Installation,maintenance and overhaul of machinery

Objectives : At the end of this lesson you shall be able to
- **explain installation procedure**
- **state maintenance of machine**
- **desribe overhauling procedure**

Installation

The sequence of installation methods are as follows.

- foundations
- fitting and moving
- levelling
- testing

Foundations

Machinery foundation is a built up structure designed to support the machine and to take up the static and dynamic load of the machine,besides keeping the machine in alignment

The machine foundation must fullfil the following requirments.

- It must support the machines at a given height and must be able to take up the static and dynamic loads.
- It should preserve the alignment of the machine
- It should absorb the vibration of the moving parts

Lifting and moving

For lifting and moving the machines,the equipments like hoists,derricks and cranes are employed and also ropes are used to tie the machine

Levelling

It is necessary to provide a good solid foundation upon which the machine is set and accurately levelled. Performance of any machine tool depends upon its level and foundation.

Levelling of a machine is done using:

steel wedges

levelling blocks

jacking screws.

The steel wedges (Fig 1) can be used with or without steel packing at three or more points under the machine bed. By tapping,adjust the wedges so that the machine is levelled longitudinally and transversely preparatory to tightening down and grouting.

Accurate levelling can be achieved by the use of laminated shims. (Fig 2)

Fig 1
LEVELLING OF CENTRE LATHE USING TAPER WEDGE

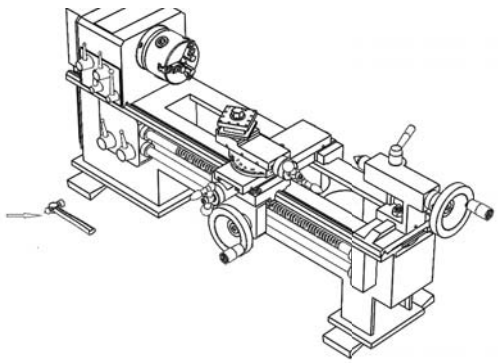

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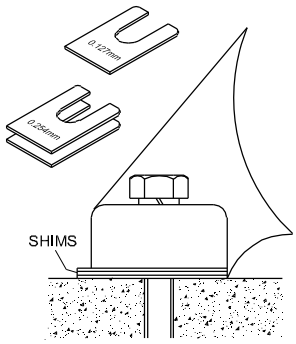
Fig 2



LAMINATED PACKING SHIMS

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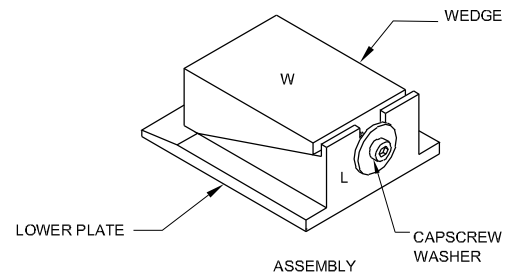
These packing shims are obtainable in sets in which each individual shim is of a different gauge and combinations of these can be used to obtain the desired thickness.

When a machine is placed on these levelling blocks (Fig 3) the machine bed does not touch the foundation but rests entirely on the levelling blocks thus permitting the machine to be raised or lowered to the required height and levelled up.

It also permits the machine to be re-levelled at any time.

The machine is also levelled by the use of the jacking screws provided as shown in Fig 4, where the screw is

Fig 3



seen to bear upon a steel plate let into the floor. Extrasensitive levels are used for setting lathes,grinders and precision machines. To protect subsequent movement of the machine,a cement fillet is made all round the machine base as indicated in Fig 5. While grouting with cement, care should be taken not to upset the level of the machine during the process.

Fig 4

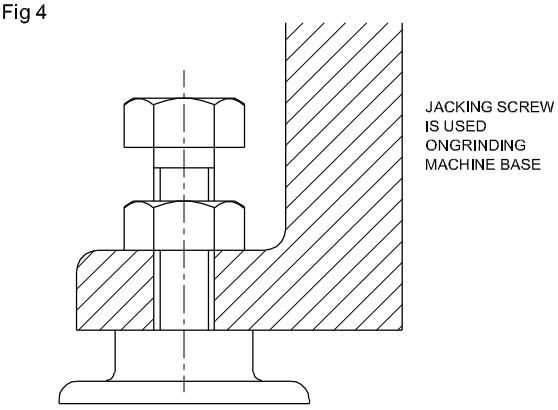
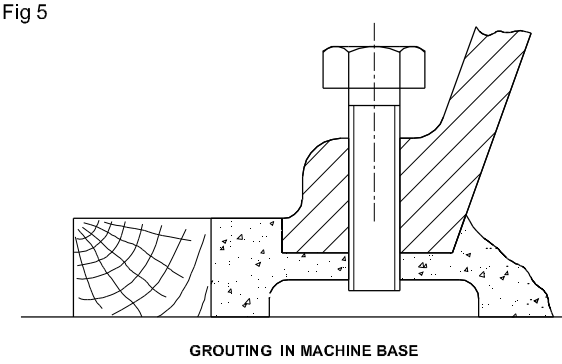


Fig 5



Some machines are also mounted on antivibration pads. In this case,the machine is levelled using levelling bolts.

Testing

Testing machine tools

Unless a machine tool is accurate,it will not produce accurate work. It is necessary for the manufacturer to state the degree of accuracy of the various movements controlling the accuracy of the components produced by the machine.

Acceptance test charts

Most makers of machine tools do this by means of test charts which indicate the maximum permissible error, together with the actual error of the part when it was tested at the maker's works.

Such information and test are invaluable for checking machines after repairing so as to ensure that

- It has not been distorted in transit
- It has been properly fixed in position
- it will yield an accurate product.

The test charts are in three sections.

- Levelling
- Geometrical test
- performance test

Levelling

The machine must first be carefully levelled on a rigid floor by means of steel wedges,packings etc. and checked with precision level as specified in the charts. Each test is based on the correct erection and levellling of the machine.

Geometrical test

This test is carried out ot know the grade of accuracy of the assembled machine while idle and in an unloaded condition and after running the main spindle for atleast an hour at its mean speed. The machine should be tested in its fully assembled state.

Ensure that the machine is levelled before the test is done.

Performance test

This test is to ascertain the precision of a machine tool for the finishing operation for which the machine has been designed.

The practical tests should be carried out on pieces,the production of which does not require operations other than those for which the machine has beeen built.

The degree of working accuracy of the machine,besides depending on the machine itself,is also influenced by the following factors.

- The type of cutting tools
- The material of the cutting tool and workpiece
- The cutting speed feed and depth of cut
- Tool and work- holding units
- The skill of the operator

Test charts

A test chart is prepared for each machine by the manufacturer of the machine. It consists of instruction for testing names of the measuring instruments used,sketches and details of permissiable error and actural error. It provides a convenient basis for conducting tests.

Periodic acceptance test

The machine tool is expected to produce accurate workpieces not only when it is new but throughout its working life. A machine tool must be able to produce workpieces within specified limits. For this reason the wear of the machine must not exceed certain limits. It must be watched,and parts which are faulty,due to wear or other damage, must be replaced or repaired without delay.

The periodic acceptance tests are to be carried out after overhaul and re-conditioning of the machine tool. Apart from the regular general inspection of the machine tool. immediate steps must be taken when faulty workspieces are produced by a machine i.e. when machined dimensions lie outside the specified limits. In such cases,the accuracy and performance of the machine must be tested without delay. Faults can be eliminated only if the causes of the errors are known.

Maintenance is a process adapted to extent the life as well as the performance of machines,equipments,tools etc.

Types of maintenance

- Scheduled maintenance
- Preventive maintenance
- Breakdown maintenance
- Predictive maintenance

Scheduled maintenance

- This is called as routine maintenance.
- In order to get trouble free service from productive equipments.
- Following activites is necessary to carry out.
  - i) Lubrication
  - ii) Periodic inspection
  - iii) Adjustments of various parts
  - iv) Cleaning
  - v) Periodic overhaul
  - vi) Repair and replacement, etc.

All the above maintenance operations are carried out while the machine is running or during pre-planned shutdowns.

This type of maintenance may prevent breakdown of equipments.

Routine maintenance should not interfere with production schedules.

Preventive maintenance

- Preventive maintenance is the maintenance undertaken to prevent breakdown.
- Weak spots as bearings, parts under excessive vibration and heat etc., are located by regular inspection.
- The parts of equipments are changed before the end of its lifetime to reduce danger of breakdown.
- The underlying principle of preventive maintenance is that “Prevention is better than cure”.
- Preventive maintenance is a definite programme of periodic cleaning, servicing, inspection and replacement of worn out and damage parts for vital plant facilities.

Importance of Preventive maintenance

Preventive maintenance is important because of the following advantages.

- Prevention of accidents.
- Prevention of damage to material and equipment.
- Reduce downtime and lower unit cost.
- Prevention of economic losses resulting from machinery breakdown.
- Decrease maintenance and repair cost.
- Increased efficiency in machinery performance.
- Improve quantity and quality of product.
- Reduced major and repetitive repairs of machines.
- Finds small problems before they become big ones.

Breakdown maintenance

This is called corrective maintenance or emergency maintenance. A machine is permitted to run without much attention till it breaks down. When it actually breaks down, it will be attended, since no attempt is made to prevent the occurence of breakdown.

Breakdown maintenance is harmful. It is unpredictable and results in production loss. Hence any breakdown has to be given more priority and the equipment shall be got back into service as quickly as possible. In addition to repairing, causes of breakdown shall be investigated in order to avoid breakdowns in future.

Cause of equipment breakdown

- Failure to replace wornout parts.
- Lack of proper lubrication and cooling system.

- External factors such as voltage fluctuations, poor quality oils, etc.
- Not caring for equipments vibrations, unusual sounds, excessive heat on equipments and other minor faults.

Disadvantages of breakdown maintenance

- Production delays and stoppage.
- Inefficient use of maintenance manpower.
- Production and maintenance overtime.
- Not suitable for items regulated by statutory provisions. Eg., Cranes, Lifts, Pressure vessels, etc.

Difference between breakdown maintenace and preventive maintenance

Sl. No.	Breakdown maintenace	Preventive maintenance
1.	Maintenance is undertaken only after breakdown	Maintenance is undertaken only before breakdown
2.	No attempt is made to prevent breakdown	Maintenance is made to prevent breakdown
3.	This is unpredictable activity.	Predictable activity.
4.	Maintenance cost less.	Cost of maintenance is high.
5.	Not suitable for equipments like cranes, hoists, pressure vessels.	Can be applied to all types of equipments.
6.	Results in production loss and more “Down time”	Such disadvantages are eliminated.

Predictive maintenance

Scheduled programme of maintenance and preventive maintenance need careful planning. Hence it is necessary to know what is happening to different parts of machine tool equipment under actual working conditions. This will be useful to estimate the lifetime of different parts of machine tool equipments and to access the frequency of periodical maintenance.

In predictive maintenance, condition of equipment are checked periodically making use of human senses such as hearing, smell, sight etc.

There are sensitive instruments to predict troubles in machines.

- Audio gauges
- Vibration analyzers
- Amplitude meters
- Pyrometers
- Strain gauges etc.

The above sensitive instrument are useful for the maintenance men to take timely action such as equipment adjustment, recondition or overhauling.

Abnormal sound coming out of a running machine predicts a trouble. Overheat of a bearing predicts a trouble. Simple hand touch can point out many abnormal conditions and thus predict trouble.

Predictive maintenance increases the service life of machine tool and equipment without fear of failure.

Effect of maintenance on machine tool equipments life output and quality

- Life of machine tool equipment increases with increase in the performance of machine tool equipment.
- The products will be of good quality. The quality of goods produced may be consistent.
- Output of goods from the machine increases. This also results in lower unit cost.

Proactive maintenance

Proactive maintenance is a preventive maintenance strategy for maintaining the reliability of machines or equipment. The purpose of proactive maintenance is to view machine failure and similar problems as something that can be anticipated and dealt with before they occur.

Proactive maintenance focuses primarily on determining the root causes of machine failure, and dealing with those issues before problems occur. It is often seen as a cost-effective practice since it allows a company to avoid machine failure and solves issues before they become problems.

Reactive maintenance

The oldest maintenance approach is reactive. Equipment is not repaired or replaced unitil it breaks. In this maintenance equipment fails with little or no warning so this could be down until replacement parts arrive, resulting in income loss. In this maintenance cost and down time increased and also create safety issues. Reactive maintenance can be suitable in some situation such as for non critical and low cost equipment with little or no risk of capital loss or production loss.

Importance of breakdown maintenance and preventive maintenance in productivity

The importance of an effective maintenance program cannot be overlooked because it plays such an important role in the effectiveness of lean manufacturing. As in personal health care insurance, maintenance may be considered the health care of our manufacturing machines and equipment. It is required to effectively decrease waste and run an efficient, continuous manufacturing operation, business, or service operation. The cost of routine maintenance is very small when it is compared to the cost of a major breakdown at which time there is no production.

Purpose of maintenance

The importance use of routine maintenance is to ensure that all equipment required for production is operating at 100% efficiency at all times. Through short daily inspections, cleaning, lubricating and making small adjustment, small problems can be detected and corrected before they become a major problem that can shut down a production line. A good maintenance program requires company wide participation and support by everyone ranging from the top executive to the shop floor personel.

Overhauling

Ensure that all the lubrication points are lubricated regularly as recommended in the manual.

Use Servoway-32 oil for the pillar. Anti-frictional bearings on the main spindle head are to be lubricated by Servogem Grease - 2 once in 3 months.

If the spindle is supported by plain bearings,use Servo -System 32 oil.

Check the belt tension once in three months. If necessary, adjust the tension.

When replacing with a new belt, if required,check the tension of the belt after a week,and adjust, if necessary.

The machine should be overhauled once in 2 or 3 years depending upon the usage.

Anti-friction bearing should not be cleaned using compressed air as compressed air normally contains water particles which will corrode the bearing. Also while using compressed air, dust, dirt and other absasive particles will be whirling in the surrounding areas and enter into the bearing causing damage to the race - ways and rolling elements.

Antifriction bearings should be handled in dust free environment.

Types of belts and fasteners

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

Types of belts

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

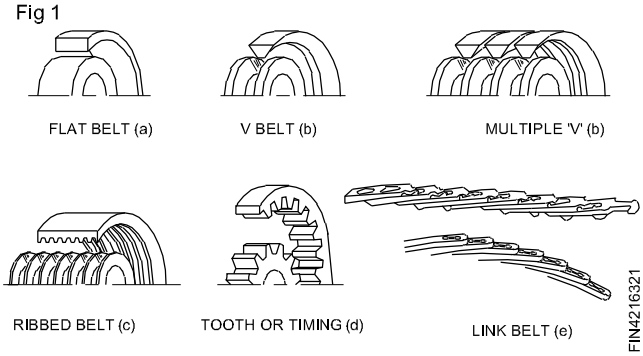
- Flat belt (Fig 1a)
- V-belt and multiple V-belt (Fig 1b)
- Ribbed belt (Fig 1c)
- Toothed or timing belt (Fig 1d)
- Link belt (Fig 1e)

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

Fig 1

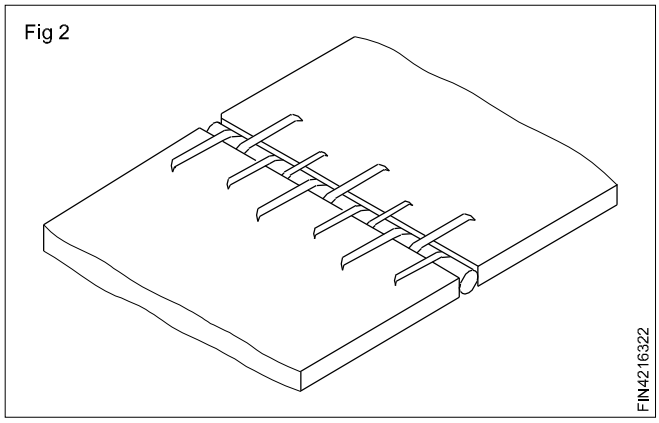


Types of fasteners

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

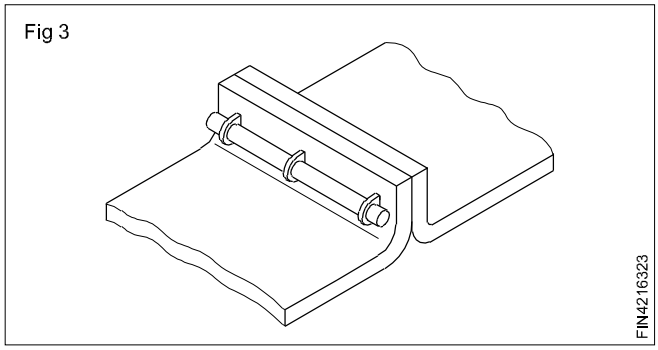
Wire type belt fastener

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



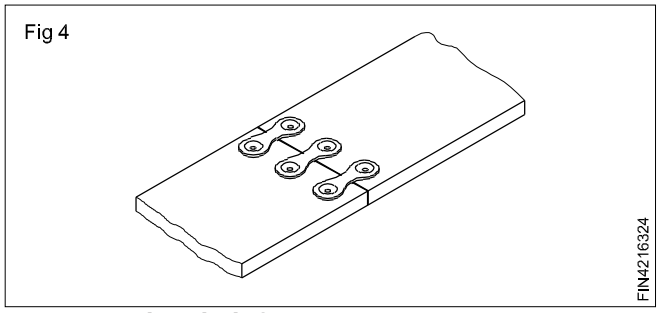
'Lagrelle' type belt fastener

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



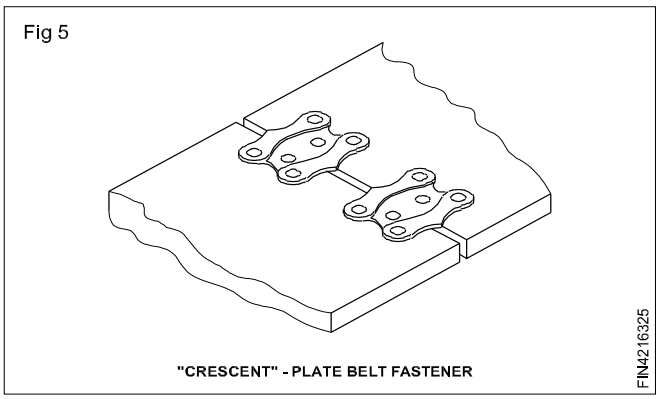
Jackson-type belt fastener

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



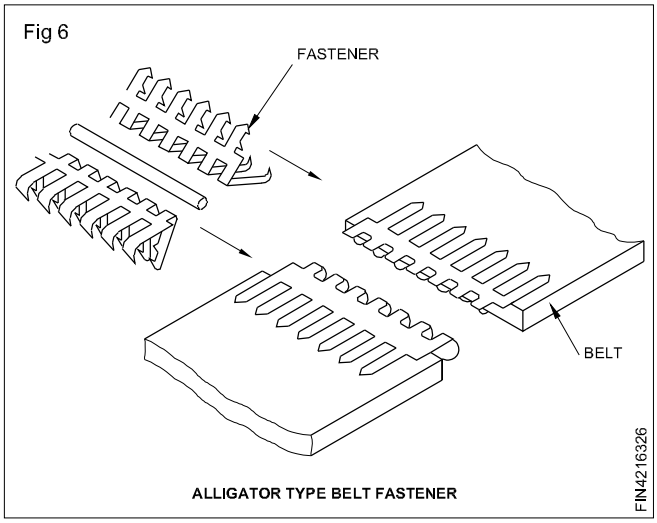
Crescent plate belt fastener

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



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.



Specification

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

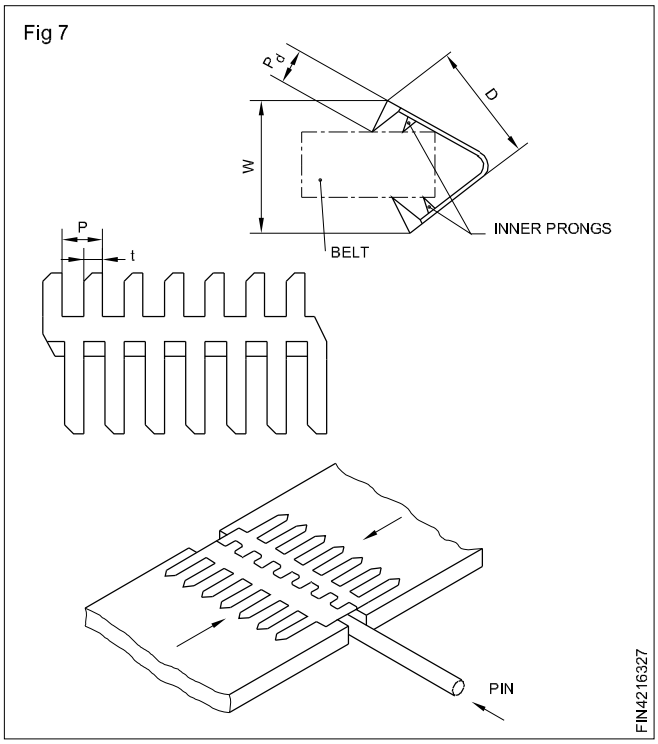


Table - 1

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

Fastener designation	Pin 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.**

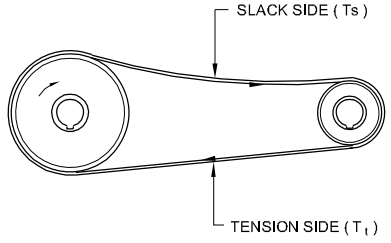
Belt tension

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

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

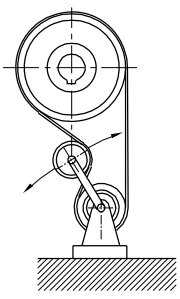
The ratio of the tight side to the slack side tension is commonly referred to as the tension ratio. A higher ratio between the tight side and slack side tension makes the belt loose and slip.

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

Adjustment of tension

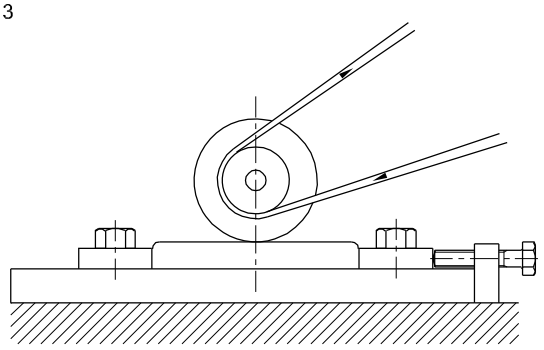
When the distance between two pulleys is fixed, the tension of a belt is adjusted by an idler. (Fig 2)

Fig 2



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

Fig 3



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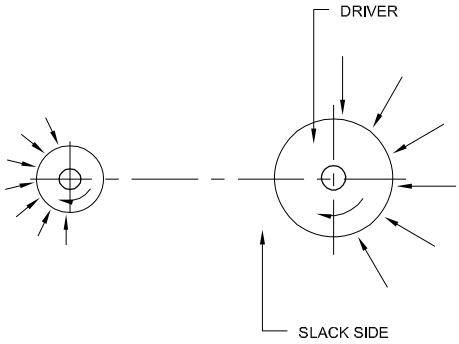
Arc of contact

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 4



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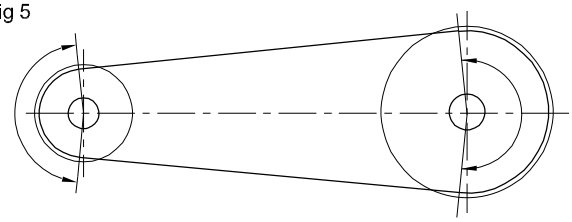
If the wrapping angle is big, the pulley can transmit high torque. (Fig 5)

Fig 5



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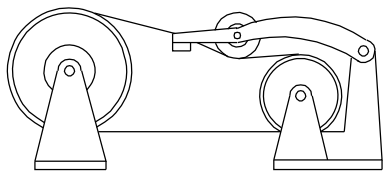
Belt efficiency

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



THE USE OF A JOCKEY PULLEY TO MAINTAIN CORRECT BELT TENSION

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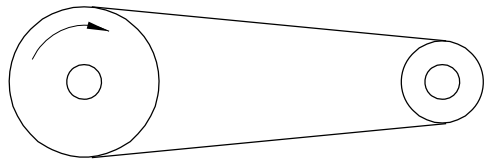
Excessive tension in the belt reduces the arc of contact, and introduces additional stresses which drastically reduce the life of the belt and bearings. (Fig 7)

Fig 7



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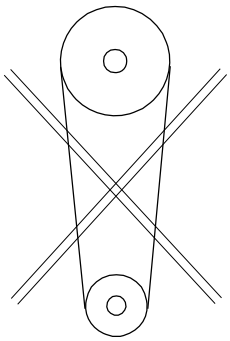
Vertical drives should definitely be avoided because the belt tension necessary to withstand gravitational pull (Fig 8) and accompanying slippage would result in adverse effects.

Fig 8



THE EFFECT OF GRAVITY ON A VERTICAL BELT

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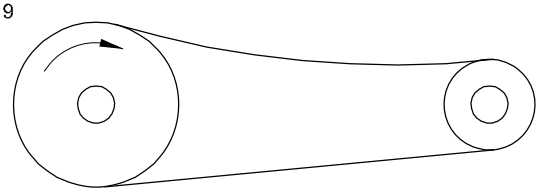
On the open belt drive, the slack side (Fig 9) must be at the top and the centre distance between the pulleys should be the maximum.

Fig 9



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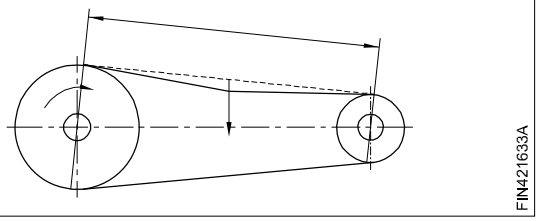
To measure tension of V-belt drives

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



- 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.