption that the belt is infinitely thin. The belt thickness and the position of the neutral layer are not considered.

Fig 1



Exact formula for the calculation of the geometric belt length of a two pulley drive:

$$lg = 2_c \sin(\frac{\beta}{2}) + \frac{\pi}{2}\left[d_S\ d_l + \frac{(d_l - d_S)(180 - \beta)}{180} \right] (mm)$$

c = center distance (mm)

d_s = diameter of small pulley (mm)

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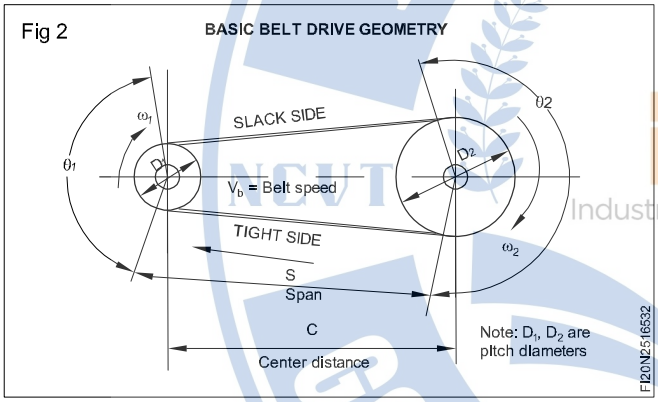
According to SANS 1669 Bag centre	Belt Face 1350	900 1050 1700	1050 1200 1850	1200 1350 2050	1350 1500 2300	1500 1700 2450	1650 1850 2600	1800 2000 2900	2100 2300 3200	2400 2600
Pulley Diameter	Shat Dia Pulley Dia				Resultant tensions (KN)					
200	100/315	21	18	16	13	10	10	9	8	7
250	110/400	30	26	23	19	16	14	13	12	10
315	120/400	45	37	33	27	22	20	19	16	14
400	130/400	60	51	45	37	30	28	26	22	19
500	140/500	80	70	60	50	41	37	35	30	75
630	150/500	100	90	80	66	54	49	45	40	35
800	160/500	119	119	105	86	70	64	60	50	45
1000	170/630	144	144	133	110	88	81	75	65	55
1250	180/630	170	170	165	138	112	100	95	82	70
	190/630	200	200	200	170	138	130	120	100	90

Fig 2 BASIC BELT DRIVE GEOMETRY



d_l = diameter of large pulley (mm)

β = arc of contact on small pulley [°]

$$\beta = 2\arccos\frac{(d_l - d_s)}{2c} = [°]$$

- The belt is placing around the two sheaves while the center distance between them is reduced, then sheaves are moved apart
- Friction causes the belt to grip the driving sheave, increasing the tension in one side, called the "tight side", of the drive
- The opposite side of the belt is still under tension (at a smaller value) that is called the 'slack side'.

Clutches and types

Objectives : At the end of this lesson you shall be able to
- **state the function of clutches**
- **name the different types of clutches**
- **state the application of the different types of clutches.**

Power transmission by clutches

The purpose of the clutch is to connect or disconnect the various mechanisms to the power source. Various types of clutches are incorporated in machine tools.

Types of clutches

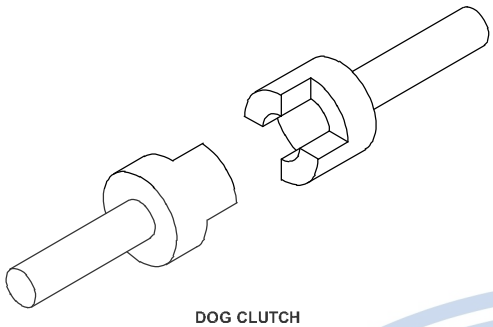
- Dog clutch
- Cone clutch
- Multi-plate clutch
- Electromagnetic multiple disc clutch.
- Air clutch
- Centrifugal clutch

- Overriding clutch
- Single plate clutch

Dog clutch (Fig 1)

The dog clutch provides a positive drive but can only be engaged when two elements of the clutch are stationary or are being gently moved by hand.

Fig 1



DOG CLUTCH

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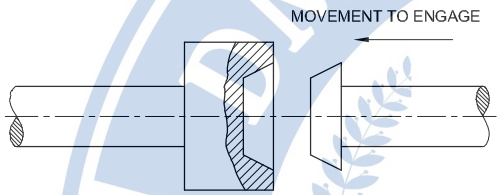
Cone clutch (Fig 2)

The cone clutch can be engaged progressively whilst one or both of the elements are rotating. It can transmit low power.

Fig 2



THE CONE CLUTCH

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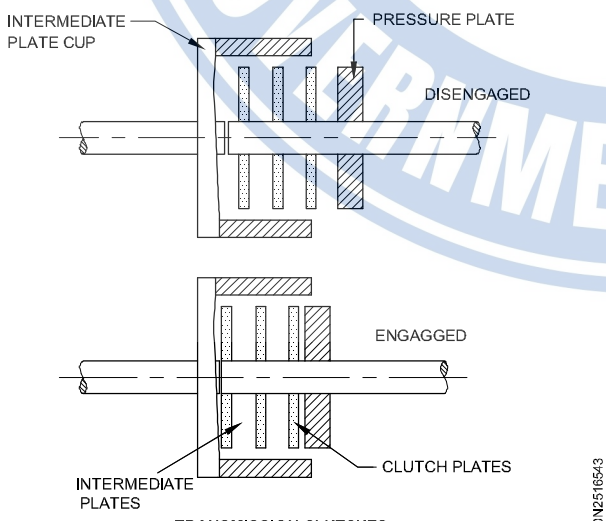
Multi-plate clutch (Fig 3)

The multi-plate clutch is widely used in machine tools to connect the transmission gearbox to the driving motor. It is compact, smooth in operation and very powerful. A brake is frequently built into the clutch so that the transmission gearbox is rapidly brought to rest when the clutch is disengaged.

Fig 3



TRANSMISSION CLUTCHES

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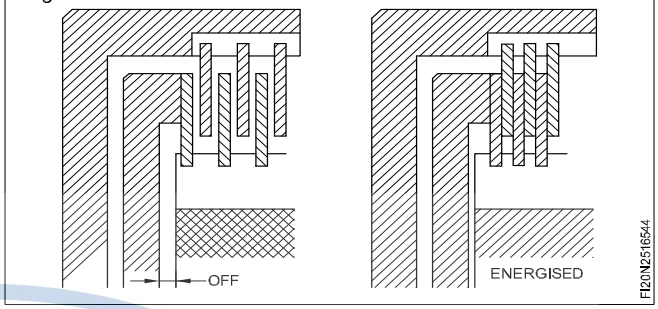
Electromagnetic multiple disc clutch (Fig 4)

This clutch joins the shaft and the gear. It can be operated through a cable from a distance. If direct current is applied, it builds a magnetic field on a magnetic coil. It flows through the discs and firmly pulls and attracts the armature disc. The armature clamps the plates together so that they transmit the drive.

Fig 4



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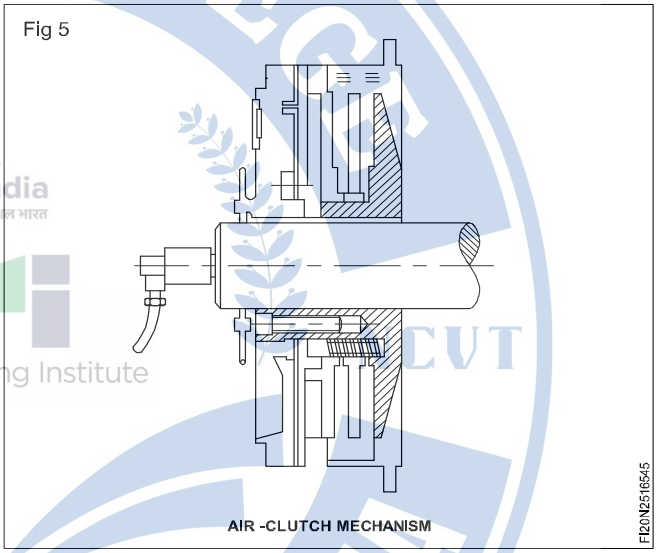
Air clutch (Fig 5)

An air clutch requires no mechanical adjustment since the moving parts automatically take up any wear on the friction surface. Air pressure must be maintained continuously while the clutch is engaged.

Fig 5



AIR -CLUTCH MECHANISM

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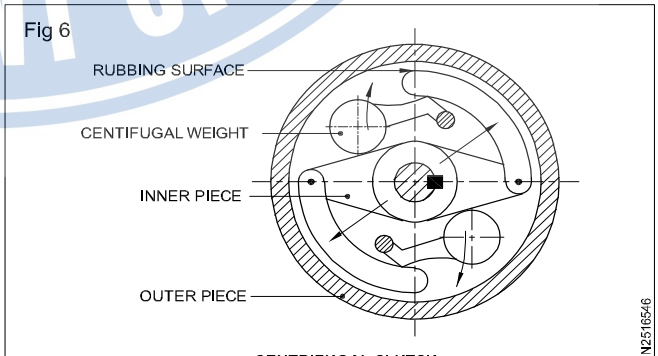
Centrifugal clutch (Fig 6)

When the inner piece has achieved a sufficiently high speed, the centrifugal weights swivel towards the outside, press the jaws on the outer piece with the friction lining and the clutch is closed. When the speed is reduced, the clutch opens by itself. Eg. moped.

Fig 6



CENTRIFUGAL CLUTCH

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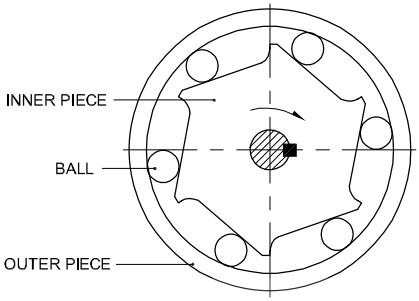
Overriding clutch (Fig 7)

When the inner piece has to be faster the overriding clutch transfers the turning moment by the climbing of balls or the cylindrical rollers. It opens in the opposite case.

Fig 7



OVER -RIDING CLUTCH

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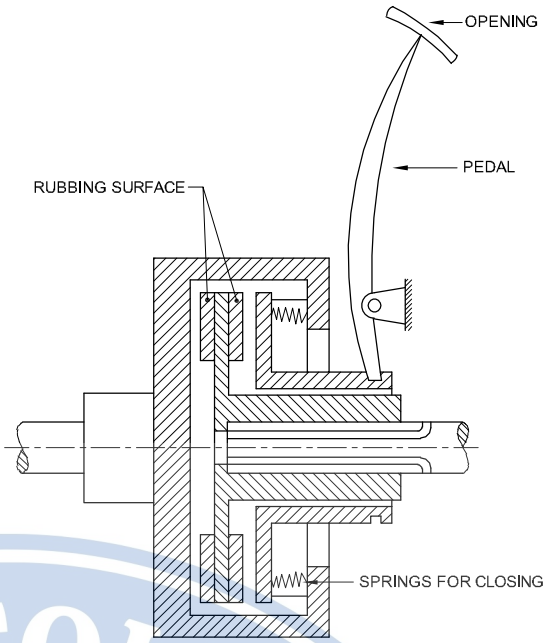
Single plate clutch (Fig 8)

This is used in automobile vehicles. The rubbing surface is covered with friction lining of asbestos/plastic/cotton, with steel wires. The contact force is produced by springs which effect the continuous closing of the clutch. The pedal force acts against the spring force and opens the clutch.

Fig 8



SINGLE PLATE CLUTCH

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Chain and wire rope for power transmission

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

- **state the uses of rope drives**
- **list the materials of rope**
- **state the purpose of jackey pulleys**
- **state the uses of chain drive**
- **list the advantages of chain drive.**

Ropes and rope drive

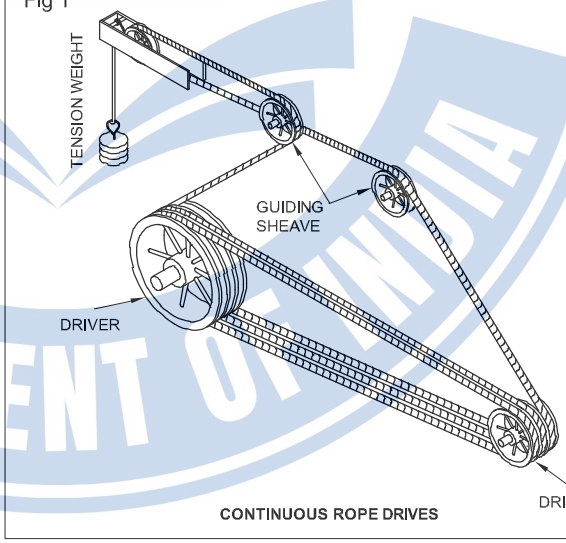
The ropes are made from cotton, hemp, manila, synthetic jute, steel wire, etc.

Rope drives are used for long distance and for large amounts of power transmission. The rope drives are mainly employed in mining and textile industries. Rope drives can be employed when there is a misalignment between the pulleys within limits and in fluctuating temperature and humidity conditions. Fig 1 shows a continuous rope drive in which a single rope passes over the sheaves several times, and the slackness being taken up by a tension carriage.

Wrapping angle of pulley

Fig 2 and 3 illustrate the contact area of the belt and wrapping angle. If the wrapping angle is big, the pulley can transmit high torque. If the contact area and wrapping angle is less, it can transmit low torque.

Fig 1



CONTINUOUS ROPE DRIVES

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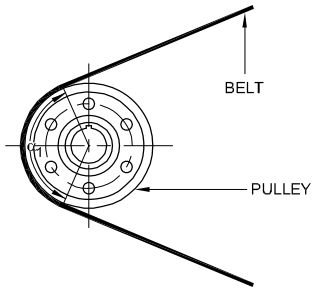
Fig 2



WRAPPING ANGLE IS SMALL (α_1)

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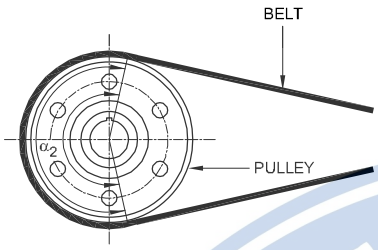
Fig 3



WRAPPING ANGLE IS LARGE (α_2)

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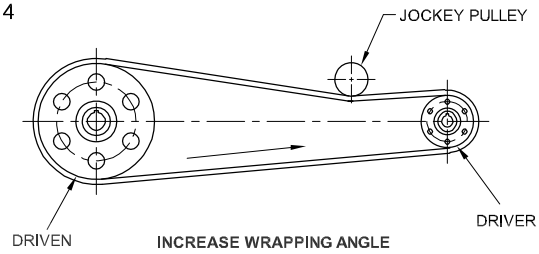
Jockey pulley

The contact surface between the belt and the pulley is increased by providing a jockey pulley which increases the wrapping angle and transmits high torque.

The jockey pulley should be put on the slack side of the belt near the driving pulley. (Fig 4)

Fig 4



INCREASE WRAPPING ANGLE

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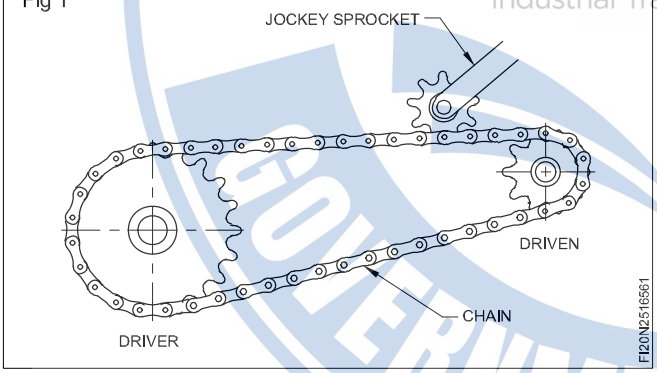
Chains and sprockets

Objectives : At the end of this lesson you shall be able to
- **state the advantages of chains drives**
- **state the use of a jockey sprocket**
- **state the types and specifications of chains**
- **brief the maintenance features of the chain drive.**

Chain drive (Fig 1)

Fig 1



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Chain drives are used for transmission of motion at constant velocity ratio without creep and slippage. Chains are used in conjunction with sprocket pinions and sprocket wheels. Chains and sprockets are available in both british and metric standards. The sprockets are generally keyed to the shafts.

Advantages of a chain drive

- Positive contact between the chain and the drive sprockets eliminates the possibility of slips.
- Has a wide range of driving power.
- Can be used where there is a large distance between the driving and driven shafts.
- Useful for low speed and high torque transmissions.
- Can absorb shocks.
- Chain drives are compact.
- Chain drives withstand heat, dirt and weather exposure when properly lubricated.

Jockey sprocket (Fig 1)

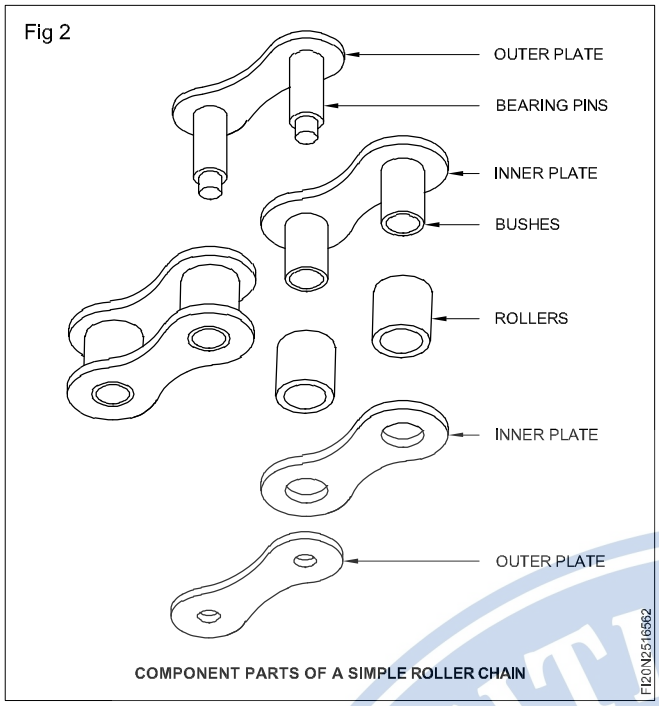
A spring-loaded jockey sprocket can be used to tension a chain which transmits the drive between the sprockets with fixed centres.

Types of chains

There are many types of chains but follow two types are commonly used.

- Roller chain
- Toothed chain

Roller chain (Fig 2)

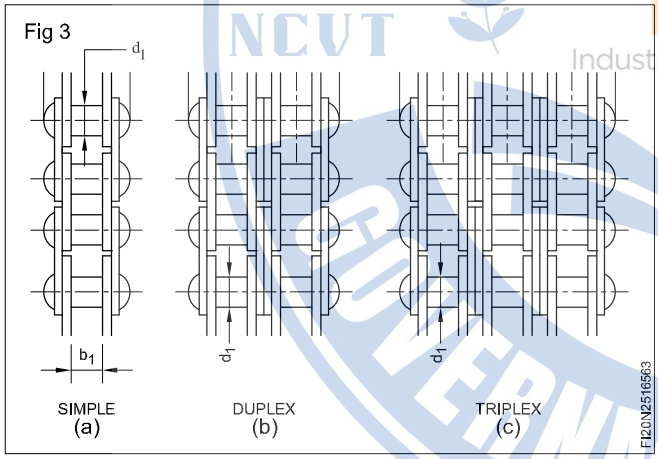


Rollers are housed between the connecting links and rotate freely on the bush. The bush is pressed in the holes of internal link and can rotate about the pin.

a. Single roller type chain is called a Simplex chain. (Fig 3a)

b. Double roller type chain is called a Duplex chain. (Fig 3b)

c. Triple roller type called a Triple chain. (Fig 3c)

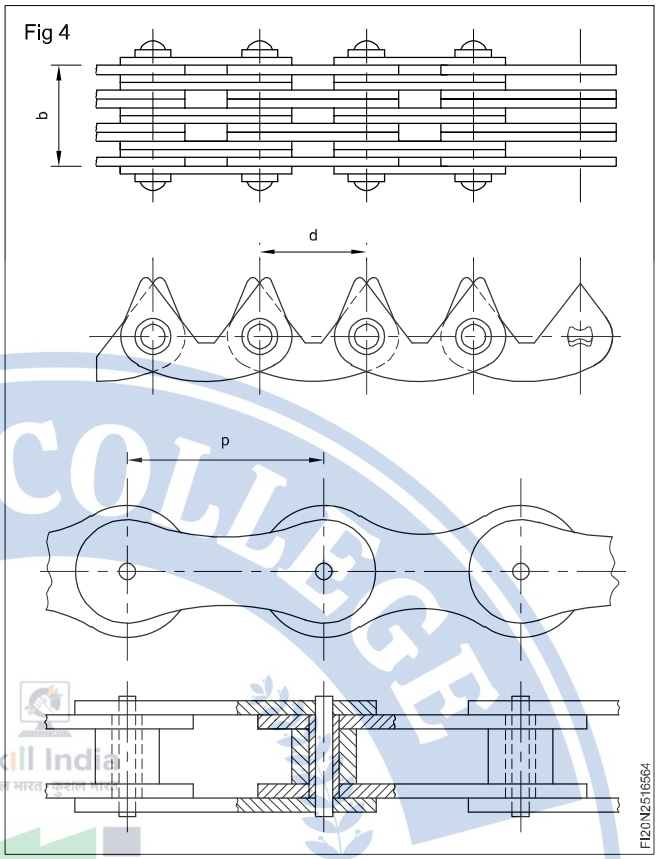


Toothed chain or silent chain

These chains are provided for noiseless and uniform drive. It consist of a row of toothed links connected through bushes.

Chain specification

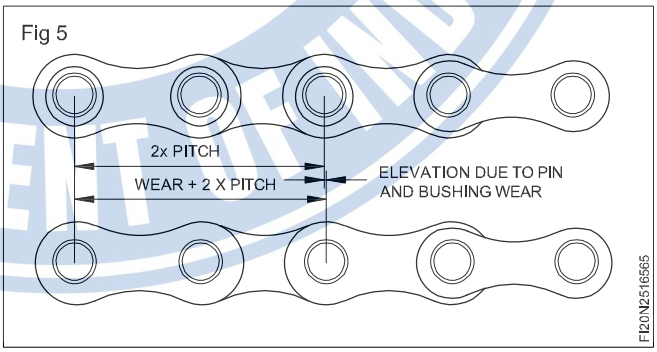
Chains are specified by the pitch. For roller chains pitch is the distance between the centre-to-centre of adjacent pins. Width refers to normal width of the link measured within the side of the plates. Diameter means the actual outside diameter of the roller. (Fig 4)



ISI 2403-1975 gives the specifies dimensions for standard chains of different diameters.

Maintenance features for chain drive

- Check alignment periodically and rectify if necessary.
- Inspect the chain for elongation. Excess clearance at point signifies elongation as shown in fig 5. The chain should be replaced as excess elongation spoils the sprocket.



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Elements of spur gear

Objectives : At the end of this lesson you shall be able to
- **state the basic elements of a spur gear**
- **calculate spur gear tooth proportions with the given data.**

Spur gear elements

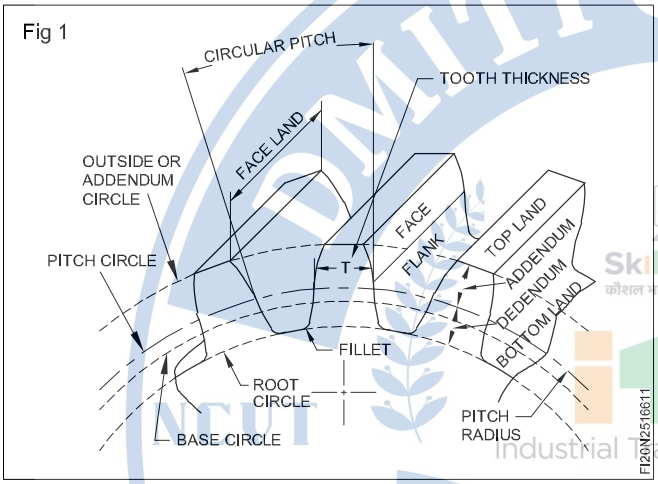
A spur gear is the simplest form of gears. The tooth proportions of the spur gears are expressed in terms of modules.

Module

It is defined as the ratio of the pitch diameter to the number of teeth of a gear. The module is denoted by the letter 'm' and is expressed in millimetres. The module is one of the major determining parameters of a gear.

Basic Elements (Fig 1)

Fig 1



Pitch circle

It is the imaginary circle on which two mating gears seems to be rolling.

The gear calculations are based on this circle.

Circular pitch: 'CP or 'P'

It is the distance from the point of one tooth to the corresponding point of the adjacent tooth measured on pitch circle.

Pitch circle diameter (PCD)

The diameter is called pitch circle diameter (PCI) or simply pitch diameter.

It is denoted by the letter 'd' with proper subscripts *eg.* d1 for pinion and d2 for the matting gear.

Addendum circle

Addendum circle or outside circle bounds the outer edges of the teeth of a gear and its diameter is denoted by 'da'.

Root circle

The root circle or dedendum circle bounds the bottom of the teeth and its diameter is denoted by 'df'.

Base circle ('db')

This is the circle from which the involute tooth profile is developed. Its diameter is denoted by db.

Addendum (ha) (Fig 2)

It is the radial distance between the pitch circle and the addendum circle and is denoted by ha.

Dedendum (hf) (Fig 2)

It is the radial distance between the pitch circle and the root circle, and is denoted by hf.

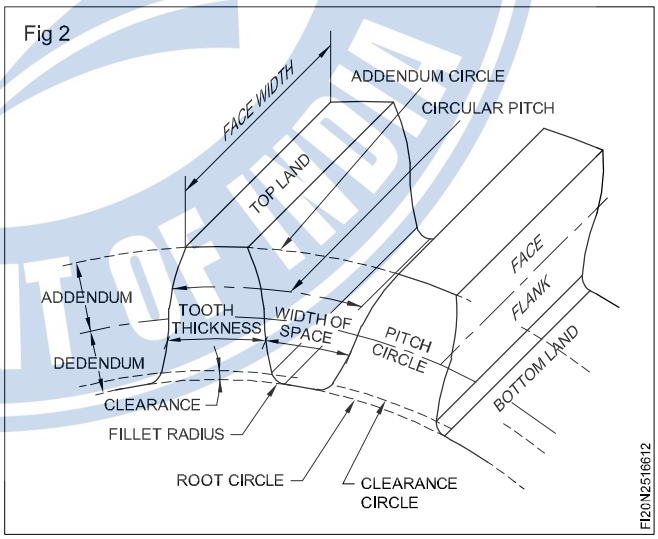
Land (Fig 2)

The land and the bottom land are surfaces at the top of the tooth and the bottom of the tooth space respectively.

Working depth (Fig 2)

This is the distance of engagement of two mating teeth and is equal to the sum of addendums of the mating teeth of the two gears in the case of standard systems and is expressed as '2ha'.

Fig 2



Velocity ratio of gear train

The gear train transmits motion without slip.

Different speeds can be obtained by shifting gear position in the gear- box. Fig 3 shows the feed change by swivelling and sliding the swivel arm in the Norton gearbox of lathes.

Formula for velocity ratio of gear train

$N_1 T_1 = N_2 T_2$

where

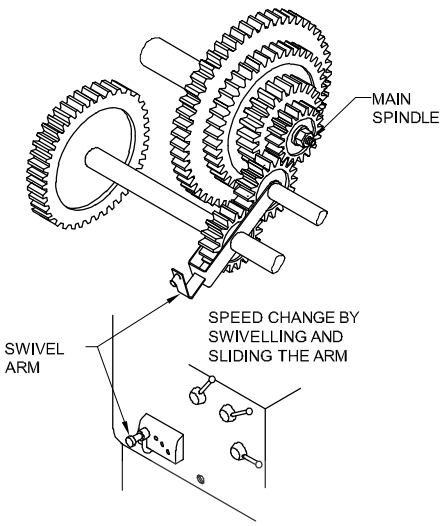
N_1 = RPM of driver gear

T_1 = number of teeth in the driver gear

N_2 = rpm of the follower/driven gear

T_2 = number of teeth in the driven gear.

Fig 3



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Types of gears

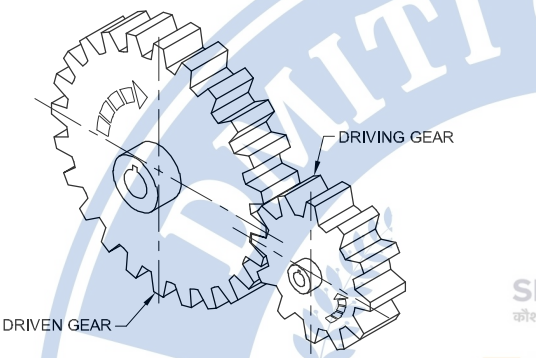
Objectives : At the end of this lesson you shall be able to
- **state the purpose of gears**
- **name the most common forms of gears and state their uses**
- **determine the velocity ratio of a gear train**
- **state the care and maintenance of gears.**

Purpose of gears

Gears are used to transmit torque/motion from the driving shaft to the driven/follower shaft:

- to change the velocity ratio
- to change the direction of rotation. (Fig 1)
- to get a positive drive.

Fig 1



Gears are made from cast iron, steel, non-ferrous, plastic or fibre material.

Types

Spur gear

The teeth are cut parallel to the axis of rotation. The spur gears are used to transmit power between two parallel shafts.

Fig 2 shows two spur gears mating each other and Fig 3 illustrates the application of gears in the centre lathe to transmit motion from the main spindle to the lead screw.

Helical gear

In a helical gear, the teeth are cut at an angle to the axis of rotation. It may be used to transmit power between two parallel shafts. Helical gears run more silently than a spur gear.

Fig 4 shows a set of helical gears mounted on two parallel shafts. These are widely used in automobile vehicles. The application of helical gears in an oil pump is illustrated in Fig 5.

The end thrust is exerted by the driving and driven gears in the case of helical gears and the thrust may be eliminated by using double helical gears. These gears are called herring-bone gears. (Fig 6)

Fig 2

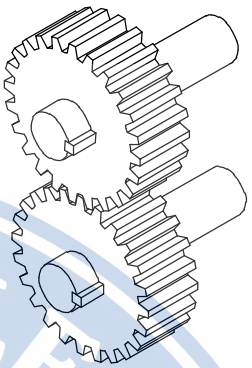


Fig 3

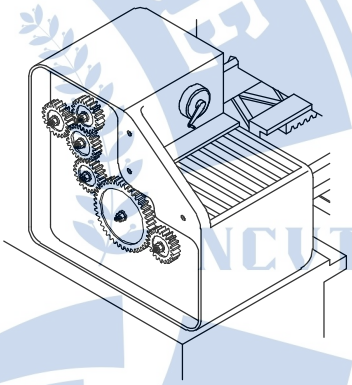


Fig 4

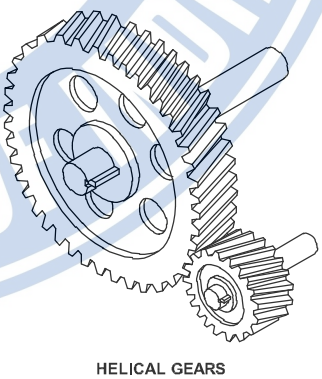


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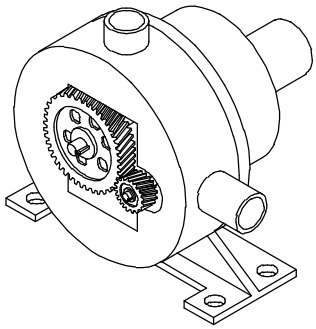
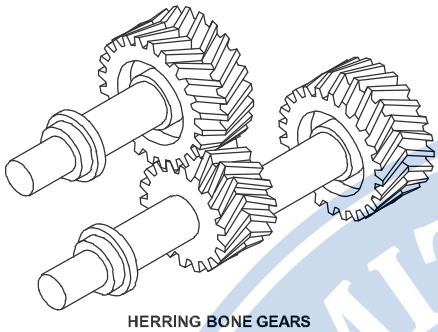
Fig 5



HELICAL GEARS

FI20N2516715

Fig 6



HERRING BONE GEARS

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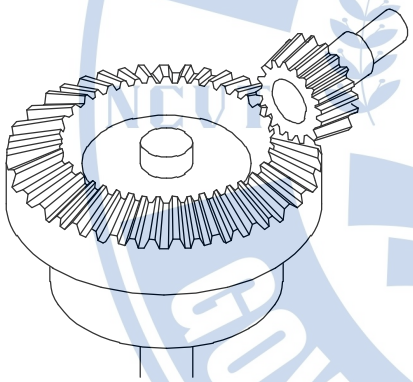
Bevel gear

The bevel gears shown in Fig 7 are used to transmit motion between shafts at various angles to each other. The teeth profile may be straight or spiral.

Fig 7



BEVEL GEAR

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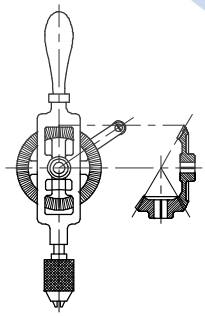
In a hand driller, the bevel gears transmit motion when the shafts are at right angles to each other. (Fig 8)

Fig 8



BEVEL GEAR

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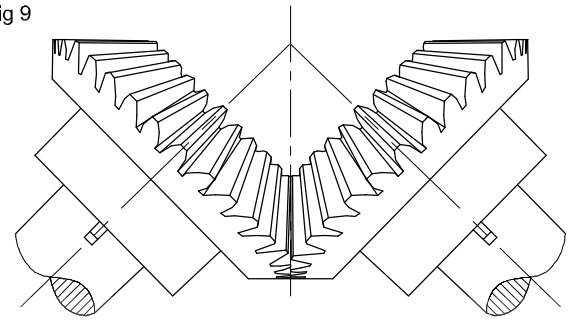
Mitre gears

If two bevel gears are symmetrical to each other and transmit motion at right angles, such gears may be called 'mitre gears'. (Fig 9)

Fig 9



MITRE GEARING

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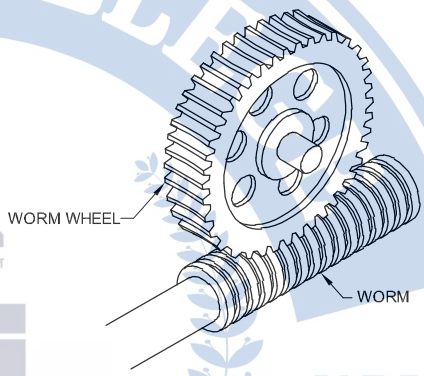
Worm shaft and worm gear

The worm shaft has spiral teeth cut on the shaft and the worm wheel is a special form of gear teeth cut to mesh with the worm shaft. (Fig 10)

Fig 10



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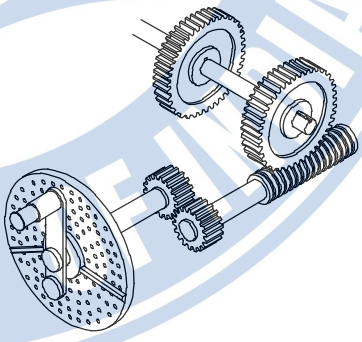
These are widely used for speed reduction purpose.

The application of worm and worm gear in the index-head gear mechanism is shown in Fig 11.

Fig 11



FI20N2516718B

This system transmits motion at right angles to the axis of motion at different planes.

Rack and pinion

The rack and pinion can change rotary into linear movement and vice versa. (Fig 12)

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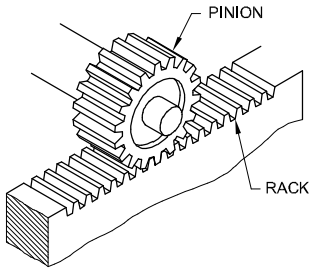
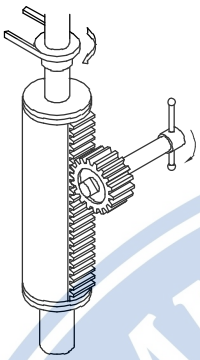
Fig 12



FI20N251671C

This mechanism is used in drilling machines as illustrated in Fig 13.

Fig 13

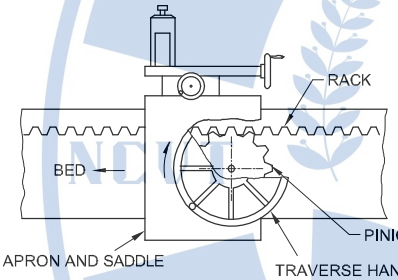


DRILLER

FI20N251671D

Fig 14 shows the application of the rack and pinion in lathe traverse mechanism.

Fig 14



RACK AND PINION
(LATHE TRAVERSE MECHANISM)

FI20N251671E

Hypoid gears

The hypoid gears are used in automotive differential gearboxes. A pair of hypoid gears (illustrated in Fig 15) is similar to the spiral bevel gear but with the shafts offset. The tooth action between each gear is a combination of rolling and sliding action along a straight line. The pitch surfaces are hyperboloids of revolution; as such the gears are called hypoid gears.

Velocity ratio of gear train

The gear train transmits motion without slip.

Different speeds can be obtained byshifting gear position in the gear- box. Fig 16 shows the feed change by swivelling and sliding the swivel arm in the Norton gearbox of lathes.

Fig 15

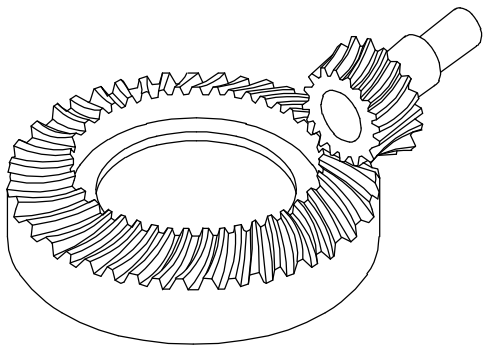


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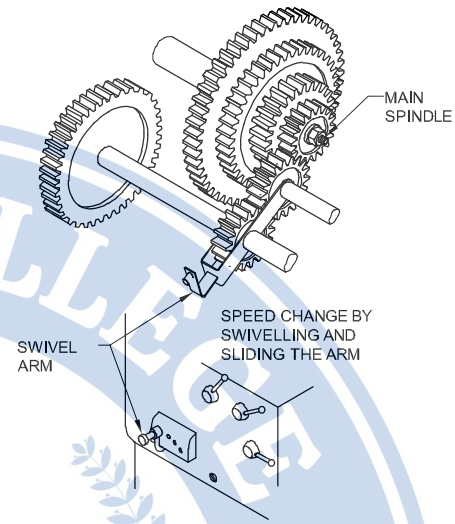
Fig 16



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Velocity ratio of worm gear

It is the ratio of number of turns of the worm to 1 turn of the worm wheel.

$$\text{Speed ratio} = \frac{z2}{z1}$$

Where z2 = Number of teeth on the worm wheel.

Z1 = Number of starts on the worm.

Methods of machining worm

- On a centre lathe
- On a worm milling machine
- On a gear hobbing machine

Methods of machining a wormwheel

- On a milling machine
- On a hobbing machine

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Repair broken gear tooth (Dovetail blank method)

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

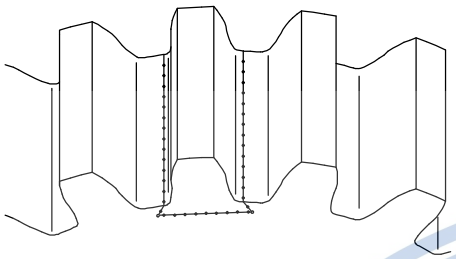
- **repair broken gear tooth by dovetail method.**

Support the gear against a Vee block and clamp it by parallel camp.

Mark the dovetail groove on the gear wheel form both sides using a venier height gauge and vernier bevel protractor.

Punch the marking lines.(Fig 1)

Fig 1



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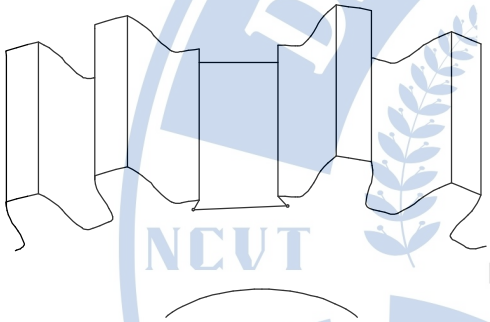
Drill 3mm dia. relief holes one each on the corner of the dovetail.

Remove material from the gear to shape and size of dovetail as per marking. (Fig 2)

Fig 2



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File the blank to the profile of the gear tooth as per punch mark.

File the dovetail portion of the blank.

Fit the blank into the dovetail groove of the gear wheel. If necessary,file the blank till it fits in.

Apply Prussian blue on the dovetail groove to check the high spots in the blank piece.

Remove the high spots and make a snug fit in the dovetail groove.

Drill 5.9mm dia. -2 holes up to a depth of 33 mm on the blank and gear wheel in assembled condition.

Ream the holes using a hand reamer.

Dismantle the assembly and remove the chips from the holes of the gear and the blank.

Assemble again and fit the dowel pins in the holes by a slight tapping.

File the profile of the gear tooth to the correct shape.

Use a template to check the profile.

File on the sides of the blank,flush with the gear.

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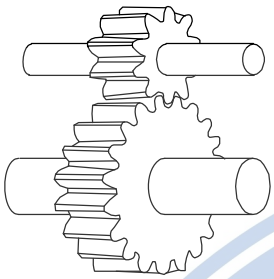
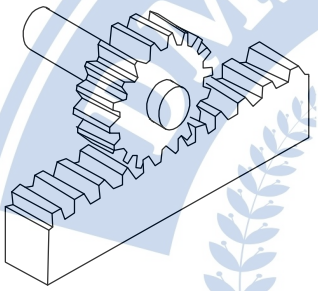
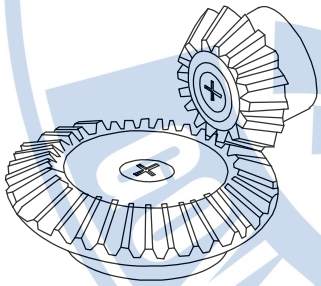
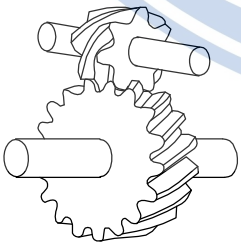
Fixing gear wheel for various purpose drives

Objectives : At the end of this lesson you shall be able to
- **name the different methods of gear fixing for different drives**
- **list the use of each type gear**
- **state the cause and remedies of gear tooth wear**
- **state the methods of fitting different type gears.**

	**Parallel axes** Transmit power and motion between parallel shafts. Spur gears and helical gears are used. Example: Lathe gear box
	Change the rotary motion into the rectilinear motion and vice versa. A combination of spur gear and rack or a combination of helical gear and helical rack is needed to do work. Example: Dial test indicator
	**Intersersecting axes** Transmit power and motion between intersecting shafts at right (90°) angles. Straight bevel gears or spiral bevel gears are used. Example: Shaping machine table
	**Non parallel, non intersecting axes** Transmit motion and power between nonparallel, nonintersecting shafts that are usually at right angles (90°). Screw gears and worm gear pair are used. Example: Dividing head

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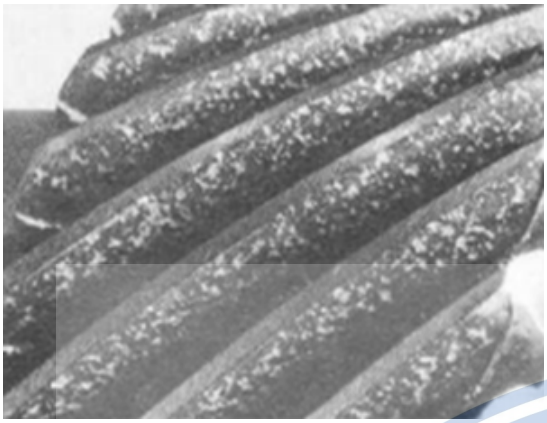
Wear and tear of toothed wheel and their remedies

Wear: A surface phenomenon in which layers of material is removed or "worn away"

Moderate wear



Exessive wear

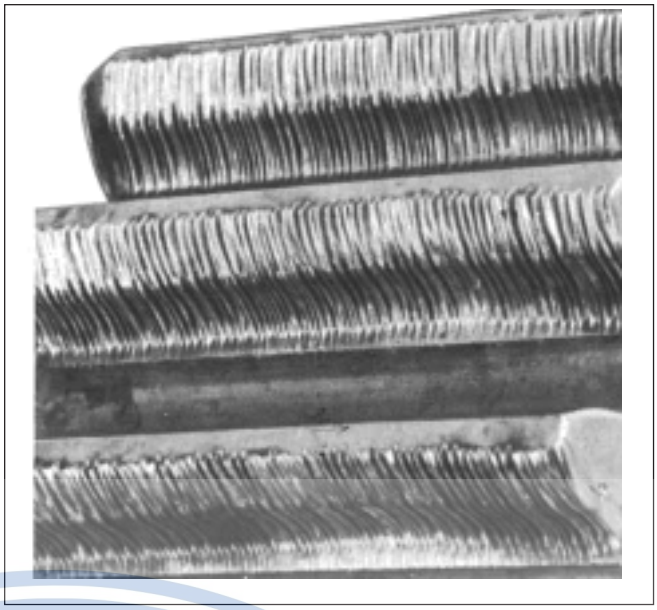
Cause: Wear in progress,in a dequate lubricant film

Remedies: Increasing lubricating film strength, sufficient oil is supplied to working surfaces.

Abrasive wear

Cause: foreign material in the lubrication metallic debris. from the gear.

Corrosive wear



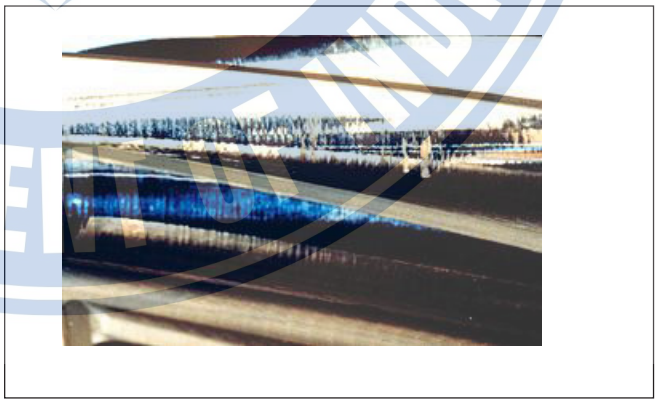
Cause: Corrosive elements in oil

Remedies: Use of filter and use high thick lubricating oil.

Crushing

Causes: Surface irregularities,misalignment of gears.

Remedies: Smooth gear surfaces, reduce dynamic loading limit, keeping the load below the endurance limit.



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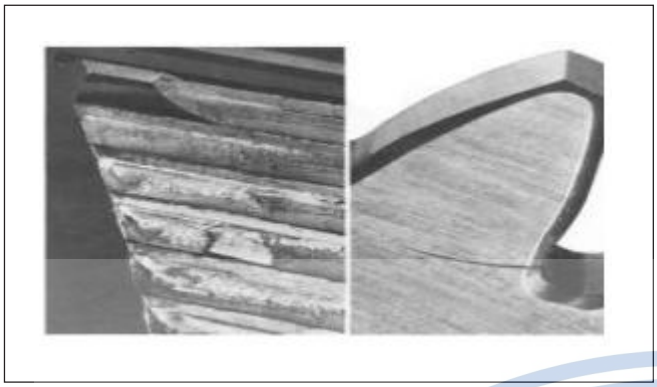
Fracture: Fracture is caused by breakage of whole tooth

Fatigue breakage

Cause: Extreme tooth loads, notches

Remedy: Higher strength material,load in with endurance limit



Overload

Cause: Overload which exceeds tensile strength

Remedy: Torque limiting overload protectiondevices

Plastic flow: Cold working of tooth surfaces caused by high contact stress.

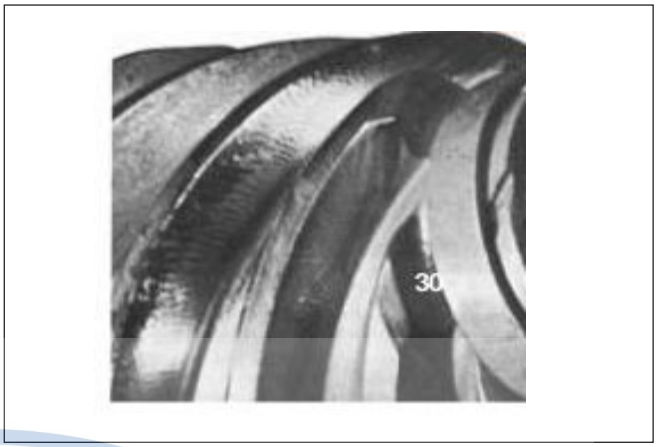
Cold flow

Causes: Rolling and peening action of much under heavy loads.

Rippling

Cause: Cyclic loads under high contact stresses.

Remedy: Case hardening of tooth surface.



Method of fitting spiral gear, helical gear, bevel gear and worm gear

Worm and worm wheel

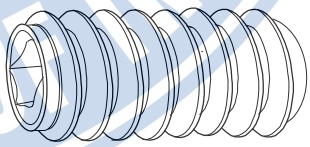
The mounting of worm gears is critical to their implementation. Multiple points of contact are necessary between the drive and gear, so high work loads do not overwork the same lead angle, which could lead to gear failure. Enveloped worm gear sets are normally assembled in the same housing, to ensure proper mating and due to the sets' small footprint.

Consider the gear center, bore diameter and shaft diameter. The gear center can be a bored hole or an integral shaft. The bore diameter is the diameter of the center hole. The shaft diameter is the diameter of the shaft for gears with an integral shaft. Worms and worm gears can be mounted on a hub or shaft. A hub is a cylindrical projection on one or both sides of a worm or worm gear, often for the provision of a screw or other shaft attachment mechanism.Hubless gears are typically attached via press fit, adhesive or internal keyway.

Shaft mounting choices include the following:

Keyway: One or more square cutouts exist in the gear bore for exact mounting on the shaft.

Fig 1



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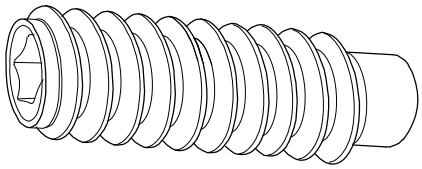
Set screw: The gear is attached to the shaft by screws through the hub.

Fig 2



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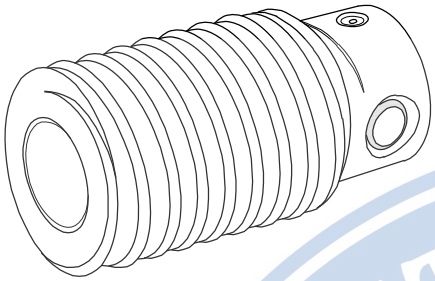
Simple bore: A straight bore designed for adhesive attachment.

Fig 3



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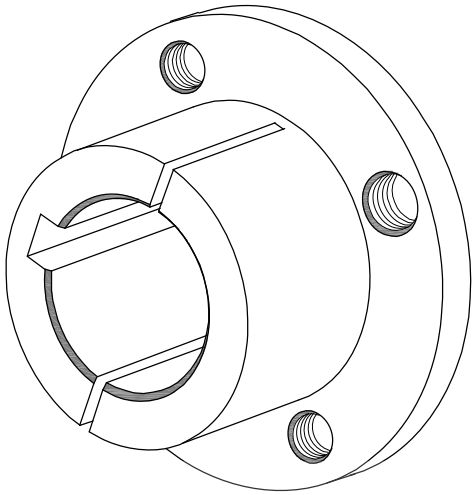
Split: The hub is split into several pieces that are tightened down by a separate clamp to grip the shaft.

Fig 4



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Helical gear

Consider the gear center, bore diameter and shaft diameter. The gear center can be a bored hole or an integral shaft. The bore diameter is the diameter of the center hole. The shaft diameter is the diameter of the shaft for gears with an integral shaft. Helical gears can be mounted on a hub or shaft. A hub is a cylindrical projection on one or both sides of a helical gear, often for the provision of a screw or other shaft attachment mechanism. Hubless gears are typically attached via press fit, adhesive or internal keyway

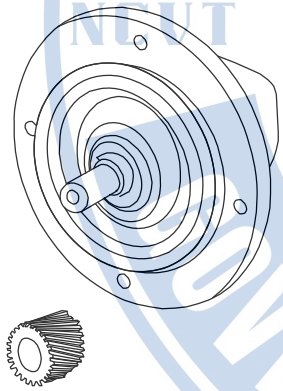
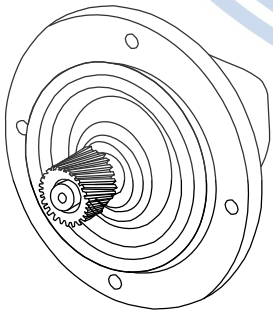
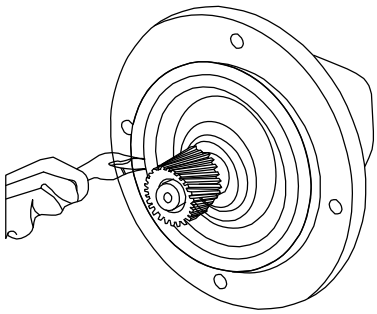
Illustration	Procedure
	• Prepare the input side. • **Important:** The round chamfer on the bore of the pinion must lie in the direction of the shaft shouder.
	Mount the pinion onto the shaft.

Illustration	Procedure
	Fit the retaining ring using the pliers.

Bevel gear

Bevel gears are **gears** where the axes of the two shafts intersect and the tooth-bearing faces of the **gears** themselves are conically shaped. **Bevel gears** are most often **mounted** on shafts that are 90 degrees apart, but can be designed to work at other angles as well.

Several parameters contribute to proper assembly to operate the gear box smoothly and efficiently.The most important are

- Back lash Fig 1
- Mounting distance Fig 2

Fig 5

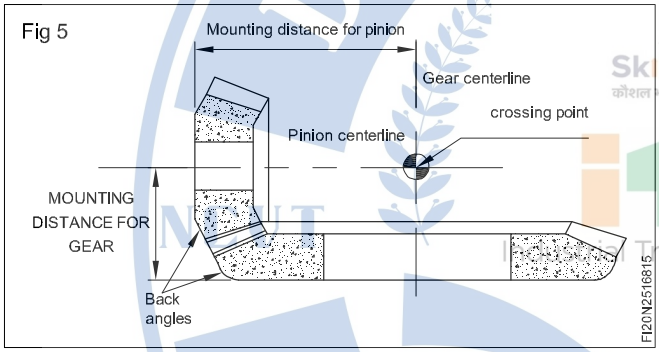
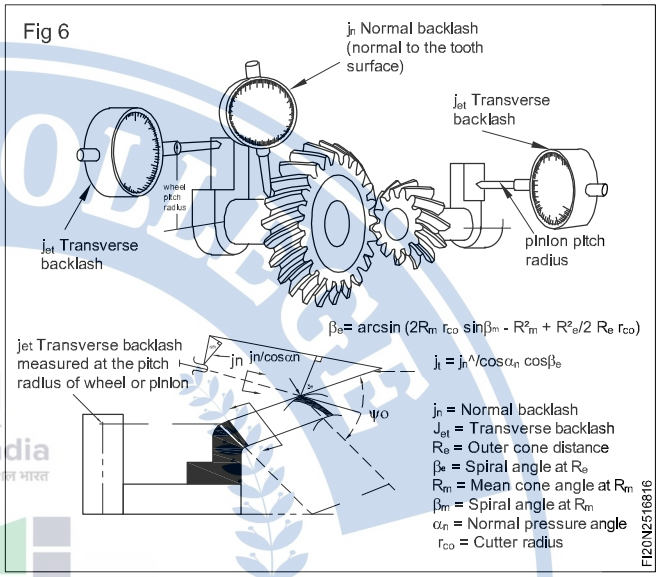


Fig 6



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