SAW SHARPENING AND MAINTENANCE OF MACHINES

WOOD TECHNOLOGY

TRAINING MANUAL

November, 2022.

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ABBREVIATION

Hi-ATB: High Alternate Top Bevel

MDF: Medium Density Fibreboard

OEE: Overall Equipment Effectiveness

RCD: Residual Current Device

RPM: Revolutions Per Minute

TCG: Triple Chip Grind

LEARNING UNIT 1: MAINTENANCE

1.1 Introduction

The goal of maintenance is to eliminate or to avoid unnecessary or unplanned downtime due to failure, to ensure the reliability and safety of plant equipment. Knowing that all equipment components will wear, appropriate man-agreement must be applied to avoid unplanned failure.

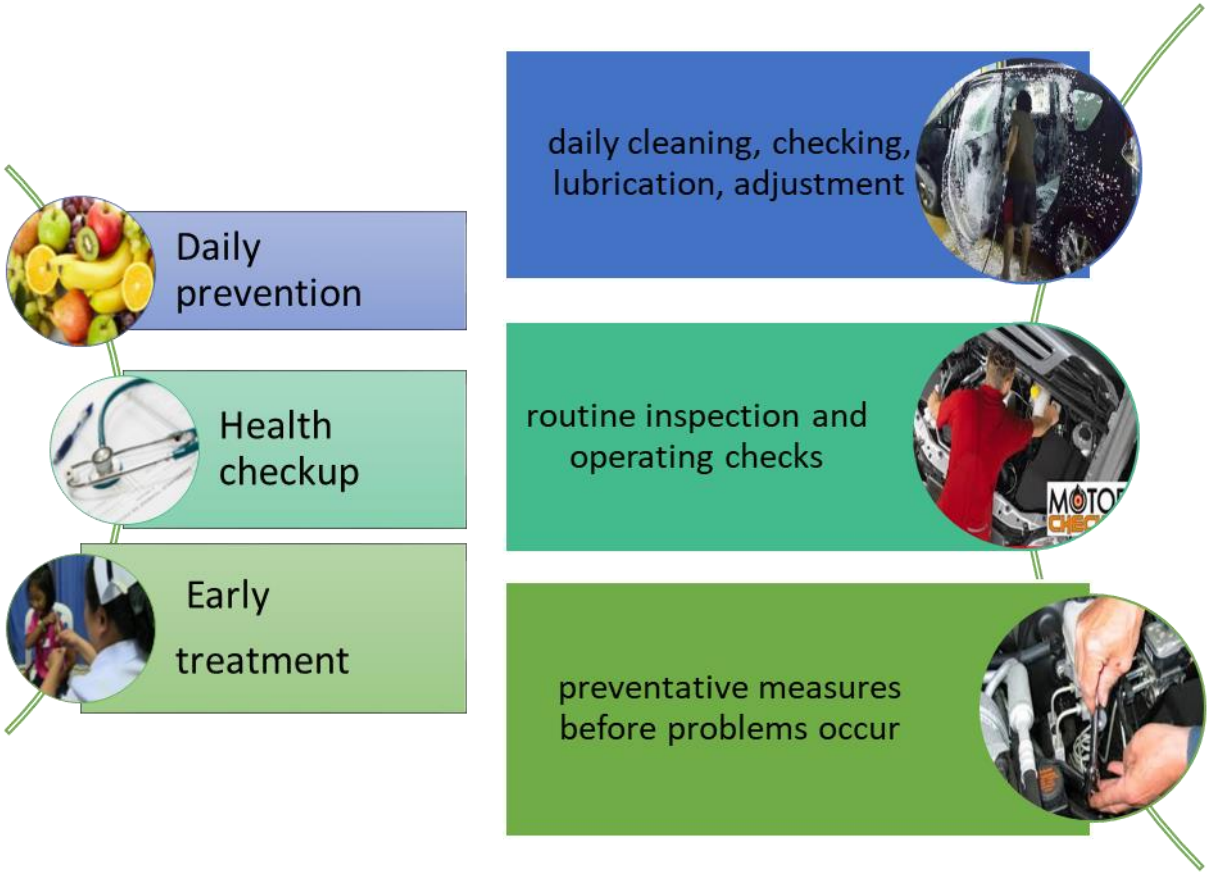
Maintenance can influence the entire plant operation, from product quality to on-time delivery, to safety records and to the impact of environmental pollutions. Poor maintenance procedures can cost some company millions of Rwandan francs in repairs, poor quality and lost production, whereas good maintenance practices can cut production costs immensely. Still the advantages of maintenance management are underestimated.

Here are some samples on how we handle other common situations in life:

- We go to the doctor only when we are sick
- Our car goes into the shop only for repairs
- In our home, we call electricians, plumbers, etc. only when there is a problem
- The focus of technical education is on dismantling/reassembling equipment
- In the workplace, the best "fixer" gets the promotion

This “bad habits” has integrated itself into the maintenance workplace also. It is unlikely that these "habits" can be changed overnight. Moving from the approach of "Fixing" as the principal activity of maintenance to the approach of “Preventive Management” - which is proactive - takes time, and a good engineering.

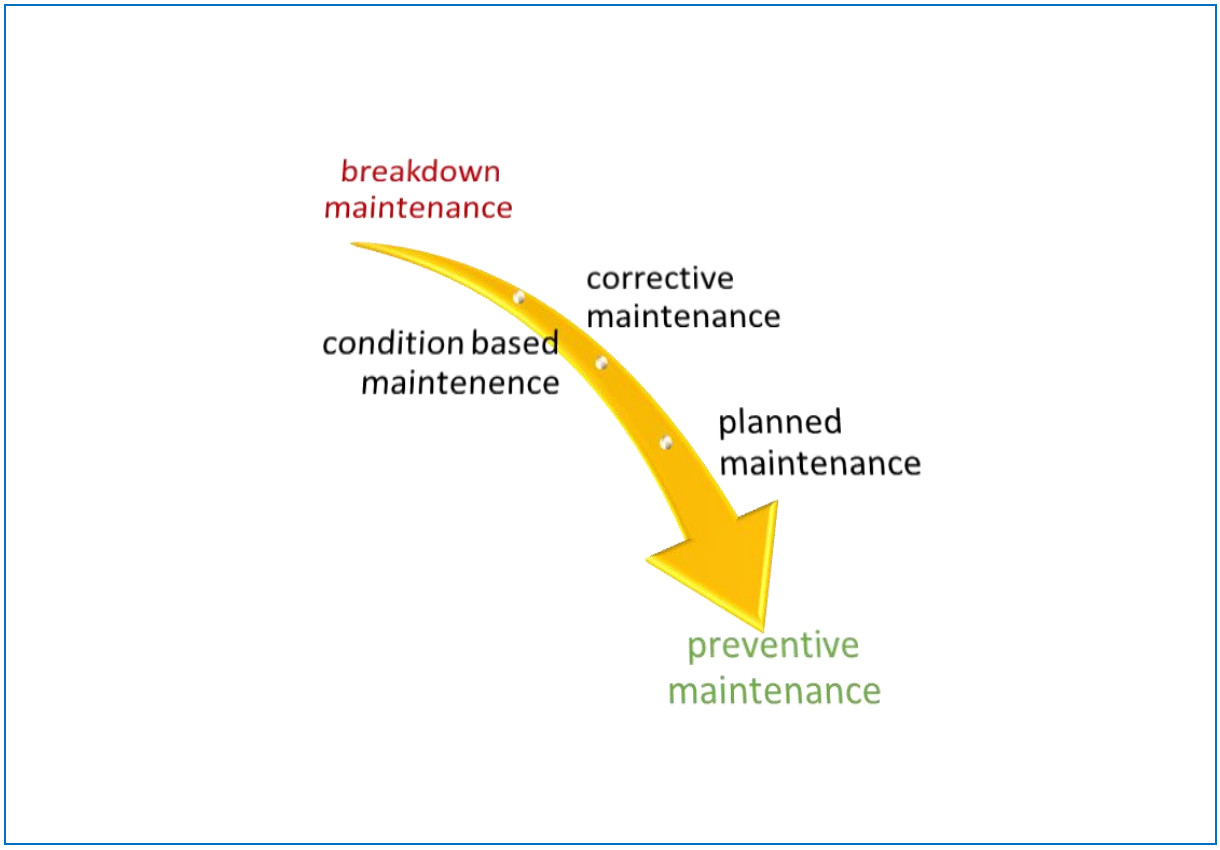
Preventive medicine **Preventive maintenance**



1.2 Planned maintenance

Planned maintenance activities include any maintenance work scheduled in advance. For example, changing the oil in a vehicle because the oil light came on is not a planned maintenance. However, changing the oil because the vehicle had gone 3,000 miles would be a planned maintenance

What Is the Difference Between Planned and Preventive Maintenance? Preventive maintenance is a form of planned maintenance. Once Preventive Maintenance tasks are identified based on time or equipment usage, planned maintenance organizes the resources needed and prioritizes work orders for their effective completion



1.3 Preventive maintenance

Any maintenance activity for which a pre-determined job procedure has been documented, for which all labour, materials, tools, and equipment required to carry out the task have been estimated, and their availability assured before start of the task. Repair or replace on time or cycles.

Preventive maintenance is done by a routine as follows:

1. Cleaning
2. Inspection
3. Oiling/lubrication
4. Retightening

1.3.1 Condition based / corrective/ maintenance

The use of specialist to measure the condition of equipment. Vibration Analysis, Lubrication Analysis and a Thermography are all examples of Condition Monitoring techniques. Changes in hardware, loading or procedures. Condition monitoring detects the presence of root causes of failure.

1.3.2 Breakdown maintenance

Breakdown maintenance means wait until equipment fails and repair it; reaction is done only after machine failure. No routine maintenance tasks are performed. (Reactive Maintenance)

EXERCISE 30'

- Q1: How many times did you do breakdown maintenance a week?
- Q2: Describe a situation of breakdown maintenance?
- Q3: If you implement preventive maintenance what does it mean?
- Q4: Can preventive maintenance be done by anyone?
- Q5: What do you need in order to carry out preventive maintenance?

- Q1: Breakdown maintenance is the worst-case of types of maintenance, it should be avoided
- Q2: Breakdown maintenance means bigger loss of time, possible hazardous situation, and possible delay of delivery
- Q3: Preventive maintenance is done to prevent any down time or hazards
- Q4: Only experienced personnel can do preventive maintenance because you have to know function of the machine and parts
- Q5: you need to apply a routine of steps followed in your company

1.4 Sequence of maintenance

1.4.1 Benefit of preventive maintenance

a) Lengthen lifespan of equipment and machines

Keeping your equipment in good condition allows it to run longer, lowering costs. Plan preventive maintenance at just the right moment, catching the equipment before a breakdown and implement preventive maintenance report seeing an increase in the equipment's lifespan.

b) Lower risk of breakdowns

Decreased risk of breakdowns is another key benefit of preventive maintenance. In fact, most of the benefits listed here occur primarily as a result of lowered risk of breakdown. Waiting to perform maintenance until failure puts your facility at risk for lost productivity and a damaged reputation.

Only about 10% or less of industrial equipment ever truly wears out from proper use- this means that 90% of mechanical failures are due to preventable problems, avoidable with a good preventative maintenance plan in place. By proactively scheduling maintenance you can significantly lower the risk of your equipment failing, giving you peace of mind as a company leader.

c) Increase efficiency

Along with lasting longer, equipment that sees routine preventive maintenance also runs more efficiently. OEE rates equipment in three categories: availability, performance, and quality.

Availability: Downtime for reactive maintenance is typically longer than downtime for scheduled preventive maintenance, choosing preventive maintenance means more uptime and availability of equipment.

Performance: Properly maintained units can better maintain cutting and shaping friction and sliding function and setting accuracy

Quality: A machine that regularly has the belts tighten the lubrication done and replace bolts will keep the calibration longer and produce cleaner, higher quality.

d) Less unplanned downtime

Whether you decide to rely on reactive or preventive maintenance, machine downtime is inevitable when maintenance is being performed. However, downtime can be significantly reduced by scheduling maintenance in advance with a preventive maintenance plan. In the case of a reactive maintenance repair, the machine's downtime might be extended by wait times to see specialized mechanics or shipment time of necessary parts.

When preventive maintenance is performed you have the opportunity to schedule the procedure at a convenient time for you and your facility minimizing disruptions in production and efficiency.

e) Increased workplace safety

Accurately tracking and performing preventive maintenance can also improve the health and safety of your workshop. Tracking preventive maintenance will allow you to oversee all equipment in your facility and store important safety, the complete

maintenance history and safety protocols for all equipment items will become available.

f) Boost customer satisfaction

Ensuring equipment is always running as efficiently as possible directly translates to cost savings and increased revenue, but it also helps to create a strong brand image and boost customer satisfaction. In facilities manufacturing goods for sale, practicing preventive maintenance to avoid breakdowns and maintain the quality of the goods produced guarantees customer satisfaction with the product, which in turn strengthens brand image.

g) Save money

All of the reasons listed above lead back to one ultimate benefit of preventive maintenance: it saves money. Unplanned maintenance typically costs 3 to 9 times more than planned maintenance.

Emergency reactive maintenance has to accommodate the cost of rushed shipping on necessary machinery parts, compensation for specialized technicians, and lost sales revenue or productivity while the equipment isn't in use. Even worse, failing to properly implement preventive maintenance could result in the need for a full equipment replacement, causing costs to soar.

The upfront costs of performing preventive maintenance may seem intimidating at first, especially if your facility is operating under a tight budget. However, maintaining your equipment is an investment in your company's future.

1.5 Machine maintenance steps

a) Clean / inspect

Inspections are a necessary part of preventive maintenance and help organizations in two ways. First facility inspection will ensure that equipment is safe to use. Regular inspections help prevent workplace injuries and provide a business with increased liability protection. Second, regular inspections protect property. Inspections ensure that equipment is functioning as the manufacturer intended.

Inspection skills:

Use your five senses to inspect your equipment and machines: *touch, taste, sight, hearing, smelling*

b) Measure

Check all part of your machine if their setting is following the constructers initial size and position.

c) Calibrate

Machine calibration is a process during which a piece of machinery is adjusted to ensure its accuracy and precision. For example, the calibration of thicknesses to make sure the indicated thickness is the same than boards thickness.

d) Realign

Loosen misaligned dislocated, deformed parts of a machine need to be realigned. Use tools or jigs to readjust table, fence, sawblade etc.

1.6 Spare parts

A spare part, service part, repair part, or replacement part, is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed units. For any machine along the wood value chain this is a very brought cluster. it can be the standards like, drive belt, drive chain, bolt nuts. sawblade spare parts feed roller grinding wheels, band saw tires' / rubber lubricants, setting devise, abrasives.

A company has to decide what kind of spare part can be stored. Cutter and tools should be always in the shop to be replaced without any louse of time. As well part which are inexpensive and frequently cause failure or breakdown. (Drive belt, lubricant) Other spare parts will need specific order and too expensive to keep in stock. If the cost of the downtime caused by a part's failure without another in stock is greater than that of carrying the replacement, the part may be considered critical. Other considerations include ease of sourcing, time required to replace the component, risk of obsolescence of the replacement, and more.

1.7 Test run

A test run will be performed to ensure the correct setting and calibration after maintenance or repair. Any time blades or cutter are changed, a test run has to be performed to secure serviceability and safety. For a test run you will need either jigs or work pieces with measurable characteristics. Sometimes the result can be visible like a clean surface from planer sometimes measuring tools will be needed if it comes to realignment. (Is the work piece parallel?)

EXERCISE 40'

- Q1: Point out the disadvantages of preventive maintenance
- Q2: State 3 examples for calibration of your machines or tools
- Q3: What kind of spare parts are available any time on which pre order is needed?
- Q4: List sequence of maintenance to change a cutter knife at the planer

- Q1: Cost of spare parts, stop of machine production planned work, difficult scheduling
- Q2: Setting the table of drilling machine, setting the display to the cutting height,
- setting outfeed table to cutter height. Aligning fence parallel to circular sawblade
- Q3: Standard should be belt, bolt nuts specific are cutter blades cover fence
- Q4: Clean, disassemble, assemble measure, calibrate, realign

1.8 Interpret machine manual

1.8.1 Machine manual

A machine manual covers the safety, equipment and operation description. Usually, it explains the setting and tolerances the machine has. Most of the time it contents explosion drawings which let the maintenance personal see inspection and lubrication points. Spare parts are numbered/coded for further order and even trouble shooting and basic preventive maintenance is covered. With a little research you can find old manual on the internet to be sure about spare parts and frequency of greasing and lubrication.

https://manualzz.com

https://www.manualslib.com

Lubricating nipple, saw unit

Time interval:

After travel of 100 m, a message is shown on the display indicating that relubrication of the height adjustment unit is necessary.

Lubrication is necessary once a year, irrespective of the distance travelled.

How to proceed:

To relubricate, set the tilt of the saw blade to 45° and the cutting height to 0 mm. Open the machine door or remove the protective cover plate (VARIO). This allows optimum access to the lubricating nipples.

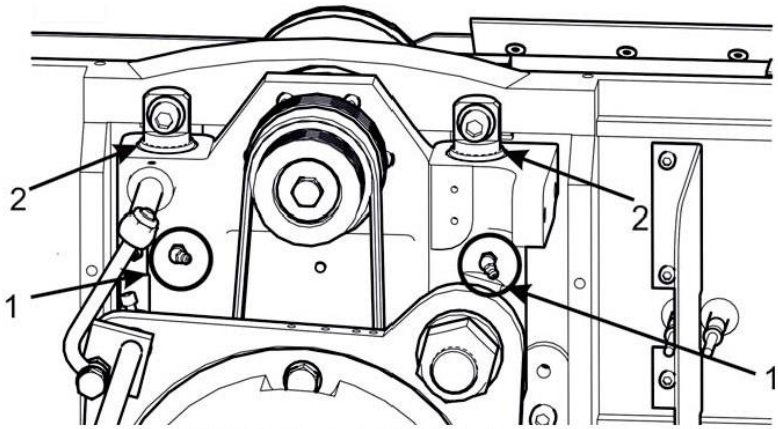


Fig. 7-14 Lubricating nipple (1), height adjustment of the saw unit tilting to one side

[1] Lubricating nipple, height adjustment

[2] Shaft sealing rings, height adjustment

Remove any emerging grease and chips from the guide rods (2).

Source: Altendorf F45 machine manual

1.8.2 Inspection points

Maintenance inspections can identify minor issues before they turn into costly repairs. Inspections ensure machines are working correctly and helps prevent equipment downtime.

Just about every plant or facility must conduct regular inspections as part of its overall maintenance program. Electrical systems, mechanical systems, and instrumentation components must be checked and subsequently serviced.

Ideally, inspections are scheduled, completed on time, and documented. Many inspections must be conducted while a production line is running or equipment is operating. Inspections cannot interrupt manufacturing or production processes, and many pieces of machinery

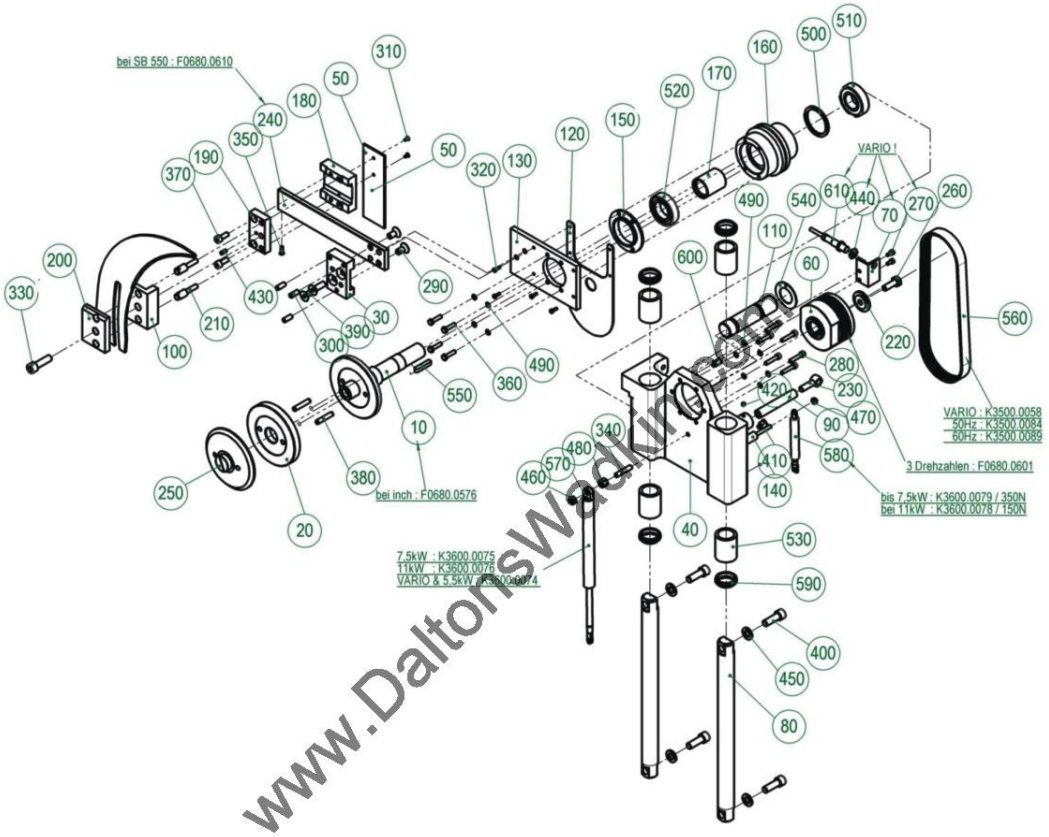
cannot be checked adequately without seeing them in action.

The best maintenance inspection programs include the following best practices:

- Condition-monitoring routes cover all needed inspections
- Guards or other protective gear can be removed in order to check belts, couplings, and chains in action
- Oil containers and other clear gauges and base bolts are clean and facilitate accurate inspections
- Maintenance staff is educated and trained in basic inspection processes
- Inspection points should be defined at area of:
    - ✓ Temperature (all critical zones, components and surfaces)
    - ✓ Vibration
    - ✓ Balance and alignment
    - ✓ Setting
    - ✓ Fixing
    - ✓ Gauge readings (temperature, pressure, vacuum, flow, speed, proximity, etc.)
    - ✓ Differential filter pressure
    - ✓ Magnetic plug collections
    - ✓ Oil level, colour and clarity at all sight glasses
    - ✓ Leak zones

1.8.3 Spare/part manual

3.2 Saw shaft main saw
B0680.0025~~f



Pos.	Article - No.	Designation
10	F0680.0575	saw shaft AKE WZ-Br.20mm (mm)
20	F0680.0581	intermediate washer SW -max.WZ-Br.20mm-
30	F0680.0620	clamping piece
40	F0680.0672	holder
50	F0680.0730	cam switch
60	F0680.0750	pulley saw shaft 6PK (VARIO)
70	F0680.0780	angle bracket
80	F0680.0860	guide bar
90	F0680.0870	tube
100	F0680.0950	clamping plate
110	F0680.1020	bolt M30x2
120	F0680.1101	protective plate
130	F0680.1110	pressure plate
140	F0680.1120	distance piece
150	F0680.1230	pressure ring
160	F3080.0512	bearing housing
170	F3080.0582	distance tube

5.4.6 Angle cut

Checking the angle cut

Before checking the angle cut, check the settings of the sliding table and of the swinging arm, and correct them if necessary.

Carry out the check as follows:

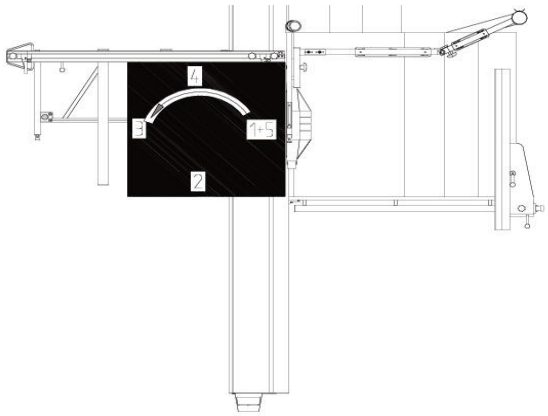


Fig. 5-47 Angle cut

As the tool, use a sharp saw blade, D = 350 mm/ 3.5/2.5/72 teeth alternate bevel at n = 5000 rpm. Take a 1000 x 1000 mm chipboard or MDF board, minimum board thickness 19 mm. Perform 5 cuts (see fig.), laying the last cut side at the crosscut fence for the next cut (turn the board counterclockwise). For the 5th cut, cut off a strip with a width of approx. 10 mm. Measure the thickness at both ends of the strip with a vernier caliper. The difference between the two dimensions divided by 4 gives the angular error per metre cut length.

Check:

The angle cut must be checked at a minimum of 2 different positions on the cross-slide of the sliding table.

Factory setting:

The cross-slide is clamped to positions of approx. 300 mm and 1300 mm from the sliding table end. In these two positions, the angle cut is checked and adjusted as described above. Ensure that the setting does not exceed the maximum permissible tolerance of **< 0.2 mm** (for the 5th cut (dimension 1 - dimension 2)).

Source: Altendorf F45 machine manual

EXERCISE 20'

- Go to the workshop and observe the parts of the circular saw pulley section. Use the manual above and identify the parts for routine maintenance
- Q1: What does the manual show?
- Q2: What kind of maintenance is described?
- Q3: What is the difference between an operation manual and a spare part manual
- Q4: Are there common spare parts listed in the manual?

- Q1: The manual shows how to clean and grease the adjustment at the lubrication nipples
- Q2: Planned condition-based maintenance after 100 meters
- Q 3: Operation shown and spare parts with order number in explosion drawings
- Q4: Spare parts in manuals are always specific for the machine only

1.9 Maintenance schedule

Before you start to develop a maintenance schedule you have to:

- ✓ Fix a schedule for cleaning and inspection fitting to your routine
- ✓ Eliminate sources of dirt debris excess lubrication etc.
- ✓ Improve cleaning maintainability
- ✓ Understand equipment function first
- ✓ Develop inspection skills
- ✓ Develop standard checklist

Equipment File:

To ensure a quick and smooth planning of maintenance activities as well as the actual repair job, it is advisable to maintain an equipment file for all equipment, used in the plant.

The following data should be included:

Specification	- Type of equipment - Brand - Model - Date of installation - Serial number - Capacity - Speed - Load
Location	- Building - Floor
Technical Documents	- Including detailed drawings - manual
Spare Part No	- Bearing - Sealing - Lubricant - Belt type and number - max and min size of blades and knives
Supplier/shop/contact	- list supplier or contact

EXERCISE 60'

Create a maintenance checklist according to the handout:

- List all your equipment which needs preventive maintenance
- Create a list or take the sample and enter one machine
- Fix areas for checkpoints and create checklist
- Fix the interval for inspection
- Write down the action

- Q1: How do you introduce the system to your personal?

Content has to have:

- Frequency clearly described
- Inspection point, lubrication aid
- Clear described action
- Q1: Present content describe action, name lubricants and provide in workshop; place the schedule at machine workshop

Sample checklist:

Check adjust inspect replace

PANEL SAW CHECKLIST						
WHEN	**WHERE**		**ACTION**			
Frequency	***Inspection point***		***Clean/ lubricate***		***Replace***	
Every Monday	Sliding table	✓	Chips and sawdust			
			Bearings WD 40			
	Table mouth piece			✓	When damaged	
	Inside tire and guards		Chips and sawdust			
	Switch					
After every shift	Saw blade		Kerosene for resin	✓	When dull	
After every shift	Inside motor/transmission side		Blow out sawdust from motor side			

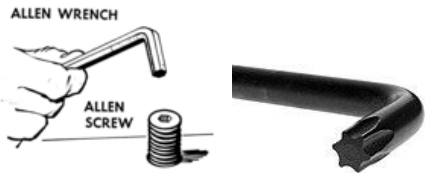
CHECKLIST						
WHEN	**WHERE**		**ACTION**			
Frequency	***Inspection point***		***Clean/lubricate***		***Replace***	

1.10 Maintenance tools

Before starting to organize your maintenance, you should check the owner's manual which is your fist important tool you will need. Many times, the mechanical maintenance at your machine is obvious from looking at it. But manuals have Helpful pictures and drawings identify parts and explain their function of the machine. To achieve all settings, tune up maintenance and repairs you will need basic tool kit for the job. A set of wrench socket hex key hammer pincer screw driver etc. should be kept specific only for maintenance purpose.

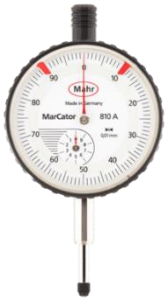
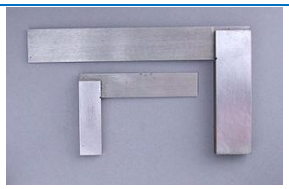
But for calibration and setting you will need tools specific for your machines.

1.10.1 Mechanical tools

Combination wrench	
Set of socket wrench	
Set of Hex or allen key Torx key	
set of screw driver philips's head And slotted head	
Hammer and combination pincer	

Source: wikipedia

1.10.2 Measuring tools

For flatness straightedges Dial indicator	
Feeler gauge	
Good quality! machinist combination square For alignment	 
Setup tools mainly used for circular saw and jointer Steel disc for alignment of sawblades	
Commercial jigs and aid For setting of planer knives And calibration	

Source: Holzmann maschienen

Jigs can be built by your own and sometime be unconventional. Use what you have if the result is precise and following rules and regulations for machining it proofs itself.

You can fabricate jigs from solid wood or MDF but take care for their quality. Most of the time it's the cheap straight edge from solid wood you will use for checking your settings.

EXERCISE 30'

- Q1 How many tools do you have for maintenance?
- Q2 Where do you store your tools
- Q 3 What is the function of a dial indicator
- Q4 Did you ever use a square for aligning the fence of a jointer?
- Q 5 How do you check the quality of a square?
- Q6 Is it possible to build your own jigs for setting and calibration?
- Q7 How do you align the sawblade to the fence?

- Q1: No one of the workshops will have tools for maintenance only but this is an essential need to provide such
- Q2: Tools are usually cluttered around but should have one box only for maintenance purpose
- Q3: Measuring to a tenth millimetre of thickness distance etc.
- Q 4: Alignment of the fence should always be done with machine try square specific for that task
- Q 5: The accuracy of the square will be measured by marking along a straight edge and flipped position
- Q 6 Jigs can be built by your own considering precise manufacturing to the calibration measurements
- Q 7 Practical task should be carried out after describing the steps

1.11 Maintenance lubricants

1.11.1 Types of lubricants

Wood as a manufacturing material implements, we have a big amount of chips and sawdust covering critical parts of our machines. If carrying out cleaning you have to consider that surfaces that are in contact with the product wood. In any case the wood will have contact with oil you will have quality problems with surface finishing treatment. (Applying varnish lacquer or oil) Using grease is general not allowed to lubricate except using a greasing pump at specific areas, lubricants in general are sawdust magnets. After cleaning you should use dry lube, or wax.

Lubrication means to know where to lubricate:

- Pivot points
- Combination of camphor, beeswax, petroleum, phenol
- Wax/ slikon spray
- Teflon /wd 40
- Light machine oil/oil for machines sae 10 w 40
- Kerosene

☞ ***Sandpaper is not a cleaning aid***

1.12 Types of cleaning aid

Cleaning aid needs to clean proper but not to damage

1. Degrease
2. Scrub off surface built up like rust or resin
3. Wax

- Dust collector for vacuuming the inner part
- Compressor for compressed air to blow out areas which cannot reach with vacuum
- Brush
- If resin is built up to thick sometimes only thinner can do
- Shavings under tables need to be cleaned with degreasing detergent
- Light oil can help taking of debris and light rust from surfaces
- Sawblades can be cleaned with
- For rust wd 40 and steel wool
- Machine wax for slips surfaces

EXERCISE 20'

Q1: What kind of cleaning aid do you use to clean a sawblade?

Q2: What is the result of using oil to clean your sawblade?

Q3: Why did rust build up on saw surface?

Q4: What is the difference between cleaning and lubrication?

Q1: Sawblade should clean with soft lye and after every shift or when building up if it is not done frequently only thinner can do never use any sandpaper!!!!

Q2: Oil built up on sawblade body and glue together with saw dust resulting in overheating and damaging the blade

Q3: Can be from compressed air with high amount of water, scratches on surface, no cleaning or maintenance

Q4: Cleaning takes of unwanted lubrication applies a film of lubricant

☞ ***For all practical exercise follow OHS, use safety operation and adhere to PPE***

PRACTICAL EXERCISE 30'

- The trainer will hand you a cutter
- Inspect the given cutter, knifes, blades (hand tools)
- Check its serviceability
- Use the correct detergent to clean
- Use the correct detergent to lubricate
- Perform cleaning
- Present the challenges to the group

LEARNING UNIT 2: BASIC PREVENTIVE MAITENANCE OF ELECTRICAL

2.1 Introduction

Caring for everything and being master of anything is the common misunderstanding of a crafts production person. For any electric repairs or handling the carpenter should be user only. That means checking, inspecting and controlling, but no carrying out of repairs or modifications.

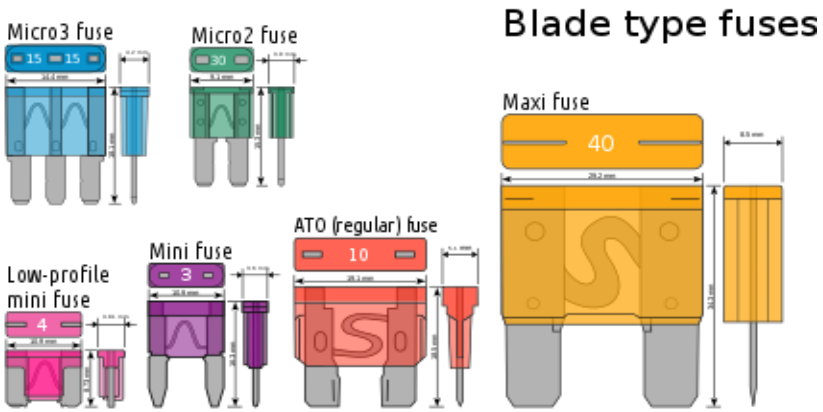
☞ ***Electric maintenance/repair is done by special skilled person only!***

Preventive maintenance of motors in wood shops is often neglected. The motors are so reliable so it is assumed that they will continue running without attention. If you maintain it periodically the lifespan of motors will be extended and repairs reduced. Motors are usually ventilated by fans mounted on the motor shaft. Clogged ducts and dirty motor windings might cause high temperature. Considering the amount of dust cleaning that has to be done frequently, at least once a week. More frequent when exceptionally dirty.

2.2 Types of circuit breaker

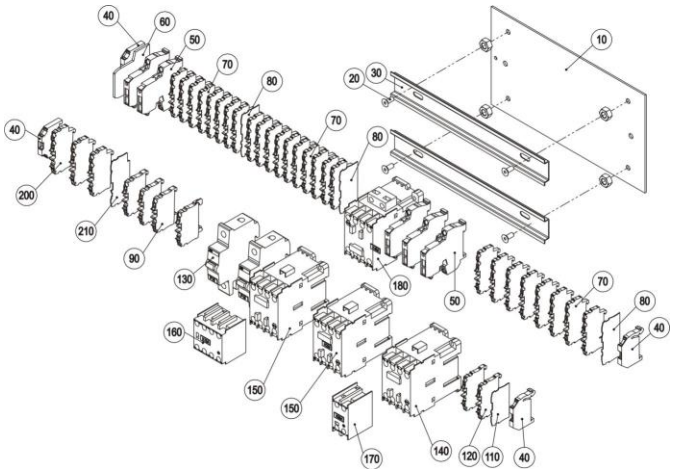
Circuit breakers are a very important part of electrical safety. They control the amount of electricity that flows through a building's electrical wiring system. If your home suffers an electric overload or a short circuit, a properly functioning circuit breaker will detect the issue and cut off the electrical supply

2.3 Types of fuses



Source: wikipedia

In electronics and electrical engineering, a fuse is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby stopping or interrupting the current.



Source: altendorf f 45 fuse terminal

2.4 Grounding of motors

Electrical machines should be grounded to eliminate the possibility of getting a shock if the motor develops a short circuit. This precaution should be taken at all times, but it is especially important wherever there is dampness. All electrical installations above the 115-volt circuits are permanent and must be grounded by an electrician. Machines that are not grounded through their foundation require a ground wire.

The ground wire may run from the machine to the outlet box if the box is connected to a metallic conduit. If the wiring systemic is non-metallic, the ground wire will need to run to some grounded system such as a water pipe or a rod driven into the ground. Many portable machines are equipped with an electrical cord containing a third wire (groundwire) which can be connected to the metal outlet box. Some receptacles are made to receive three-pronged polarized plugs. In this case the third wire is connected to the third prong, which automatically grounds the machine when the plug is inserted in the receptacle.

Exercise

- Explore the different types of fuses and breaker,
- Observe the use of grounding and discuss with the group.
- Propose action to be done at the inspected

EXERCISE 20 min

After having some proper fuse and breaker in hands the learner exercise in the workshop observation of grounding an installing of breaker and fuses.

- Q 1 Why do machine have to have ground connected to machines
- Q2 What are the most neglected hazards at wood working machines

- Q1 Accident electrical shock
- Q2 Improper wiring

2.5 Inspect the electrical connection of motor

☞ ***Inspect your machines and equipment prior to every work shift***

Do regular checks of the plug and socket for burn marks, sounds of 'arcing' (buzzing or crackling) or if it feels too hot. If you have fuses blowing or circuit-breakers tripping, then contact a registered electrician to investigate.

Any socket you plan to use to plug in a machine should have RCD (residual current device) Protection. An RCD is a life-saving device that protects against dangerous electric shock and reduces the risk of electrical fires. If you don't have RCD protection in your fuse box for your sockets, consider using an RCD plug to protect you and your property from serious appliance faults.

Before you start work, ensure that the cord is long enough to easily reach the area you're

working in – if it isn't, plug the circular saw into a fully-unwound extension led to extend your reach.

Electrical cable should never be installed on top of floor surface

- Check cable
- Check plugs
- Check sockets
- Check fuse boxes
- Check switch and setting handle

2.6 Clean electrical motors of wood working machines

Motors must be cleaned as frequently as necessary to permit an ample supply of air to flow through the motor. Clean the ventilating ducts of all motors once a week. Clean more frequently motors that are in exceptionally dirty locations and those on portable machines operated at high speeds and relatively high temperatures. The life of a motor depends upon keeping the ventilating ducts open to prevent the temperature from rising higher than the limit given on the nameplate. These ducts can be cleaned easily with dry compressed air, a portable electric blower, or hand bellows.

If compressed air is used, the pressure should ***not exceed more than 2,3 bar***

There is danger of damaging the windings and connections if the air pressure is high enough to force the wires out of their natural position.

Excessive moisture in the compressed air is also injurious to the motor as it will tend to sort out the windings. Dry air can be maintained with a compressor by installing a filter in the line to remove the water. After a time, sticky or gummy dirt, that cannot be removed by blowing air through the ventilating openings, may accumulate in a motor. The motor must then be taken apart and cleaned. In some instances, it may be advisable to have the job done by an electrician.

Steps of cleaning a motor:

1. Disconnect the motor from the circuit and the machine.
2. Remove the end plates on the motor and carefully observe the relationship and position of all the parts so that the motor can be properly reassembled.

3. Brush the windings with a clean, dry brush. Wipe them with a clean, dry cloth. If they are coated with dirty grease or oil, clean them with gasoline or naphtha. These liquids evaporate quickly and, if applied *sparingly*, will not damage the insulation.
4. Wash the metal parts with gasoline and wipe them dry with a clean cloth. Be sure all the dirt is removed and that the ventilating ducts are open.
5. Carefully reassemble the motor and tighten the end plates. Be sure that the shaft turns freely.
6. Lubricate the bearings with the proper kind of lubricant
7. Mount the motor on the machine and make the electrical connections. Start the motor and check its performance.

2.7 Inspect commutator and brush

a) Inspect and clean commutator

Some types of motors have a commutator and carbon brushes. The brushes fit into holders so that they ride on the commutator under spring pressure. Most of the friction wear between the brushes and the commutator is on the brushes, but gradually the brushes cut grooves in the commutator. Keep the commutator clean at all times.

☞ ***Do not put oil on it or on the brushes.***

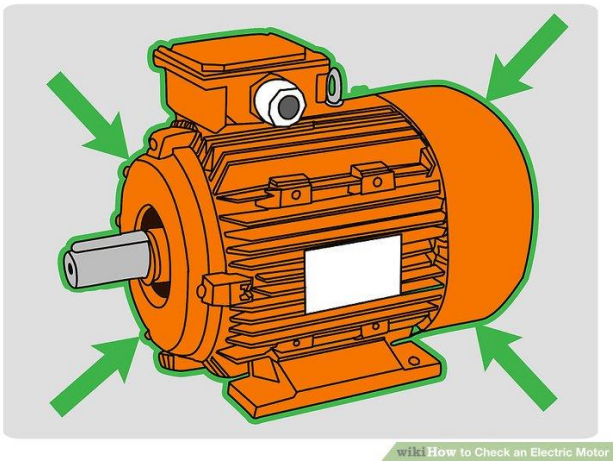
If the commutator becomes dirty or rough, carefully clean and smooth it with a piece of garnet paper. Emery cloth should not be used because it is a conductor of electricity and may cause a short circuit in the commutator. In the opinion of one manufacturer 75 per cent of portable electric tool failures is due to the lack of attention given to carbon brushes. Keep the brushes clean so that they will slide freely in their guides and be held firmly against the commutator. Check springs and brushes so that weak springs and worn brushes can be replaced immediately. The use of worn brushes may cause excessive wear to the commutator, and inefficient motor performance. New ones should be of the same type as those originally furnished with the machine.

b) Fuse boxes and switch boxes

Fuse boxes and switch boxes should be cleaned out at regular intervals with compressed air or hand bellows. The fine dust that accumulates within the boxes is frequently the cause of improper functioning of the switch. The dust particles prevent

the contact points from making the correct connection. This causes them to arc across the points and burn, especially when magnetic switches are used. Since fine dust is combustible, there is a possibility that the arcing across the contacts may ignite and cause the dust to burn violently. If knockout plugs have been removed unnecessarily, close the holes to prevent dust from entering the fuse box.

2.8 Basic trouble shooting of motors



Check the outside of the motor. If the motor has any of the following issues on the outside, they may be problems that can shorten the life of the motor because of previous overloading, wrong application, or both.

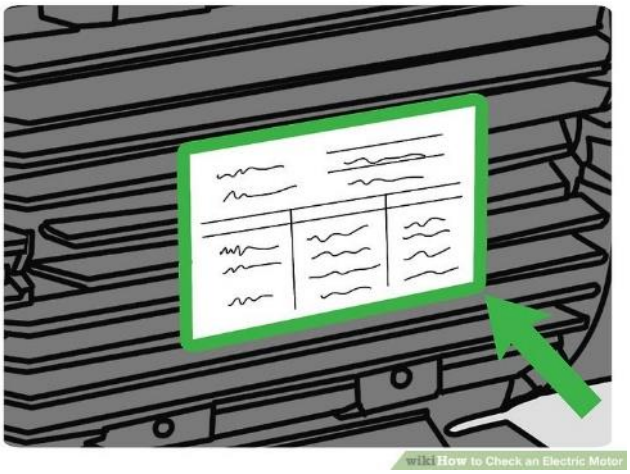
Look for:

- Broken mounting holes or feet
- Darkened paint in the middle of the motor (indicating excessive heat)
- Evidence of dirt and other foreign matter having been pulled into the motor windings through openings in the housing

Check the nameplate on the motor. The nameplate is a metal or other durable tag or label that is riveted or otherwise affixed to the outside of motor housing called the '"stator" or "frame". Important information about the motor is on the label; without it, it will be difficult to determine its suitability to a task.

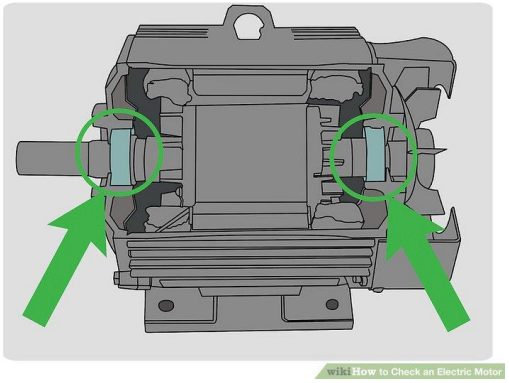
Typical information found on most motors include (but not limited to):

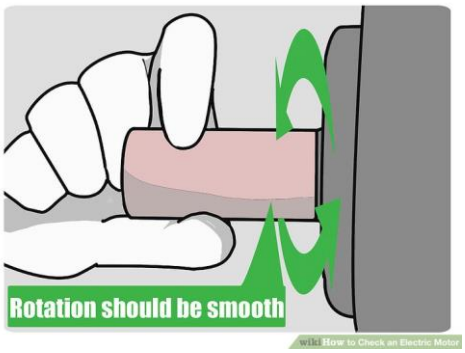
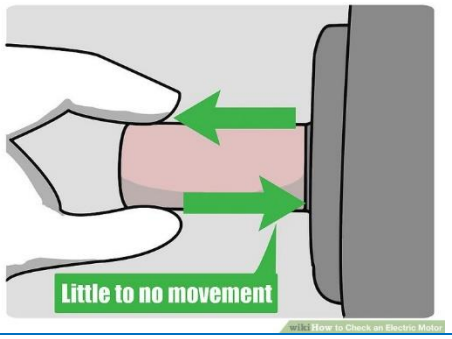
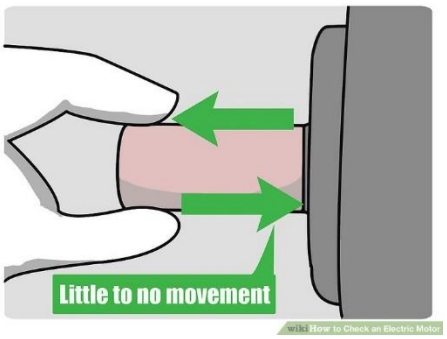
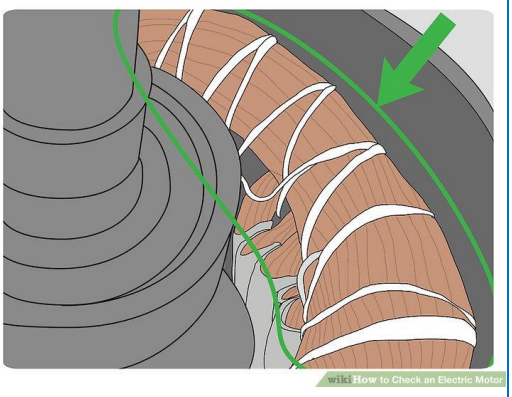
- **Manufacturer's Name:** The name of the company that made the motor
- **Model and Serial Number:** Information that identifies your particular motor
- **RPM**: The number of revolutions the rotor makes in one minute
- **Horsepower**: How much work it can perform
- **Wiring diagram:** How to connect for different voltages, speeds and direction of rotation
- **Voltage**: Voltage and phase requirements
- **Current**: Amperage requirements
- **Frame Style**: Physical dimensions and mounting pattern
- **Type**: Describes if frame is open, drip proof, total enclosed fan cooled, etc

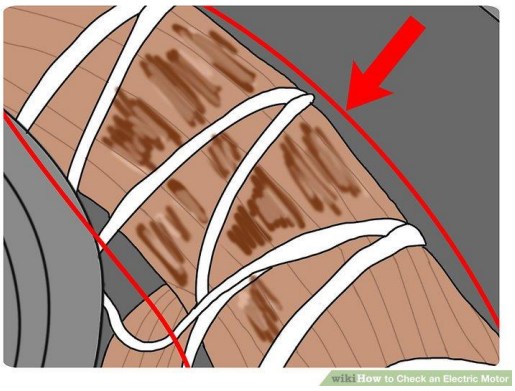


Begin to check the bearings of the motor. Many electric motor failures are caused by bearing failures. The bearings allow the shaft or rotor assembly to turn freely and smoothly in the frame. Bearings are located at both ends of the motor which are sometimes called "bell housings" or "end bells".

There are several types of bearings used. Two popular types are brass sleeve bearings and steel ball bearings. Many have fittings for lubrication while others are permanently lubricated or "maintenance free"



Perform a check of the bearings. To perform a cursory check of the bearings, place the motor on a solid surface and place one hand on the top of the motor, spin the shaft/rotor with the other hand. Closely watch, feel, and listen for any indication of rubbing, scraping, or unevenness of the spinning rotor. The rotor should spin quietly, freely and evenly.	
Push and pull the shaft in and out of the frame. A small amount of movement in and out (most household fractional horsepower types should be less than 1/8" or so) is permitted, but the closer to "none" the better. A motor that has bearing-related issues when run will be loud, overheat the bearings, and potentially fail catastrophically.	
Push and pull the shaft in and out of the frame. A small amount of movement in and out (most household fractional horsepower types should be less than 1/8" or so) is permitted, but the closer to "none" the better. A motor that has bearing-related issues when run will be loud, overheat the bearings, and potentially fail catastrophically.	
Check the windings for short circuiting to the frame. Most household appliance motors with a shorted winding will not run and will probably open the fuse or trip the circuit breaker instantly (600-volt systems are "ungrounded," so a 600-volt motor with a shorted winding may run and not trip a fuse or circuit breaker)	

Check that the windings are not open or blown. Many simple "across the line" single-phase and 3-phase motors (used in household appliances and industry respectively) can be checked simply by changing the range of the ohm meter to the lowest offered (R X 1), zeroing the meter again, and measuring the resistance between the leads of the motor. In this case, consult the wiring diagram of the motor to be sure that the meter is measuring across each winding.	

EXERCISE 30 min

Find yourself in groups at a sawing unit an inspect:

- Inspect a circular saw in your workshop
- Follow the steps discussed before and write down your findings
- Create a chart which can be used as a routine chart for checking motors in your workshop (make it easy to tick if done)

Inspection needs to cover:

- Q 1 Casing of motor
- Q 2 Visible abnormalities
- Q 3 Sensitive rotation scraping of rubbing
- Q 4 Movable parts are free moving
- Q 5 No excess movement at parts possible

Recap from unit one: use your senses for inspection

Sample:

Machine	Inspect	Done
Motor circular saw	Mounting	✓
	Colour of the cover	
	Dirt into motor windings	
	Rotate bearing	
	Push and pull bearing	
	Check winding for shortcut to frame	
	Check damaged winding s or blown	
	Check fan	

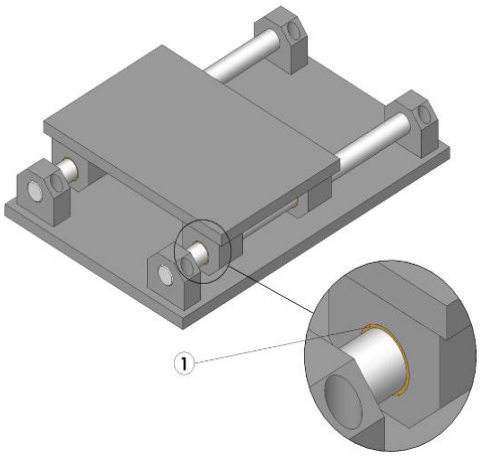
LEARNING UNIT 3: MAINTENANCE ON BEARINGS

3.1 Introduction

A bearing is a component of a machine which permits a force to be transmitted between two moving elements. Bearings hold moving parts in position and transfer the force with minimum amount of friction.

3.2 Identify types of bearings

Plain bearing



May be classified under two general headings, **plain** and **antifriction**.

Plain bearings are those in which the transfer of load between two moving surfaces is produced by sliding contact. One of these parts is a material selected because of its structural properties, usually steel. The other member is composed of a material which operates effectively against the structural part. These materials have a high resistance to wear and can withstand the stresses imposed upon them. The components of the bearing assembly consist of the bearing, the shaft or other moving member, and the housing which holds the bearing in place.

Ball bearing

At the factory, most open type bearings are coated with a petroleum antirust compound and wrapped in antirust paper. The petroleum is compatible with most lubricants but is not intended to take the place of the type and grade of lubricant recommended for the bearing.

The bearings should be left in the package and stored at a moderate temperature until they are needed

3.3 Inspect bearings

3.3.1 Damages and effects

Plain bearing: one in which it is possible to maintain a state of fluid friction between the contact surfaces of the metals the adhesive quality of the lubricant and the rotation of the shaft causes the lubricant to be pulled between the contact surfaces in sufficient quantities.

☞ ***Lubricant builds up a film between surfaces***

Detecting failure:

Plain bearing

Due to incorrect lubrication or mechanical problems damages through:

- Insufficient lubrication
- Improper lubricant
- Entering of dirt
- Damaged surface
- Vibration caused by unbalanced load
- Misalignment
- Lack of clearance

Ball bearing

- Insufficient lubrication
- Entrance of dirt
- Rust corrosion or erosion caused by chemical action
- Use of wrong kind of lubricant
- Excessive lubricant
- Decomposing of lubricant causing formation of resin and lumpy matter
- Mechanism out of balance causing excessive wear
- Misalignment
- Fractures ball faulty cage

3.4 Maintain bearings

Clean ball bearing:

1. Fill a solvent container with an adequate amount of the proper solvent needed to clean the particular bearing.
2. Put the bearing in a wire basket and submerge it in the solvent.
3. Soak the bearing in clean solvent until the contaminants are loosened. If contaminants still remain, soak the bearings in hot oil and brush it briskly with a stiff bristled brush.
4. Slowly revolve the bearing in a petroleum solvent or kerosene and clean out any remaining substances. Be sure the bearing is thoroughly clean.
5. Wash your hands and put a fingerprint neutralizer on them.
6. Place the bearing in a clean, light oil and rotate it slowly by hand until all the solvent has been replaced by the oil. Oil has a tendency not to adhere to surfaces that are wet with solvent.
7. Inspect the bearing for defects or looseness,
8. Mount the bearing if it is in satisfactory condition and needed for immediate use.
9. If the bearing is not for immediate use, coat it with a rust preventative compound and wrap it in antirust paper, foil, or plastic film.
10. Store the bearing in a clean room that stays at a moderate temperature

Clean assembled bearing and housing (oil lubricated)

- Remove the plug and drain the oil reservoir.
- Flush the bearing with light oil heated to 70 to 80 C while the shaft is slowly rotated. If the lubricant has hardened in the bearing, replace the drain plug and run the machine for a few minutes, using the hot oil as a lubricant.
- Drain the flushing oil from the housing and replace the plug.
- Apply a sufficient amount of the proper lubricant to the bearing.

Clean assembled bearing and housing (grease lubricated)

- Clean all the surfaces around the bearing housing.
- Place a drain pan or container under the bearing housing.
- Remove all the grease drain plugs that are related to the bearing.
- Flush light, hot oil through the bearing while rotating the shaft slowly. In cases of badly oxidized' grease deposits, flush the bearing with hot water.
- Continue the hot-oil flushing process until the hot-water emulsion is eliminated.
- Inspect all lubrication holes and connections to be sure they are clear of foreign matter.

- Fill the bearing with the recommended type and grade of lubricant.
- Run the machine until the grease has drained to the proper level.
- Replace the drain plugs.

3.5 Inspect bearing

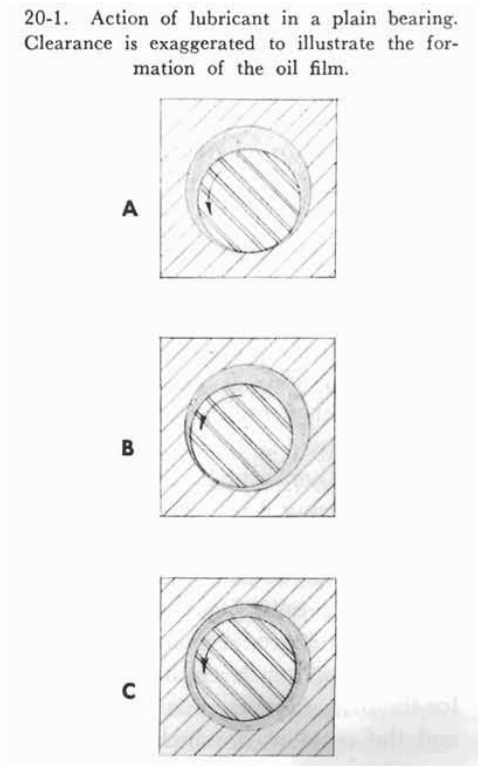
Bearings should be examined each time a machine is disassembled. If any contaminants have entered the bearings or if the bearings have operated for a relatively long period of time, they should be thoroughly cleaned and inspected. When it is necessary to replace a damaged bearing with a used one, the used bearing should be cleaned and thoroughly examined to determine if it is in sufficient condition to warrant its use. All components of a bearing must be carefully checked.

1. Examine the raceways for scratches, scoring, pits, and signs of irregular wear
2. Examine each ball for flaking, cracks, discoloration, and irregular wear.
3. Examine retainers for cracks, loose rivets, distorted shape, and excessive wear.
4. Check the bearing for excessive scratches, scores, and pits. The internal wear, indicating worn perfections are caused by con- balls and raceways.
5. Allowing the bearing to vibrate and make an intermittent noise. In addition to the cracking and flaking, the balls may be discoloured by insufficient lubrication, resulting in an abnormal temperature which may be sufficient to create a whistling sound and reduce bearing hardness
6. Spin the outer ring first to the right and then to the left by hand and notice whether it comes to a stop

Plain bearing is dependent upon the maintenance of a film of oil between the contact surfaces for proper lubrication, but this is not as important for the satisfactory performance of ball bearings.

Plain bearing:
One in which it is possible to maintain a state of fluid friction between the contact surfaces of the metals the adhesive quality of the lubricant and the rotation of the shaft cause the lubricant to be pulled between the contact surfaces in sufficient quantities to build up a film between them.

Ball bearing:
The load is supported direct metal to metal rolling contact between the balls and ball races. If sufficient lubrication is not present, the sliding action will cause increased friction and abnormal temperature rise, resulting in damaged bearing surfaces, heated balls, loss of clearance, internal overloading, and eventually the destruction of the bearing



20-1. Action of lubricant in a plain bearing. Clearance is exaggerated to illustrate the formation of the oil film.

Source: woodshop tool maintenance Cunningham and Holtrop

3.6 Select lubricant and apply lubrication

The plain bearing is dependent upon the maintenance of a film of oil between the contact surfaces for proper lubrication, but this is not as important for the satisfactory performance of ball bearings. Proper lubrication performs a number of important functions.

The principles are:

1. Reduce frictional resistance to a negligible degree by replacing
2. Mechanical friction with fluid friction.
3. Dissipate much of the heat generated.
4. Protect highly polished surfaces of the bearing from rust, erosion, and corrosion.
5. Remove contaminants from the bearing.
6. Reduce the rate of bearing wear and maintenance costs.
7. Form a partial seal to prevent foreign substances from entering the bearing.

3.7 Lubricant

The ideal lubricant for bearings is a neutral mineral oil or grease. It is very important that the lubricant not be injurious to the bearing surfaces either in its original form or through deterioration wrong lubricant will cause pitting, corrosion damaging for this reason no vegetable or animal grease can be used.

☞ ***Lubricants that contain talc, pumice, graphite, resin or other solidifying matter should not be used***

The proper type of lubricant depends on kind of ruffing surface, presence of foreign material such as water dust or dirt.

☞ ***Grease up to 5000 rpm oil below 500 rpm***

3.8 Apply lubricants

- Oil below 500 rpm high speed
- Apply when not in action medium or light oil
- Grease fill housing only one third

EXERCISE 40 min

Find yourself in groups at a sawing unit an inspect:

- Inspect bearings at machines and distinguish types of bearings
- Decide for the correct cleaning detergent and lubricate
- Demonstrate to the group where and how you apply lubricants
- Take given bearings and carry out cleaning and lubrication
- Have a look at the manual and find bearing and bearing recommendations for cleaning or lubrication
- Discuss in the group how many times you apply maintenance to bearings bushings in your workshop and share your experience

Inspection needs to cover:

- Q1: Use the correct cleaning aid
- Q2 Oil below 500 rpm
- Q3 Grease above 500 rpm
- Q4: Apply the lubricant with cloth
- Q5: Clean the bearing and inspect scratches or dysfunction
- Q6: Apply lubrication of bushing using the correct amount

LEARNING UNIT 4: TRANSMISSION SYSTEMS

4.1 Introduction

Power transmission is the movement of energy, its place of generation to a location where it is applied to perform useful work.

Three main types of power transmission are existing at manufacturing machines. Belt, gear and chain drives are common to be built in any power transmission system.

For Wood working machines generally belt driven power transmission is used for manually feeding machines, as for cabinet makers standard machines. In wood milling industry chain drives are found more often due to automatic feeding systems. If transmission of transporting/ feeding is needed, chain drives are the most common used in wood processing machines.

4.2 Belt drive

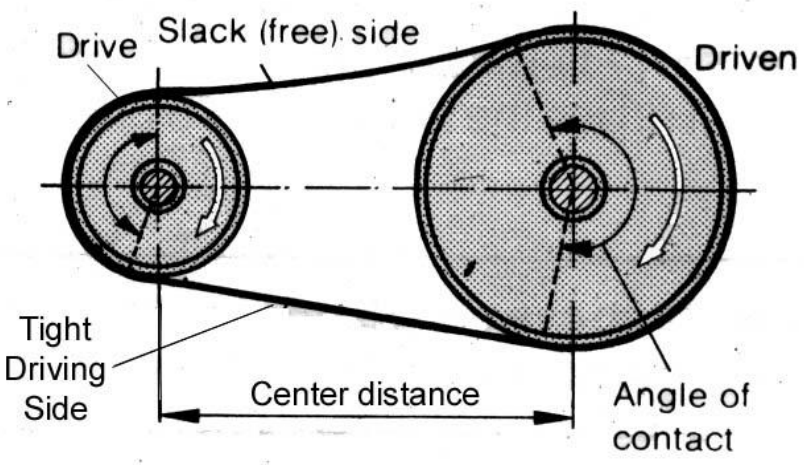
Belt drives transfer the turning moment between two shafts. This is possible because of the contact force between the belt and the belt wheels. The required contact force is generated, by the belt pre-tension, which is applied during the installation of a belt drive.

Advantages of belt drives:

- Can operate at much higher speeds than chain drives
- Elastically load transmission (quiet operation)
- Cheaper than chain drives
- Easier and cheaper to maintain than chain drives
- Lower own weight compared to chain drives (less centrifugal forces)
- Wide horsepower range (for heavy loads multiple belt drives possible - up to 12 belts)

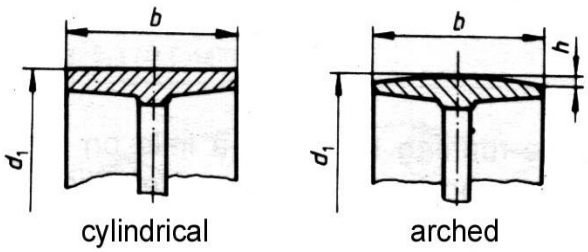
Disadvantages of belt drives:

- Limited shaft distances
- High loads for the bearings
- Due the slip effect lower speed at the driven wheel



4.3 Flat Belt Drives

This type of belt requires great care during installation. Sometimes the belts are even cut to length and spliced direct on the jobsite. Only experienced workers should do this job. The common materials are leather, nylon or a combination of both. To bring the two ends of the belt together there are different techniques from gluing, sewing and fixing with fasteners.

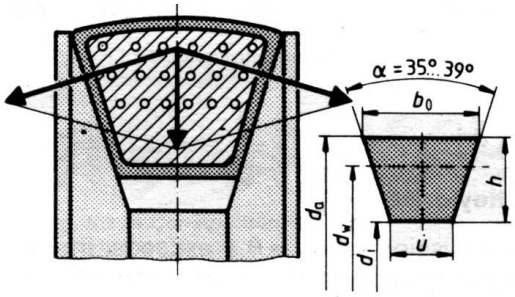


Types of pulleys for flat belt drives

4.4 V-Belt Drives

V-Belts are endlessly produced belts with a trapezoidal cross-section. The most common material combination in use is a rubber body with nylon fibers or tire cord inside to increase the tensile strength. V-belt drives can work with transmission ratios up to 10:1.

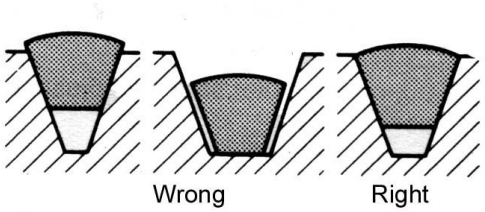
V-belt pulleys are constructed single or multi-grooved. Be careful and use the right belt-form for the given pulley groove.



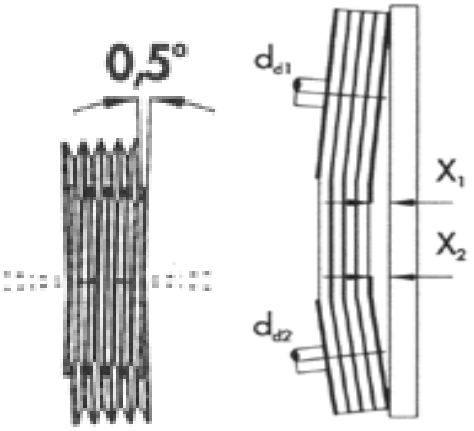
V-belt direction of force and trapezoid dimensioning

4.4.1 Installation of V-belt drive

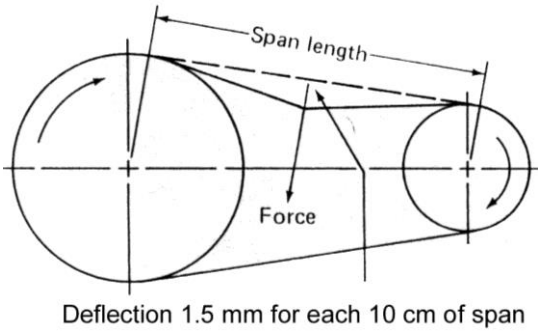
- Check if the V-belt will fit to the pulley. Only a fitting belt can transform the full transmission load.



- Align the two pulleys carefully using a straight edge. Misaligned drives can damage the bearing and the belt itself. Especially when installing multiple belt drives it is extremely important to align properly, because otherwise not all of the belts will carry the same load. The vertical misalignment should not exceed 0.5°.



- Adjusting the V-belt tension is also very important for the working life of the whole drive including the bearings. Consult the belt manufacturer to find the recommended tension for the belt. Some manufacturers offer some tension test devices



- The most common techniques to tension belts are the use of elongated holes with adjustment spindles and the use of rockers.

- For machines with nonadjustable centres, the best way to take up the slack is to install a tensioner.

4.4.2 V Belt versus flat belt

Machine can be defined as the cluster of mechanisms that can perform certain task by expanding energy. Majority of the machines are driven be mechanical power, which is nothing but torque of rotational shaft. A prime mover is used to convert other form of energy to mechanical energy. For example, an electric motor converts electric energy into mechanical power. However, such prime movers are located away from the machine unit and thus another transmission system is desired. Here comes the role of mechanical power transmission system, which transmits motion, torque and power from driver element (like

prime mover) to the driven element (such as machine unit). Four mechanical drives, namely gear drive, belt drive, chain drive and rope drive are utilized to serve this purpose.

Belt drive is one friction drive where motion and power are transmitted by means of friction. Here two pulleys are first mounted with the driver and driven shafts. An endless belt is then partially wrapped around the pulleys maintaining appropriate tension. Belt drive is suitable for small to long distance power transmission and can inherently protect the system from overloading and vibration. Since friction force between the pulley and the belt helps transmitting power, capacity of belt drive is mainly limited by frictional characteristics, contact angle and initial tension. One way to increase transmission capacity is by increasing wrap or contact angle. This can be done by replacing open belt drive by cross belt drive, if otherwise permitted.

Typical flat belt drive (Image courtesy: forbo.com)

Another way of improving power transmission capacity is by increasing contact area between the belt and pulley. This is realized by employing V-belt drive. In flat belt drive a joined belt of rectangular cross-section is used where only one flat face of the belt remains in contact with the pulley. Although its capacity is low, it is overwhelmingly used for long distance power transmission. It can have two arrangements—open and crossed. V-belt drive utilizes an endless trapezoidal (cross-section) belt with pulleys having corresponding V-grove. Here two side surfaces of the belt remain in contact with pulley, which increases

transmission capability and reduces slip. However, it is particularly suitable when driver and driven shafts are small distance away. Various differences between flat belt drive and V-belt drive are given below in table format.

Table: Difference between flat belt drive and V-belt drive

Flat Belt Drive	V-Belt Drive
• Flat belt has rectangular cross-section where width is substantially larger than thickness.	• V-belt has trapezoidal cross-section where larger side width is almost same with thickness.
• Flat belt is jointed (hinged). So, it produces vibration and noise.	• V-belt is made endless. Thus, its operation is smooth and quite.
• In flat belt drive, only one surface of the belt remains in contact with the pulleys.	• In V-belt drive, two side surfaces of the belt remain in contact with the pulleys.
• Power transmission capacity of flat belt is comparatively lower due to higher chance of slip.	• V-belt can transmit more power without slip due to increased friction.
• It is recommended for long distance power and motion transmission.	• It is preferred for short to medium distance power and motion transmission.
• Slip also limits the achievable speed reduction. Up to 1:4 reduction is attainable.	• Higher speed reduction, up to 1:7, is attainable.
• In case of stepped pulley system, flat belt can be shifted from one diameter pulley to another without pausing the rotation.	• V-belt cannot be utilized for stepped pulley system as shifting from one pulley to another is infeasible.
• Flat belt and corresponding pulleys are simple in construction. So, this arrangement is cheaper.	• V-belt and corresponding pulleys have complicated construction. So, it is costier.

Configuration of belt:

A flat belt is hinged at one point to make an endless belt. It has rectangular cross-section where the width is substantially larger than the thickness. Only inside surface of the belt can come in contact with the pulleys. The pulleys have cylindrical shape where the outer surface only touches the belt. Therefore, the friction force between the outer surface of the pulley and inner surface of the belt is utilized to transmit motion and power from driver shaft to

driven shaft. On the other hand, a V-belt has trapezoidal cross-section where width of the belt in larger side is almost same with the thickness. The pulley also has a V-groove to accommodate the belt. V-angle of the pulley should match with the angle between two non-parallel faces of the belt.

Noise and vibration:

As mentioned earlier, a flat belt is hinged using nuts and bolts to make it endless. A groove always exists at this junction. Due to the unsymmetrical inside surface of the belt, flat belt drive produces considerable noise and vibration. This sometimes limits its application at very high speed. On the other hand, the V-belt is produced in endless fashion and thus no joining exists. Thus, it produces less vibration and its operation is also quiet.

Typical V-belt drive. Here four V-belts are used parallel to improve power transmission capacity.

*(Image courtesy: **chemverse.in**)*

Contact between belt and pulley:

As mentioned earlier, only inside surface of the flat belt remains in contact with the outer surface of the cylindrical pulley. In case of V-belt, two inclined surfaces simultaneously remain in contact with the two side surfaces of the V-shaped pulley.

Power transmission capacity:

Like every mechanical drive, basic purpose of belt drive is to transmit motion and power from one shaft to another. Since belt drive is one friction drive, so power transmission capacity primarily relies on the frictional characteristics of the mating surfaces. Whenever load exceeds frictional force, slip occurs automatically. Higher the coefficient of friction

between the belt and pulley, higher will be the transmission capacity; however, heat generation and wear will also be more.

Instead of directly increasing the coefficient of friction, it can be enhanced indirectly by employing V-belt instead of flat belt. It can be proved that effective coefficient of friction in V-belt is 2 – 3 times higher (based on V-angle of the belt, which is usually 40°) compared to flat belt of same material. Accordingly, V-belt drive can transmit substantially higher power without slip.

Distance between shafts:

A suitable mechanical drive is selected based on the centre distance between driver and driven shafts. For example, gear drive is suitable for small centre distance, typically up to 1m. Chain drive can be employed for small to moderate distance, usually up to 3m with the assistance of idle sprockets. Belt drive can be utilized for a wide range of centre distances—from below 1m to as long as 15m. A flat belt drive is particularly suitable for long distance power transmission; whereas, V-belt is preferred for small distance only (usually below 1m).

Speed reduction:

Machine units are driven by prime movers. Usually, the driver shaft of the prime mover rotates at higher speed than it is required in driven shaft of the machines. Thus, a reduction in rotational speed is required and this can be achieved by changing the diameters of the driver and driven pulleys. However, every mechanical drive can alter velocity ratio within a range. A flat belt drive can offer speed reduction up to 1:4; higher than this can undesirably increase slip. Because of higher effective coefficient of friction, V-belt offers higher speed reduction, even up to 1:7.

Shifting of belt:

Sometimes a single machine unit requires varying speed at different stages of operation. Also, a single prime mover can be employed for driving multiple machines, each requiring varying speed of operation. In such scenario, stepped pulley is adopted where a number of pulleys having different diameter is mounted on a single shaft. If flat belt is employed, then the belt can be shifted easily from one pulley to another in running condition. Thus, rotational speed of the driven shaft can be altered without stopping the driver unit (a

mechanised adjustment of belt length is highly required to maintain belt tension). Such shifting provision is not available in V-belt drive as they require specialized pulley with V-groove.

Economic aspect:

Constriction of flat belt and corresponding pulley is simple. Length of the flat can also be adjusted multiple times as it is joined by nuts and bolts. Longevity and easy construction make this drive unit cheaper. V-belt and corresponding pulley is costlier. Its length cannot be adjusted and thus it has shorter service life. Scientific comparison among flat belt drive and V-belt drive is presented in this article.

4.5 Chain Drives

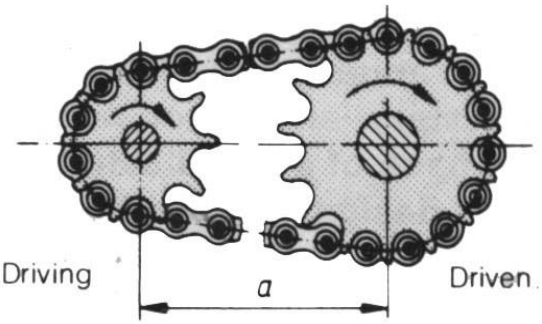
In general, chain drives transfer slip-free power between two shafts over a distance which cannot be bridged with gears. The transmission forces are carried by the chain-links gripping in the teeth of the sprocket wheels.

Advantages of chain drives:

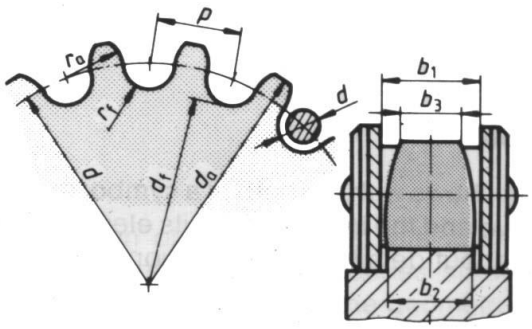
- Usable in a wide range of drive applications
- Moderate to heavy loads
- Can be used in critical areas where moisture, heat and oil are present

Disadvantages of chain drives:

- Only for lower speeds (except high performance precision roller chain drives)
- Relatively high maintenance costs
- With moderate or high speeds permanent lubrication necessary



Simple chain drive

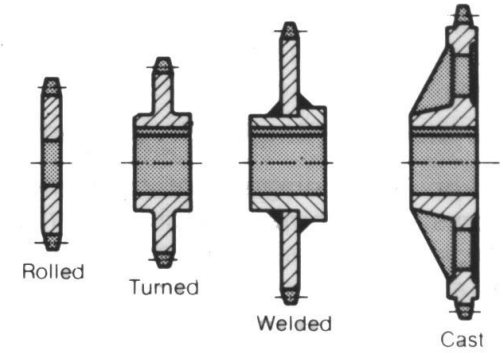


Main dimensions of sprocket wheel

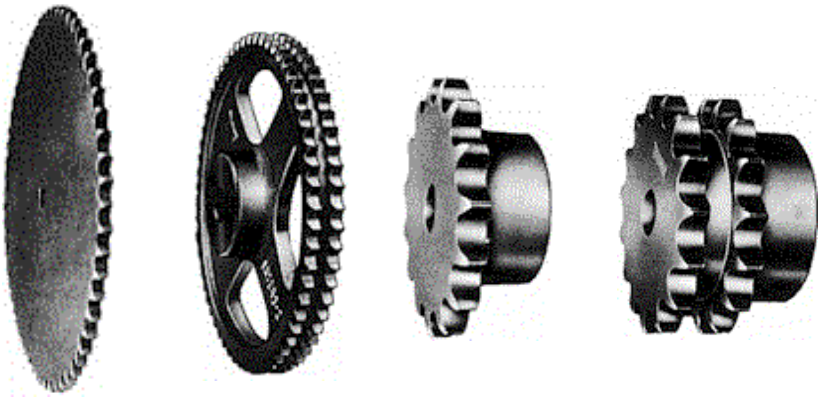
4.6 The Sprocket

Sprockets are available on the market in a big variety. They are normally made out of the following materials: Low Carbon Steel, High Carbon and Cast Iron.

The borehole comes often with standard sizes. It must be machined to the required size.



Manufacturing method

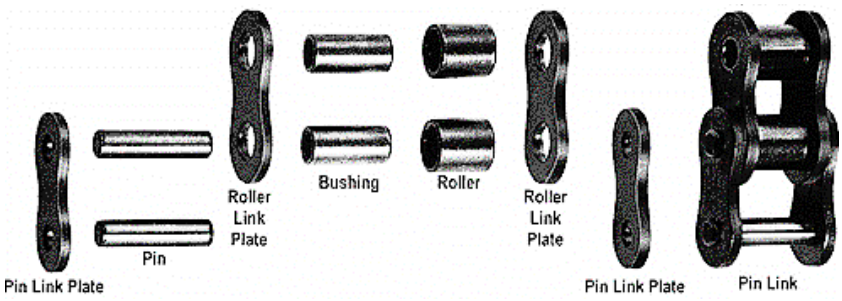


4.6.1 Sprocket Teeth:

Chain drives are also used for high-speed power transmission. To meet this requirement, the sprocket tooth tips are strengthened by means of high frequency hardening.

Hardening of tooth tips is required in the following cases:

- The number of teeth is 24 or less and the sprocket is used at higher speeds
- Small sprockets and speed ratios over 1:4
- Use with heavy loads at low speed
- Use under abrasive conditions



4.7 The Chain

4.7.1 Roller chain layout

➢ Speed Ratio and Chain Lap

The speed ratio of Chain drives can range up to 7:1 under normal conditions. However, a speed ratio of 10:1 is possible if the required speed is very slow. Chain lap on the small sprocket must be at least 120°.

➢ Distance between Shafts

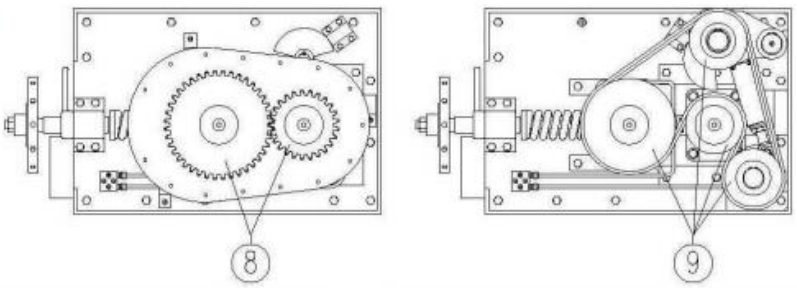
Optimum distance between sprockets is 30 to 50 times the pitch of the chain except when there is a pulsating load. In such cases, the distance can be up to 20 times the pitch of the chain.

➢ Layout

When arranging the roller chain drive, the centreline of both sprockets should be as close to horizontal as possible, though the angle of installation can be up to 60°. If installation is close to vertical, the chain tends to slip off the sprockets easily with slight chain elongation, in this case, an idler or guide stopper is recommended.

➢ Gear drive

gear drive or belt drive



Source: LA MECCANICA SRL di Reffo

In engagement drive, power is transmitted by means of successive engagement and disengagement, as in case of chain drive and gear drive. Another criterion of classifying mechanical drives is the presence or absence of flexible element. A flexible drive is one that consists of one intermediate flexible element between the driver and driven shafts, as in case of belt, chain and rope drives. Opposite to this, a rigid drive does not contain any intermediate element. Here two rigid bodies remain in direct contact, for example gear drive.

Gear drive is an example of engagement drive, rigid drive, and positive drive.

Another criterion of classifying mechanical drives is whether it can provide constant velocity ratio. A positive drive is free from slip, creep and polygonal effect and thus can provide constant velocity ratio. Only gear drive satisfies this condition; whereas, other three drives are non-positive drives. Therefore, gear drive is one engagement type positive drive that is used to transmit motion, torque and power between driver and driven shafts, preferably over short distance. Since it is rigid drive, it can transmit heavy power without noticeable problem. On the other hand, belt drive is a friction drive that is specifically suitable for medium to larger distance power transmission. Various differences between gear drive and belt drive are given below in table format.

EXERCISE 30'

- Q1: Name types of drives
- Q2: What are advantages of belt drive
- Q3: Name machines you know which are belt driven
- Q4: Describe why panel saw with direct drive are not allowed

- Q1: Belt chain, gear
- Q2: Safety easy to maintain, adjust for different speed less dust built up
- Q3: Panel saw, belt sander, jointer thicknesser, drill press
- Q4: Safety, accident, destroy motor if stuck in wood

➢ Differences between gear drive and belt drive

Gear Drive	Belt Drive
• Gear drive is one type of engagement drive.	• Belt drive is one type of friction drive.
• In gear drive, driver and driven shafts are connected by rigid links. No intermediate flexible element exists between the two shafts.	• In belt drive, driver and driven shafts are connected by intermediate flexible element (belt).
• It is a positive drive; so, velocity ratio remains constant.	• It is non-positive drive as slip and creep occur frequently.
• Gear drive cannot protect the system from impact and overloading.	• Slip in belt drive helps protecting the system from impact and overloading.
• It cannot isolate driver shaft from vibrations on driven shaft.	• The intermediate flexible element can absorb vibration and thereby protects driver shaft.
• It can transmit large torque and power.	• Belt drive is not preferred for large torque and power transmission.
• High speed reduction can be achieved easily.	• It cannot provide steep velocity reduction.
• It is suitable for short distance power and motion transmission.	• It is suitable for medium to larger distance power and motion transmission.
• Driver and driven shafts rotate in opposite directions. Additional gear is required to obtain rotation in same direction.	• Driver and driven shafts can be rotated either in same or opposite direction employing flat or close belt system.
• Gear drive cannot tolerate small amount of locational or angular misalignment.	• Small amount of locational or angular misalignment does not pose any problem in belt drive.
• Gear drive requires full lubrication. Its initial cost and maintenance cost are also higher.	• Seldom lubrication is required in belt drive. Moreover, its initial cost and maintenance cost are lower.
• Here line contact occurs between	• Here area contact occurs between belt and pulley.

two mating gears, which results low friction and low power loss. So, it provides high efficiency.	So, power loss is more due to high friction, which also results in lower efficiency.
• Performance of gear drive is not affected by small variation in atmosphere temperature.	• Length of belt increases with increase in temperature and thus slip occurs undesirably.

4.8 Brakes

An electric brake is commonly used in corded tools such as circular saws, miter saws, routers, band saws, angle grinders, and more recently, table saws. These mechanisms are designed to prevent injuries resulting from things like kickback or skin-to-blade contact. All new wood cutting or shaping machines have these electrical brakes to stop the cutter rotating in maximum 2 seconds. In case of accidents the time to cause hazard is minimized by the safety stop.

Other breaks work manually like the one on band saw unit which stop rotation of the wheel.

Not to mix up with the emergency switch, which is a separated witch used to stop motor rotation in case of emergency and operated manually

The relation to the transmission will change the speed and the strength of the stop movement.

If a motor with defect belt transmission is stopped there is still a change to stop the motor at the moment of force to the sawblade. The belt will simply slip and allow the sawblade to stop if stuck in wood.

Stop control of transmission is sometimes done manually like at the carpenter band saw with a foot brake simply connected to the driven wheel.

4.9 Maintenance of belt and chain drives

General maintenance of transmission drives is following simple principles listed below. If maintenance Is carried out specific it will always refer to the machine maintained and the manufacturer requirement and settings.

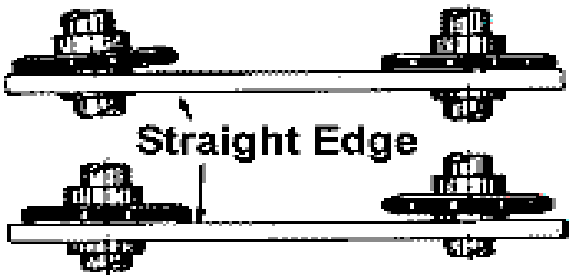
☞ ***If carrying out maintenance you have to follow the basic steps of maintenance: inspect clean measure set calibrate test run***

4.9.1 Chain drives

➢ **Roller chain Installation**

Aligning Shafts:

For efficient operation, both the driving and driven shafts must be level and they must be parallel with each other. To align the sprockets, use a straight edge. Misaligned drives can damage the bearing after a short time.

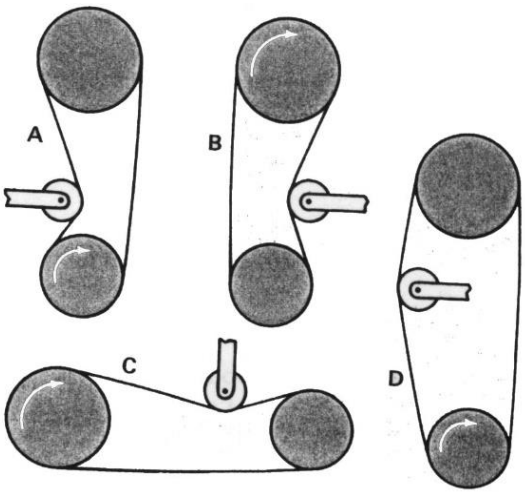


Chain Tension:

Generally, roller chain is used with adequate slack. If the chain is tightened excessively, chain damage or rapid use of lubricant may result. If the chain is too loose, damage due to vibration or chain winding, may result. Adequate slack is to be adjusted to 2 % up to 4% of the chain span.

☞ ***For example, if the span is 800mm, slack should be 800mm x 0.04 = 32mm.***

The chain will elongate slightly from the beginning of initial driving from 0.05% to 0.1% of the full length. As this causes extra slack, adjustment of slack is required. An idler can be used to take up the slack or the shaft can be adjusted. After this adjustment, chain elongation



should be minimal. If you place the idler outside the chain loop (picture A, B, C) install it nearer to the small drive sprocket. If you place it inside the chain loop, (picture D) mount it nearer to the large sprocket.

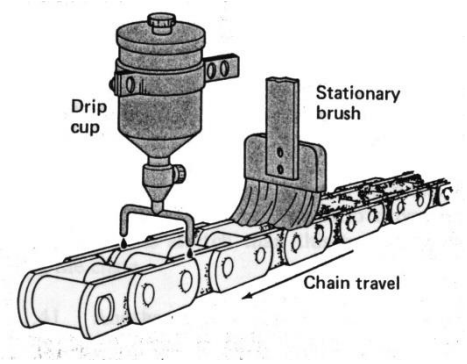
➢ Roller chain Lubrication

Proper lubrication of roller chain is essential for good performance and full chain life. Care should be taken to strictly follow the lubrication schedule and recommendations. If this is not done, the service life of the chain will be shortened and maximum power transmission will not be delivered, no matter how high performing the chain or sprocket is.

Since wear between pins and bushings cause chain elongation, lubrication must be maintained on all contact surfaces

Proper lubrication forms an oil film which:

- Reduces abrasion and chain wear
- Reduces chain friction and noise
- Functions as a coolant when the chain is run at high speeds
- Functions as a cushion against impact



Only high-grade oil of suitable viscosity should be used. The proper type of oil to be used depends on the chain specifications, working conditions and lubrication system.

☞ ***Oils to avoid:*** *Heavy oil, Low-grade oil, Impure oil or grease*

Types of lubrication application:

- Manual ApplicationOil is applied with an oil filler or brush on the slack side of the chain.
- Oil Bath Lubrication
  The chain is installed in a leak free casing.
- Lubrication By Rotating DiscOil can be splashed on the chain using a rotating disc installed in a leak-free casing. For this method, speed along the circumference of the disc should be over 200 m/min. If the width of the chain is over 125 mm, use a rotating disc on both sides
- Lubrication Using a PumpThe chain is contained in a leak free case and a pump is used to circulate and cool the oil

➢ Chain Maintenance

Chain is usually replaced when the chain does not engage properly with the sprocket due to damage of its parts or elongation. To help prevent premature wear or damage, the following points should be checked.

Observe the chain and sprockets:

- Abnormal Noise
- Chain rising on the sprocket
- Stiff bending of chain
- Whether the chain contacts the case
- Damage on the sprocket teeth surfaces and side surfaces of teeth and engaging area
- Bending of chain and rotation of roller
- Vibration of the chain
- Chain winding around the sprocket
- Amount and condition of lubrication
- Abrasive stretches of the chain
- Appearance of chain, check for dirt, corrosion, damage on the outside surface of the roller, contact marks, etc

Lubrication

While the chain is driving, check if the lubricating oil moves toward the link plates, and if the chain or rotating disc is immersed in the lubricating oil of the oil bath. When the chain is stopped, check for dirt or abrasive particles produced by improper lubrication. When the chain is removed, the connecting link pin and the edge of the inside of the bushing should be checked. If there is any damage, or a red or reddish-brown colour can be noticed, lubrication is improper or insufficient. Regardless of the lubricating system used, roller chain should be washed periodically with petroleum or gasoline.

Sprocket

Chain and sprocket engagement can be checked by observing the roller and tooth surfaces. The installation should also be checked. The normal area where wear will occur is slightly above the bottom of the lowest point between the sprocket teeth.

Chain Elongation

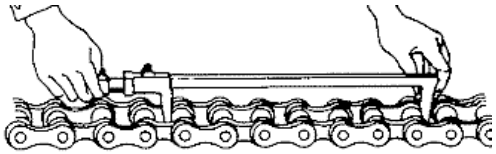
Chain stretch is calculated as the total amount of elongation caused by wear. Chain life can be estimated by measuring chain elongation.

Measuring Chain Elongation:

- The chain should be measured by stretching it slightly
- Measure the distance, using a Vernier calliper. Note: When measuring, use at least 6 to 10 links to help keep any measuring error to a minimum. When measurement cannot be done with a Vernier calliper, it is possible, though less accurate, to use a tape measure. If a tape measure is used, the measured length should be as long as possible.

Maximum Allowable Chain Elongation

Number of teeth on driving sprocket	Chain Elongation
60 and under	1.5 %
61 to 80	1.2 %
81 to 100	1.0 %
100 and over	0.8 %



Replacement of Chain

There are two relatively simple methods for cutting Roller Chain. One way is to use bench vise and punch, and the other is to use a chain breaker:

Using a bench vise and punch:

- For riveted type Roller Chain, first grind down one end of the pin to be removed. For split pin type, be sure to take out the pin.
- Put the chain into the vise and tighten the vise to secure the chain.
- Hit the head of the pin with a punch or hammer. Be sure to hit the pins alternately so that they can be removed at the same time.

➢ Belt drive maintenance

Maintenance principles for v-belt drives

There are three generally accepted maintenance principles for installing new belts or any multiple-belt drive.

- **Principle no. 1: Always replace all the belts.**

  Older belts naturally become stretched or worn from use. If old and new belts are mixed, the new belts will be tighter, will carry more than their share of the load, will probably fail before their time and may also contribute to uneven pulley wear.

- **Principle no. 2: Always use a matched set of belts from one manufacturer.**

  If unmatched belts and brands are mixed, the belts may have different dimensional and performance characteristics, and they could work against each other, resulting in unusual strain and short service life.

- **Principle no. 3: Always adjust belts after a short run-in period**

  The newer generations of belts are made of thermally active polyester tensile cords with a higher elongation resistance. Even for this new type of belts, it is recommended to re-adjust the tension of the belts after a short run-in period.

Care of belts:

1. Keep clean and free from oil. Oil causes rubber belts to deteriorate.
2. Do not use belt dressing. The gripping action of the belt is sufficient to prevent slipping.
3. Do not pry or use force of any kind to try to mount the belt in the grooves of the sheaves, because the strain may break the fabric.
4. When belts on a multiple drive become worn or broken, replace them with a matched set used belts may be saved to make up a matched set for temporary use. (a new belt should never be put on a drive with old belts because it will carry more than its share of the load until it stretches.)
5. Use belts that match the grooves. If the grooves become worn and do not fit new belts, replace the sheave.
6. Keep sheaves in alignment. The sides of the belt and the grooves wear excessively when the sheaves are not properly aligned. Be sure the shafts are parallel.
7. The speed of ordinary v belts should not exceed 5,000 feet per minute. Special belts are more satisfactory for higher speed.
8. Do not subject rubber belts to a temperature higher than 50°c

V-belt drive troubleshoots:

Problem	Cause	Cure
Belt slips	• Drive under-tensioned • Drive overloaded • Worn pulleys • Shock loads	• Re-tension properly • Redesign with larger pulleys or more belts • Replace pulleys • Drive under-tensioned or under-loaded. Check drive design
Belts wear rapidly	• Pulleys worn • Overloaded drive • Belt hitting guard/frame • Dirt and grit entering drive	• Replace or re-machine • Redesign with larger pulleys or more belts • Provide more clearance • Provide closed guards
Belt mismatched	• Mixed old and new belts • Belts not of same make • Worn or improperly machined pulleys	• Replace with new set • Replace with new set • Belt will ride at different positions in the grooves. Replace pulleys.
Belt brakes	• Improper belt installation • Insufficient tension • Shock loads	• Belt squeezed over pulley. Install new belts properly • Belts whipped on start-up or under shock • Drive under-tensioned or under-loaded. Check drive design
Belt jumps grooves	• Drive misaligned • Tensioner not located properly • Excessive whip and vibration	• Check and realign • Redesign tensioner position • Shorten center distance or add tensioner
Belts crack	• Belt slipping • Excessive heat • Pulley or tensioner to small • Chemical attack	• Increase tension • Provide adequate ventilation. Check slippage • Increase diameter • Provide adequate protection

Belt vibration	• Pulleys not balanced • Weak base construction • Resonant condition	• Provide dynamically balanced pulleys • Redesign with additional supports or bearings • Until there is an improvement try to change center distance; increase or decrease number of belts or add tensioner

Positive-drive belts (also synchronous belt or toothed belt)

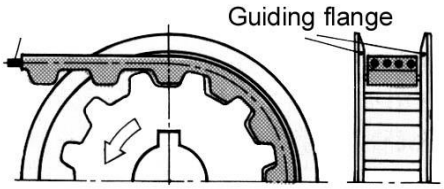
Positive-belt drives are widely in use in all parts of industry. One advantage of this belt type is the constant speed for driven wheel and drive wheel, because of the teeth, which do not allow any slip.

To install positive-drive belts, follow the same general procedure as for v-belts. It is normal for this type of belts to ride towards one side of the pulley when operating. Most of the pulleys will come with two flanges. If there is only one flange, then install the flanged side to the side where the belt moves.

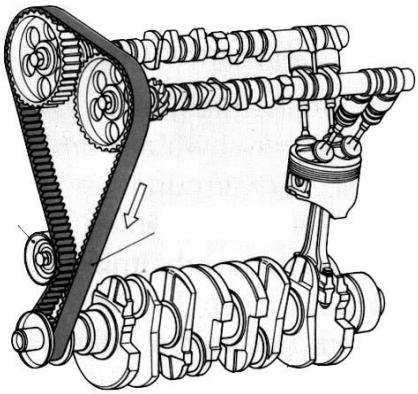
Positive-belts do no rely heavily on tension to operate. Unlike v-belts and flat belts, all they need is to fit properly on the pulley, tooth to tooth. If available, follow the instructions of the belt manufacturer to tension the belt. This will extend the life expectancy. Tensioners

should be used whenever it is absolute necessary to prevent a jump over of some teeth of the belt.

The material of “Synchronous Belts” is normally a polyurethane body for abrasion and chemical resistance, and for stretching resistance aramid fiber tensile cords. The tensile cords also provide excellent flex fatigue life and high resistance to shock and alternating loads. Nylon facing gives strength and durability to the belt teeth.



Toothed belt drive (synchronous belt drive)



Toothed belt with idler for driving camshafts

EXERCISE 60’

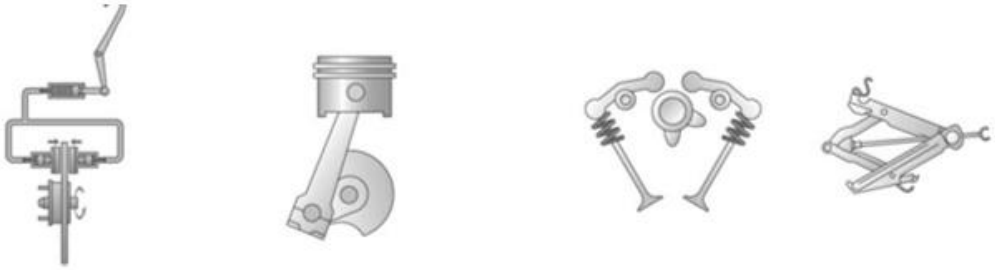
- Q1: List the steps of maintenance a drives
- Q2: Why does the sawblade stop cutting in a 5 cm thick solid wood and how do you react
- Q3: A sound is heard from the thicknesses when starting the feeder what is the reason and what is the action?
- Q4: The machine does not stop rotation although you used the emergency switch

- Q1: Clean, inspect, measure, set, align calibrate test run
- Q2: Belt slips. Stop machine retention properly according to manufacturer setting
- Q3: The chain is too long and without lubrication retention and lubricate
- Q4: Belt is cut

Exercise Drives

Identify drives on the pictures? from left to right up to down

Gearbox gear transmission, friction gear, chain gear, belt gear, pressure transmission, pneumatic transmission, hydraulic transmission, articulated gearbox, cam gear, helical gearbox



Answer following question: which gear is found in which machine?

Sewing machine	Belt drive
Drill press	Belt drive
Car lift	Helical gear
Bicycle dynamo	Friction gear
Cordless drill	Gear transmission
Bicycle	Gear drive
Compressor	Belt drive

Exercise (group work Integrated situation):

You have to carry out maintenance at a band saw:

- Plan your work ahead.
- Steps,
- Arrange tools needed,
- Inspect the setting of the belt at the band saw.
- Inspect alignment set the correct Tension,
- Check serviceability of belt
- Check for damages

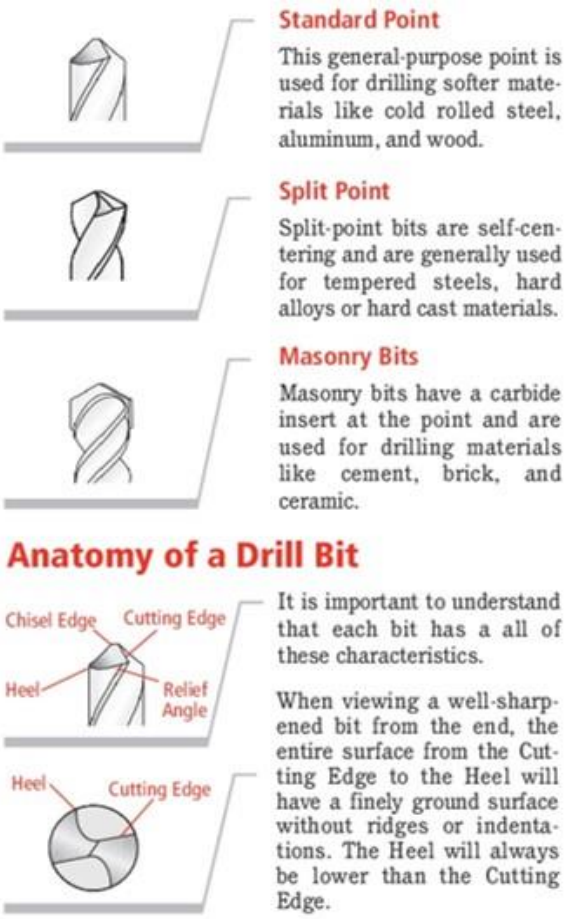
4.10 Types of cutter bits and blades

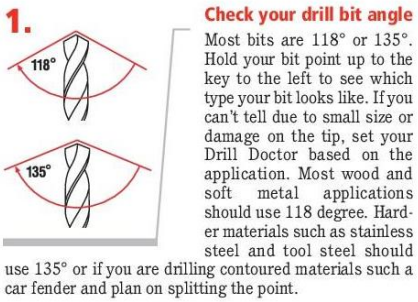
4.10.1 Drill Bits

Are cutting tools used to remove material to create holes, almost always of circular cross-section. Drills come in many sizes and shapes and can create different kinds of holes in many different materials. In order to create holes, drill bits are usually attached to a drill, which powers them to cut through the work piece, typically by rotation. The drill will grasp the upper end of a bit called the shank in the chuck.

Point angel bit for exact centering only used for wood

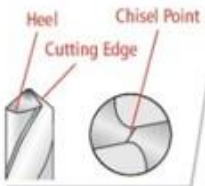
Forstner drill bit /flat bottomed holes





Identifying Correctly Sharpened Drill Bits (and what to do with those that aren't!)

Correctly Sharpened Bits

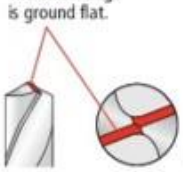


The entire surface from the Cutting Edge to the Heel will have a finely ground surface without ridges or indentations. The Heel will always be lower than the Cutting Edge. The Chisel Edge will be clean and straight.

Incorrectly Sharpened Bits

Problem

The Chisel Edge is ground flat.



Cause

Chuck Jaws did not grip drill bit properly in the aligning process (Page 8).

Solution

Realign the bit by carefully following steps 1 through 5 on Pages 8 to 10.

Problem

The Chisel Edge is not clean or straight.

Cause

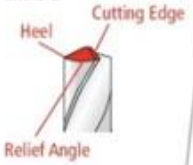
The bit isn't completely ground yet.

Solution

Continue sharpening the bit until the chisel is clean and straight. If the machine quits removing material before the chisel is clean, realign and sharpen again. (Model 750X users can increase or decrease MTO (material take-off) to speed up this process.

Problem

Insuffecient (Negative) relief or a slow cutting drill bit.



Cause

Drill bit alignment.

Solution

Re-align the drill using the Adjustable Alignment procedure on page 19. To increase relief, insert the alignment guide on the chuck closer to the (+) side of the alignment port, then sharpen the bit.

Problem

Bit backing out or slipping out of the jaws when you are sharpening

Cause

Chuck too loose or too much pressure when sharpening.

Solution

Use more torque when tightening the Chuck or less pressure when sharpening. Clean the Chuck w/ compressed air if the problem persists.

Split Points

Split point drill bits prevent walk-around on the material before they begin to cut.

This feature is described as self-centering. The need to center punch is effectively eliminated. A standard drill bit chisel point has to wear an area in the middle of the hole to be drilled before the cutting edges will remove material. Due to its additional cutting lips along the chisel edge, a split point will begin cutting immediately. Up to 70% less thrust (when compared to a non-split or conventional point) is required to drill a hole with a split point.

Source: drill doctor user manual

EXERCISE 20'

- Q1: Name the anatomy of a drill bit
- Q2: What is the difference between masonry bit and twist drill bit
- Q3: Why do carpenter like to use brad point bits?

- Q1: Cutting edge; heel; shank
- Q2: Twist is used for metal, wood and plastics masons for stone/bricks
- Q 3: Easy to center précised working difficult to sharpen

LEARNING UNIT 5: SHARPENING OF CUTTER AND TOOLS

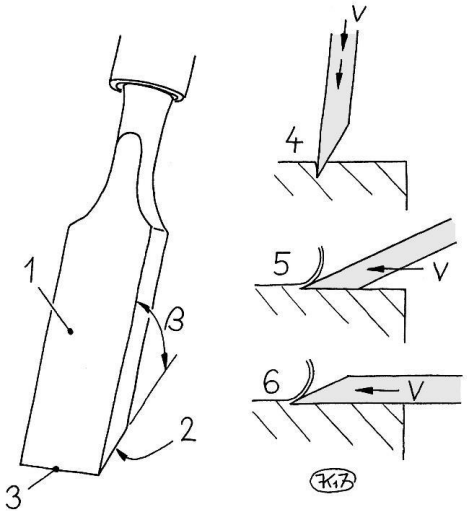
5.1 Sharpening chisel blades and plane blades: the basics

5.1.1 Cutting with a chisel

A chisel blade has a bevel on one side and a flat back on the other. These two surfaces intersect to form the acute-angled wedge with its sharp cutting edge. The most important feature of the wedge is its wedge angle β (beta) that includes the back and bevel. For most chisel blades this angle is around 30°.

How a chisel cut

- 1: Back
- 2: Bevel
- 3: Cutting edge
- 4: Mortising
- 5: Paring, sliding on the bevel
- 6: Paring, sliding on the back
- v: Movement of blade
- β (beta)wedge angle of cutting edge



You can use a chisel for mortising (the edge is driven into the wood by hammer blows to separate it and force it apart) or for paring (the blade slides on the wood and lifts off a chip that is deflected via the leading face of the wedge, also referred to as the rake face.

If the blade slides on the bevel (the back acts as rake face), the depth of cut can be varied by raising or lowering the handle. If it slides on the back (the bevel acts as rake face), the cut is exactly straight ahead.

Precise paring depends on the guiding function of the long, flat back extending all the way to the cutting edge. Chisels with bevels on both sides are carving tools, not suitable for joinery.

5.1.2 Cutting with a plane

A plane blade also has a **back**, a **bevel** and a **wedge** with wedge angle β. However, it is not held by hand, but clamped into a plane on a slanting surface called a bed. The sole of the

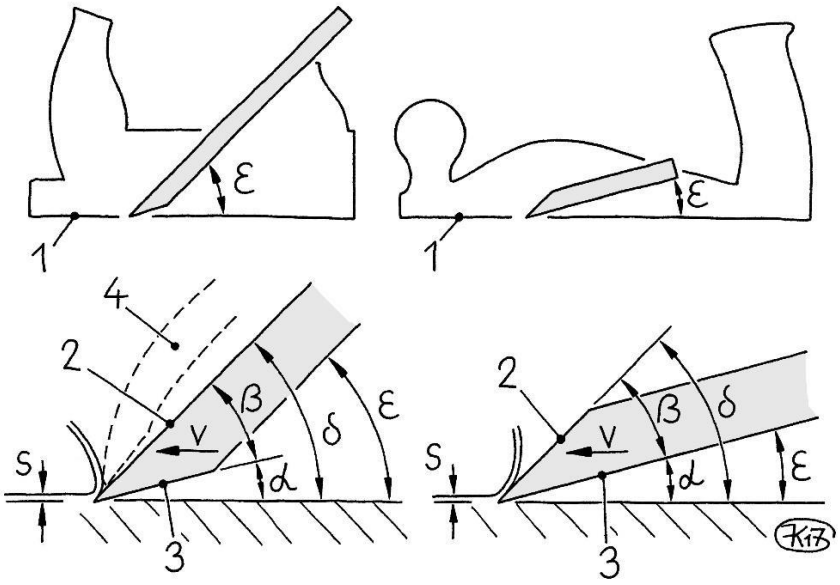
plane slides over the work piece, so that the blade is guided at a constant angle and with a constant cutting depth (= shaving thickness).

How a plane blade cuts

Left: Plane with bevel down

Right: Plane with bevel up (also called low angle plane)

- 1: Sole of plane
- 2: Rake face
- 3: Clearance face
- 4: Chip breaker (optional)
- s: Shaving thickness
- v: Direction of movement
- α : clearance angle min10°
- β : Wedge angle
- ε : Bedding angle
- δ : Cutting angle



- The cutting process is quite different to that with a chisel, the crucial difference being the presence of a clearance angle.
- **Plane with bevel down**: This is the traditional design
- The bevel does not come into contact with the work piece, it acts as clearance face.
- The wedge-shaped gap between bevel and cut surface is the clearance angle α (alpha).

☞ ***The clearance angle avoids any unnecessary friction between the material and the cutting edge.***

When planning wood, this angle should not be much less than *10°3*, so that the wood springing back after the cut does not rub against the clearance face. A sufficiently large clearance angle is a prerequisite for a good chip removal rate both for hand and machine tools. This is far more than in metal working, because wood is more elastic than metal.

Tools for wood must be far sharper because the cutting speed is much lower and the driving power very low. The sharpness of the blade is especially important when planning. Only a truly sharp plane works well.

5.2 The cutting edge and the principle of sharpening

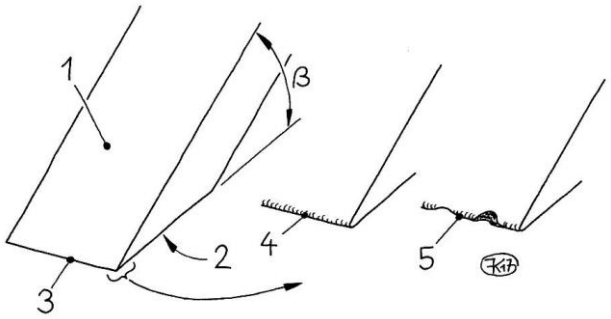
5.2.2 Sharp, dull, damaged

Chisel or plane blades for fine woodworking must be much sharper than machine tools. This sharpness can be achieved if both surfaces have a micro finished, almost a polished, surface where the bevel and back meet at a wedge angle β (beta) of 30°.

5.2.3 State of cutting edge

- **Left**: sharp blade
- **Centre**: dull (rounded) cutting edge
- **Right**: dull and damaged cutting edge

- 1: back
- 2: bevel
- 3: sharp cutting edge
- 4: dull cutting edge
- 5: dull and damaged cutting edge
- β: wedge angle



A sharp blade will cut wood effortlessly. Once it has been in use for some time, the force you need to apply becomes noticeably bigger and the cutting edge will no longer lift a thin shaving as readily as before. It is dull. The soft but abrasive wood has attacked the hard steel and removed material. This has caused the cutting edge to become minimally rounded and roughened – it is no longer sharp.

But if the cutting edge was overloaded or came in contact with hard foreign bodies (for instance, through mortising or planing wood with knots or mineral contaminants), the cutting edge will show additional evidence of damage such as notches or deformations. These will leave visible marks on any surface cut with the blade.

You can see whether a cutting edge is sharp and undamaged or not, even without a magnifying glass.

Back of a chisel with damages and scratches

5.2.4 Principle of sharpening chisel and plane blades on bench stones

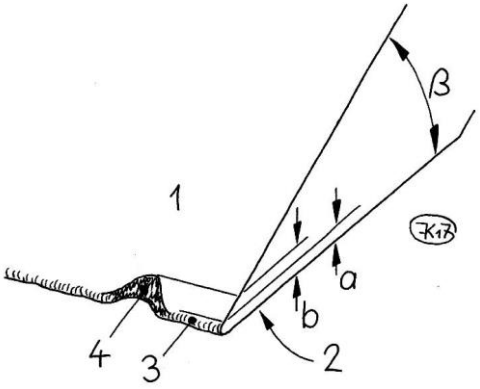
Good quality chisel and plane blades are very hard and as such can only be worked on by grinding and certainly not with a steel file! The typical grinding tool for sharpening by hand is a block-shaped, flat bench stone, called this because it is used lying on a flat surface or bench.

☞ ***Choose a hard-wearing, moisture-proof work surface, definitely not your workbench!***

You sharpen the blade by regrinding the bevel. This means that a thin layer of steel is removed. In effect, the old cutting edge is removed to reveal a new, sharp one. The blade ends up negligibly shorter, but the geometric relationships at the cutting edge are left completely unchanged.

➢ **Sharpening principle: corner of a blade**

- 1: back
- 2: bevel
- 3: cutting edge, dull (worn)
- 4: nick
- a: Material removal at the bevel to eliminate wear at the cutting edge

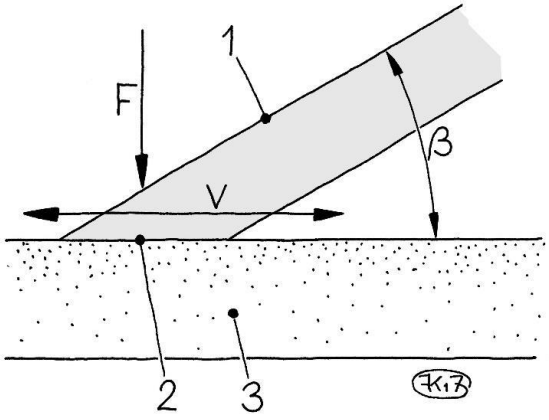


- b: Material removal at the bevel to eliminate a nick in the cutting edge
- β: Wedge angle

If the blade was merely dull (worn), the layer to be ground away is very thin, just a few hundredths of a millimetre. But if you are repairing damage to the cutting edge, then bigger amount must be ground away (layer b). To save sharpening time and to maximize the service life of the blade you should never grind off more than necessary.

➢ Sharpening principle: grinding on a bench stone

- 1: back
- 2: bevel
- 3: whetstone
- F: Applied force
- v: Grinding movement
- β: Wedge angle



Press the bevel of the blade onto the stone and move to and from, making sure you hold it at the correct angle (wedge angle β) to the stone.

This creates a freshly ground area – and a new cutting edge. Quite simple in principle – in practice, however, somewhat more complicated, because the stone that is used to create the fine surface for a good cutting edge has only a very small removal rate. You will also need to do something about the burr that usually develops – exactly along the line where you want your cutting edge to be.

Sharpen in three steps:

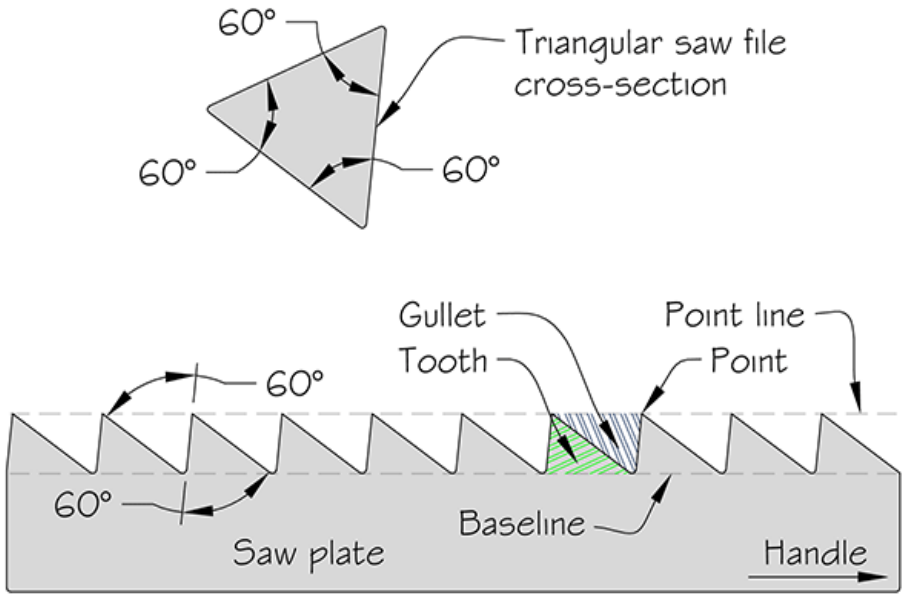
1. The bevel is ground with a coarser whetstone (about J800 to J10007 grit) until all signs of wear and damage have been removed from the cutting edge.
2. The bevel is honed, ie, ground a second time, but this time with a very fine honing stone (about J3000 to J10000 grit) that leaves a fine surface finish.
3. The back is honed to remove all unavoidable scratches and any small signs of damage from the cutting edge, as well as the very fine burr that usually forms when the bevel is honed.

EXERCISE 20'

- Q1: Name the anatomy of a chisel
- Q2: What is the clearance angle of a plane?
- Q3: What is the wedge angel of a chisel?

- Q1: Back bevel cutting angle cutting edge mortising, wedge angle
- Q2: This is the angle avoid unnecessary friction
- Q3: 30 the angle which proposes the cut

5.3 Sawblades

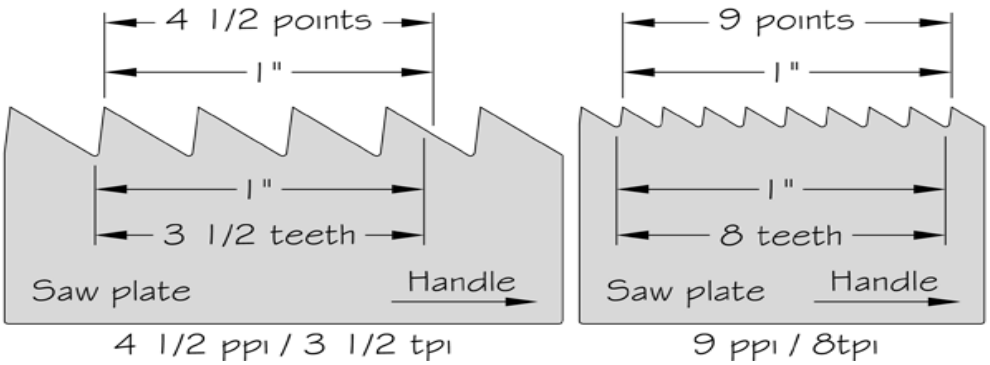


5.3.1 Pitch

Pitch is a measure of the number of points or teeth that fall within one inch, as measured along the point line. It is expressed as either points per inch (ppi) or teeth per inch (tpi).

While most American saws were (and are) described in ppi, rumor has it that British saws are traditionally described in tpi. Not to worry, though - converting between the two is simple:

- ppi = tpi + 1
- tpi = ppi - 1



Measuring pitch.

As with all other aspects of saw sharpening, there is no hard and fast rule dictating proper pitch. As a general guideline, you want at least five or six teeth in the cut at any time, lest the saw catch too easily. However, as the fineness of the work increases, so does the number of teeth in the cut, although a limit is reached when the gullets of the teeth become too small to carry out the dust or shavings, and the saw begins to bog down.

A notable exception to the above are miter box saws, which are almost invariably filed with 11 ppi, even though they are frequently used to cut wide boards. In this case, speed is sacrificed for smoothness of cut, on which a premium is placed.

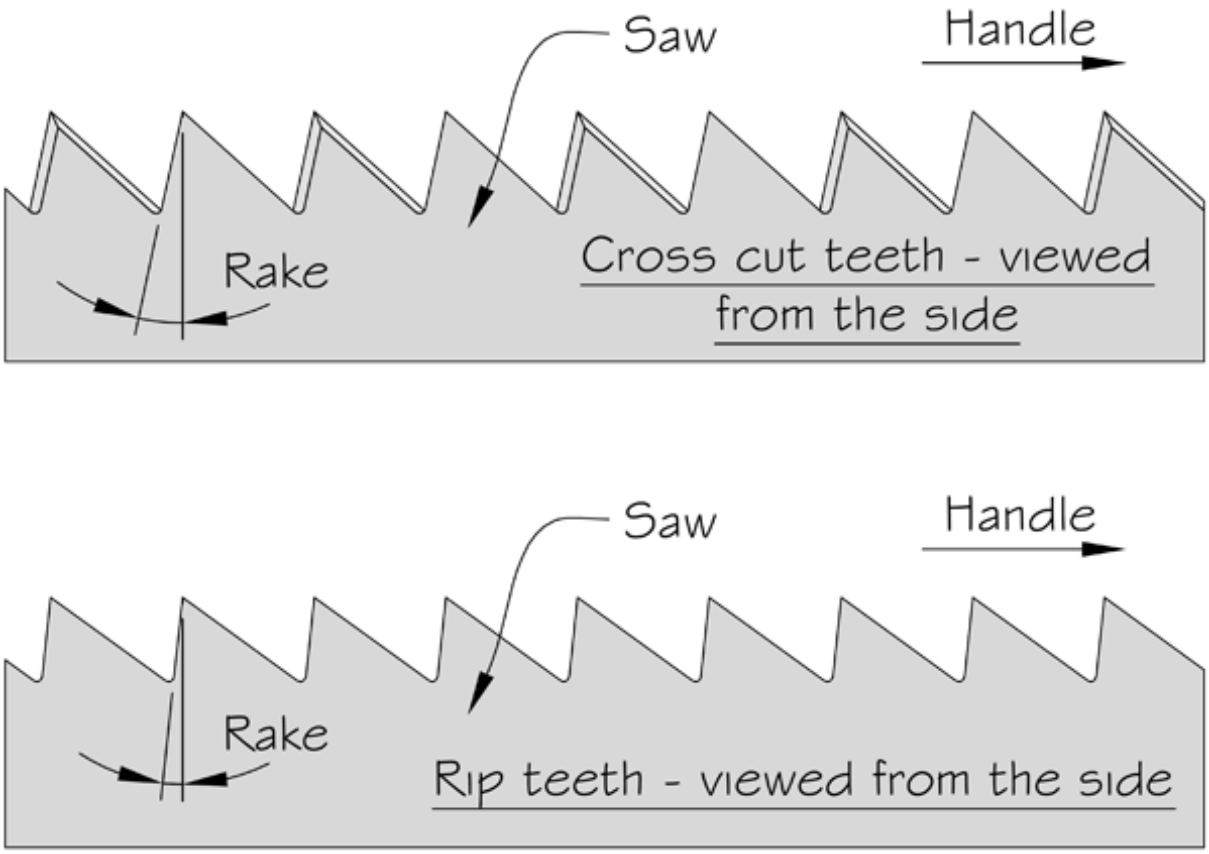
Finally, some saws are filed with progressive pitch, accomplished in one of two ways. The first is to simply file or cut the first few inches at the toe of the saw with finer teeth. The second is to gradually increase the pitch over the entire length of the saw. In either case, the pitch is usually measured at the heel of the saw plate. The goal of either filing method is the same: make the saw easier to start while taking advantage of the momentum and power present towards the middle and end of the stroke.

5.3.2 Rake

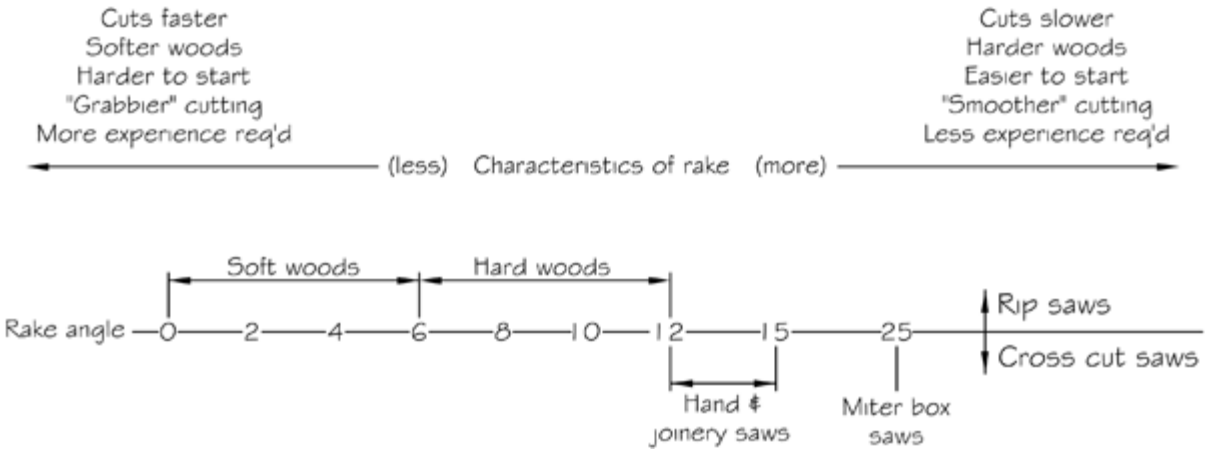
Rake is the angle that the front of the tooth makes with a line drawn perpendicular to the point line, and lying in the plane of the saw plate (Figure 9). It is created by rotating the file about its longitudinal axis (as shown in Figure 5). The main role that rake plays is controlling

the aggressiveness of the saw. All other things equal, a saw will cut more aggressively as its rake is decreased.

While most saws are filed with a uniform rake along the length of the blade, some are filed with progressive rake, which is accomplished in one of two ways. The first is to simply file or cut the first few inches at the toe of the saw with greater (more relaxed) rake. The second is to gradually decrease the rake over the entire length of the saw. The goal of either filing method is the same: make the saw easier to start while taking advantage of the momentum and power present towards the middle and end of the stroke.



Rake on rip and cross cut saws.

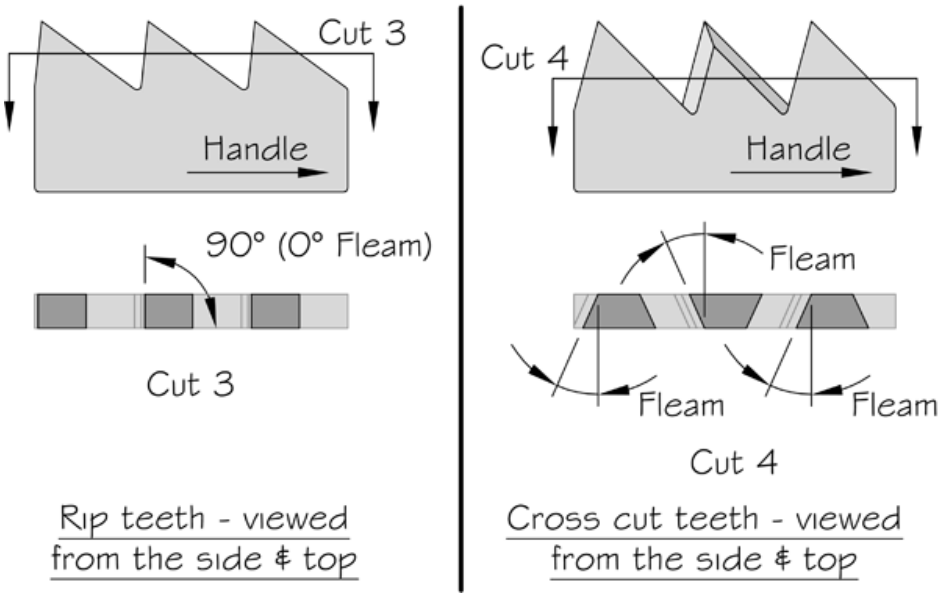


Rake guidelines and characteristics.

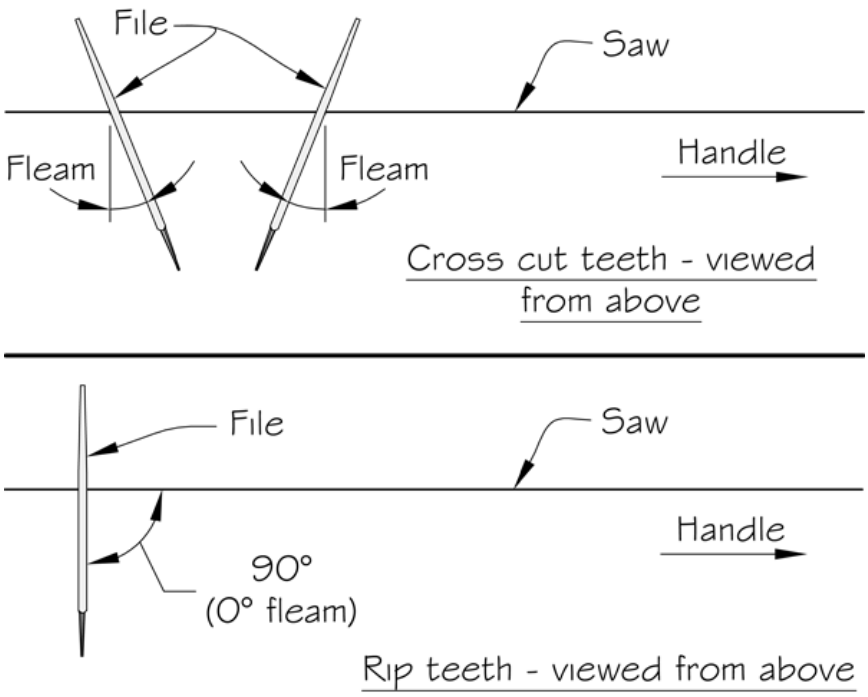
5.3.3 Bevel

Bevel is the angle that the front of the tooth makes with a line drawn perpendicular to the plane of the saw plate (Figure 12). Although bevel can be created by filing sloped gullets (see the section on point slope), the most direct method of controlling bevel is to swing the file from one side to the other so that the angle alternates from tooth to tooth (Figures 5 and 13). The main effect of bevel is on the smoothness of the cut. All other things equal, a saw will cut more cleanly as its bevel is increased.

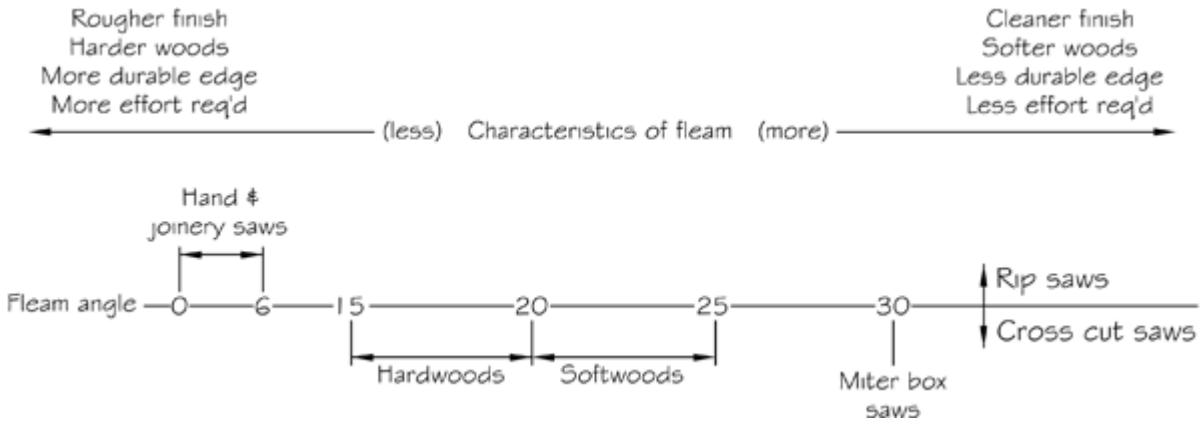
In theory, a rip saw is filed with no bevel; in practice, a few degrees of bevel is often introduced so as to leave a smoother cut, especially on saws that may deviate from pure ripping (e.g., dovetail saws).



Bevel on rip and cross cut saws (no set shown).



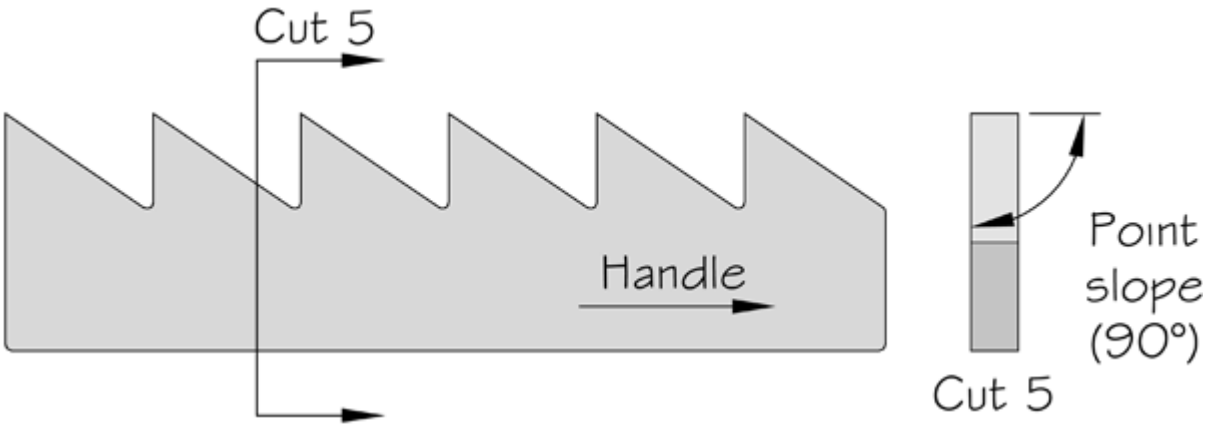
Filing bevel on rip and cross cut saws.



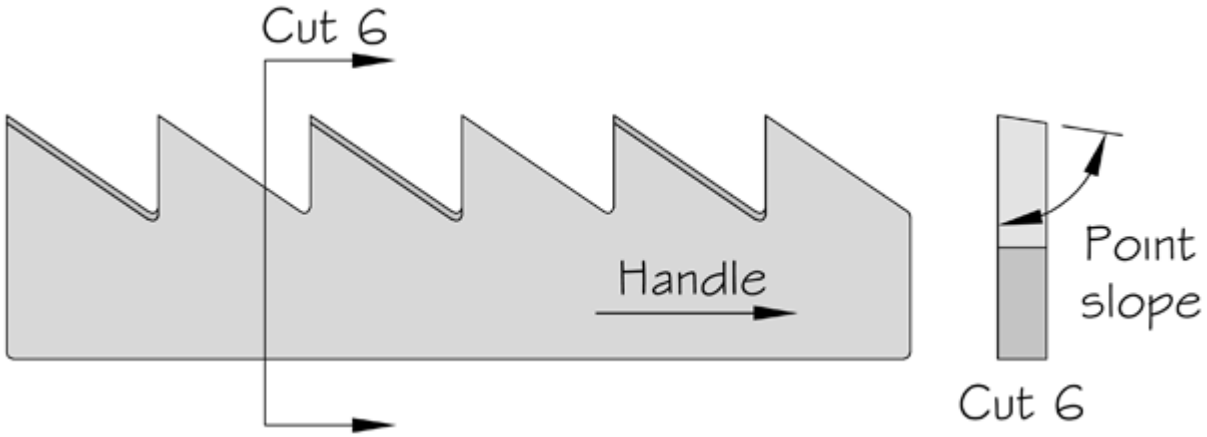
Fleam guidelines and characteristics.

5.3.4 Point Slope

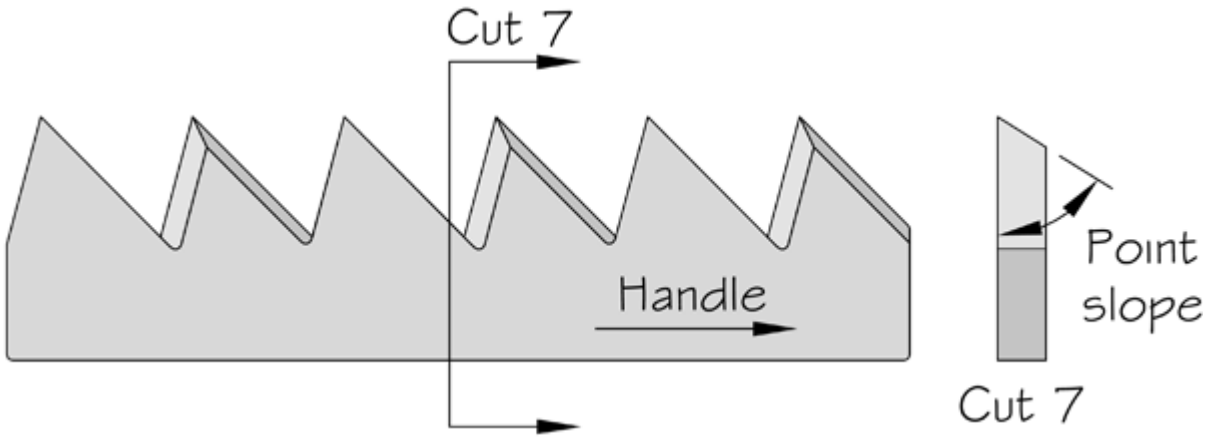
Point slope is the angle that the tip of the tooth creates with the side of the saw plate. Looking back to Figure 12, it is apparent that point slope is a by-product of filing bevel into a tooth. To complicate matters, this slope may be altered by filing teeth with sloped gullets. And this is perhaps the most important role that sloped gullets (see the next paragraph for more on sloped gullets) play in saw sharpening: by adding slope, we can strengthen the points of the teeth while maintaining the desired bevel angle, optimizing the saw for cutting harder woods. Figures 15-18 show point slopes for various tooth configurations. Notice especially the acuteness of the point of the cross-cut tooth filed for soft woods (Figure 17) when compared to that filed for hard woods (Figure 18).



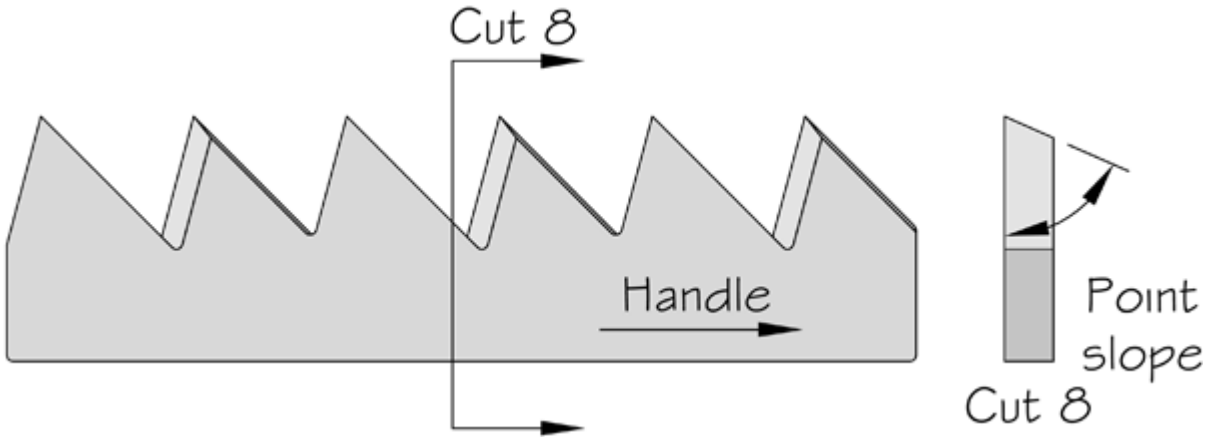
Rip teeth with unsloped gullets, viewed from the side and toe (no set shown).



Rip teeth with sloped gullets, viewed from the side and toe (no set shown).



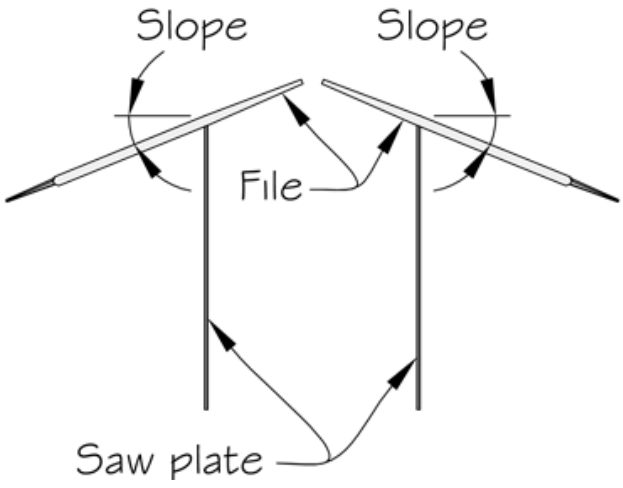
Cross cut teeth filed for soft woods, viewed from the side and toe (no set shown).



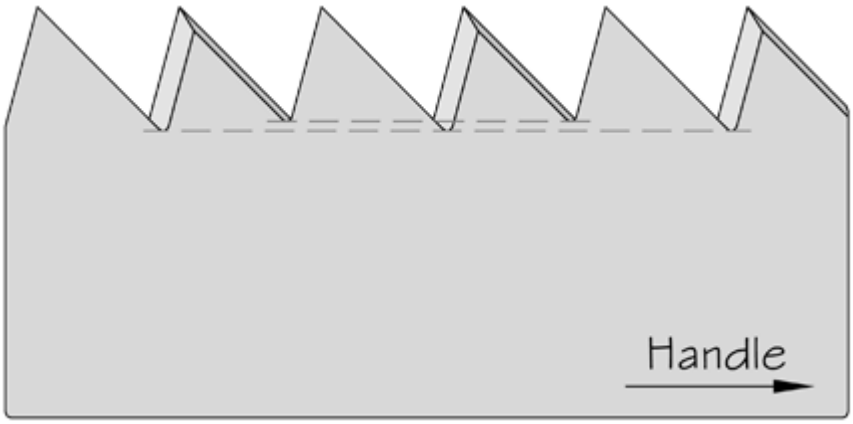
Cross cut teeth filed for hard woods, viewed from the side and toe (no set shown).

Sloped gullets are created by lowering the handle of the file vertically (Figures 5 and 19). Alternate gullets are sloped in opposite directions. In practice, the saw vise is often tilted so that the file remains horizontal, making it easier to maintain a consistent slope. In either case, the effect is the same. The tell-tale sign of sloped gullets is visible at the baseline. From the side, the bottom of every other gullet is lower than its neighbours' (Figure 20). If the saw is flipped end for end, the bottoms of these gullets are now higher than their neighbours'.

A secondary benefit of sloped gullets is the increased volume of the gullet, which allows more sawdust to be cleared on each stroke. This can be advantageous when cutting wetter wood or when cutting across wide boards (as in a miter box).

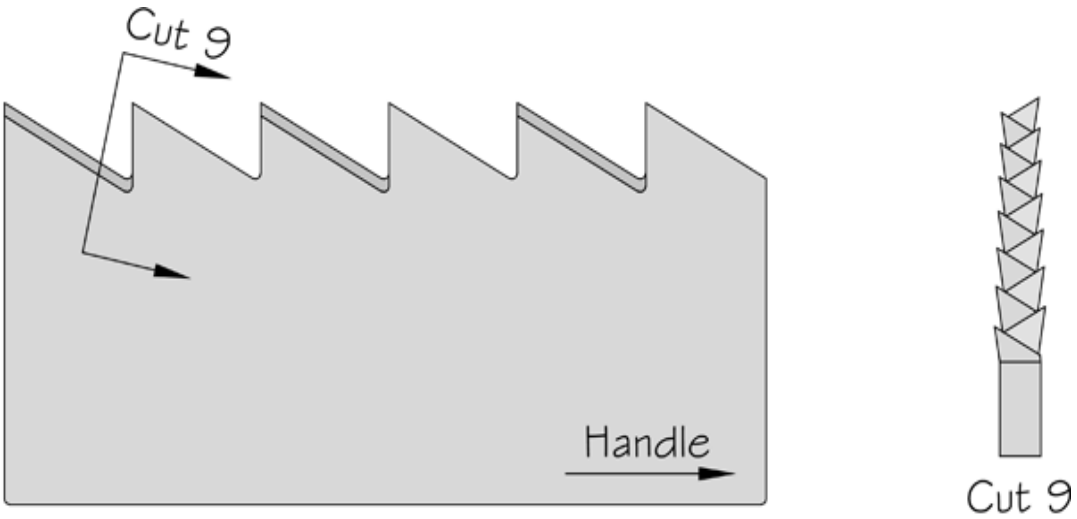


Filing slope on rip and cross cut saws, viewed from the heel or toe.



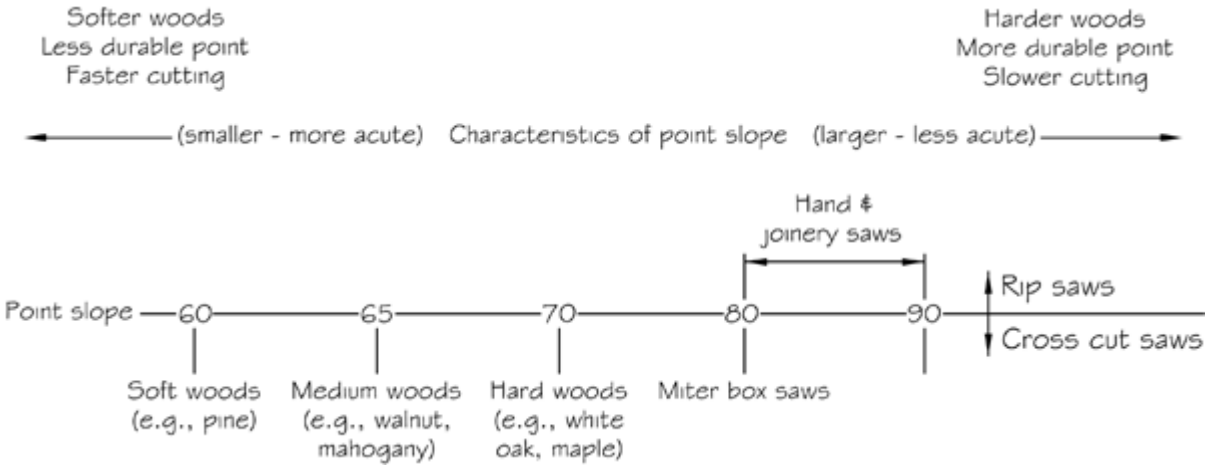
Side view of sloped gullets, showing alternating baseline.

While sloped gullets are found primarily on cross cut saws, they can also be used on rip saws. In the special case where the rake angle is 0°, the bevel on the front of the tooth remains 0° (Figure 16). I believe this makes the saw easier to start and less prone to grabbing. Others disagree, while others claim this turns the teeth into a cross cut profile. Figure 16 shows how this creates a tooth that has no bevel on the front, yet has an acute point. Figure 21 shows the tooth profile from the side and toe of a rip saw filed with sloped gullets. Comparing this profile with Figures 3 and 4, it is seen that the teeth resemble those on a cross cut saw when viewed from the toe. Those who believe that cross cut saws are defined by point slope use this image to support their view that this is a cross cut saw, while the absence of bevel lends credence to the theory that it is still a rip saw. As with so many other topics, the truth is not easily defined.



Sloped gullets on rip saw, viewed from the side and toe.

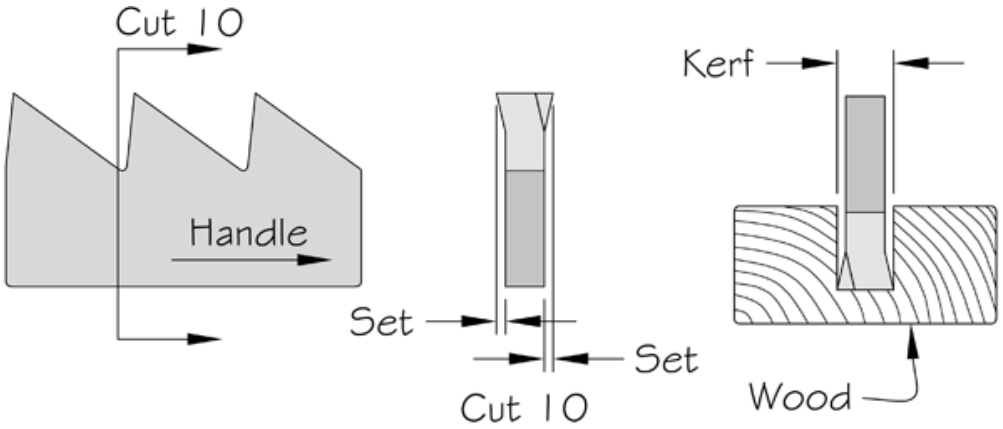
Cross cut teeth will always have some point slope, generally becoming more acute as the saw is filed for softer woods (Figure 17 and 18). Just as a chisel sharpened to a lower angle will penetrate wood with less effort than one sharpened with a higher level, so too will a saw tooth filed more acutely. And as with a chisel, an acutely filed saw tooth will be less durable.



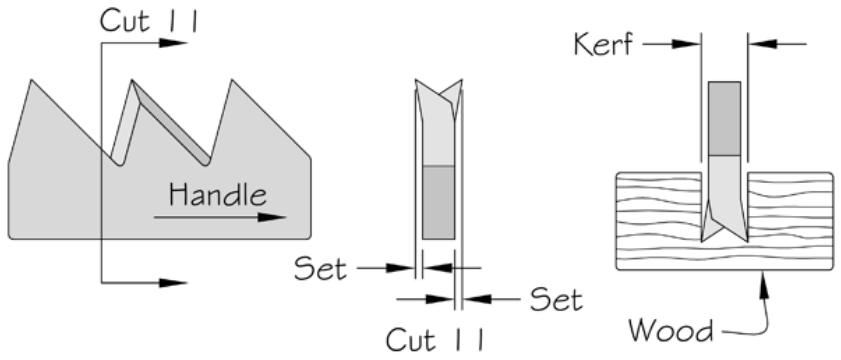
Point slope guidelines and characteristics.

5.3.5 Set

Set is created by bending the tips of the teeth in alternating directions. This creates clearance in the cut for the saw plate, reducing friction and binding. Figures 23 and 24 show this in rip and cross cut saws, respectively.

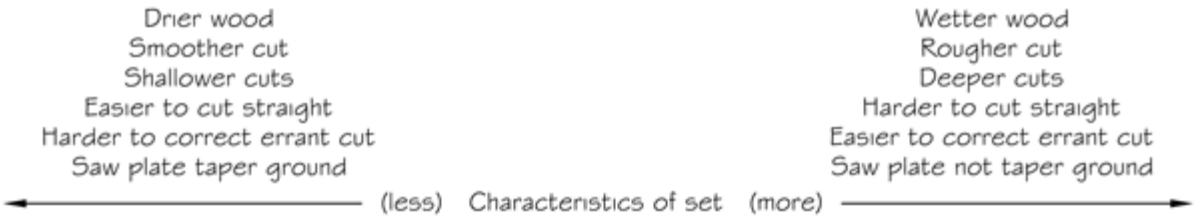


Set on rip teeth, viewed from the side and toe.



Set on cross cut teeth, viewed from the side and toe.

Set varies from none in saws that are heavily taper ground and used in dry hardwoods, to a hundredth of an inch or more in coarse saws used in wet woods. The optimal amount of set varies, but in general, the least amount needed to prevent binding in the wood being cut will work best. Additional set creates more work (by increasing the amount of wood being removed) and decreases the quality of the cut.



Characteristics of set.

EXERCISE 20'

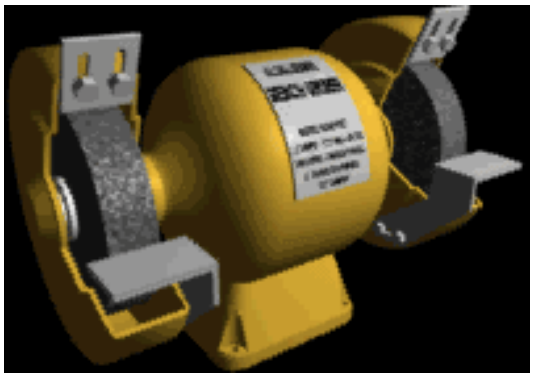
- Q1: Distinguish pitch gullet ripping
- Q2: If you want to sharpen a saw blade manually what kind of tools do you need?
- Q4: Describe cross cutting?
- Q5: If sawblade is not set correctly what will happen
- Q6: You have a chisel with ta big damage, what kind of sharpening stone do you use?

- Q1: Number of teeth in one inch; open space between teeth, sawing along the grain
- Q2: Triangular file 60° and setting tools
- Q4: Cutting the wood across the grain
- Q5: Stuck in the kerf, slow cutting, wett wood cannot be cut
- Q6: If the damage is to big only bench grinder and second sharpening stone grit 4000

5.4 Tool for sharpening

Sharpening operations usually are performed by use of grinder abrasive wheels oilstones files to reshape tools and form a sharp cutting edge

5.4.1 Bench grinder



The grinder used in the wood shop are usually of the horizontal spindle type with the arbore either on the motor shaft or on a shaft geared to the motor. They may be either bench or pedestal type. Some pedestal types have two straight cup wheels, fine md coarse, geared to a slower speed, with a straight wheel on one end of the motor shaft and a conical wheel on the other. Kerosene used to keep the wheel clean and serve as a coolant is fed to the inside of the cup wheel and is carried to the grinding surface by centrifugal force.

Some machines are equipped with special attachments for holding various kinds of tools during the grinding process. Others have only a tool rest to support work for flat grinding, making offhand grinding necessary for grinding bevels and sharpening many tools.

5.4.2 Grinder wheel

Grinding wheels are composed of abrasive compounds and are used for various grinding and machining operations This consists of coarse-particle aggregate pressed and bonded together by a cementing matrix to form a solid, circular shape

5.4.3 Sharpening stones

Composed of natural material or manmade material. They come with different grit, Grit size is given as a number, which indicates the spatial density of the particles; a higher number denotes a higher density and therefore smaller particles, (coarseness of the stone/ coarse, medium, fine) and used to sharpen edges of tools.

Wet stones are used with fluid to enhance sharpening and carry away the chips. Waterstones and oilstones are used most.

☞ ***Grit used for manual sharpening varies between 2000 and 8000***

LEARNING UNIT 6: PREPARE SHARPENING FOR MACHINE TOOLS

6.1 Working safely with sharp blades, cutter or edges

The most common concern when using sharp blades or edges is an injury, such as a cut (laceration, puncture) or an amputation.

6.1.1 What do I need to know about the safe use of hand tools with sharp blades?

To prevent cuts:

- Use the right tool for the job.
- Only use the tool only for the job it was designed for. For example, a knife should not be used as a pry bar, can opener, chisel, punch, awl, scraper, or screwdriver.
- Educate and train all staff in the safe use of any tool they may use.
- Inspect the tool before use.
- Make sure the blade is sharp. Dull blades require more force, increasing the chance of injury.
- Carry one tool at a time, tip and blade pointed down at your side.
- Work in a well-lit space so you can see what you are doing.
- Cut on a stable surface
- Where possible, use a mechanical device to hold the item.
- Hold the tool with your stronger hand.
- Use protective clothing such as Safety glasses will protect the eyes if the blade shatters or breaks.
- Cut away from your body. Make sure no body parts are in the cutting path, or in the path the blade might take if it slips.
- Place the tool at the back of the counter when not in use, with the sharp edge away from you.
- Store tools appropriately. For example, store sawblades securely in a rack or drawer, with. Or, create racks, slots, or boxes near the work space to store the tool.
- Do not use excessive pressure when cutting.
- Do not try to catch a falling tool. Quickly move out of the way, let it fall, and then pick it up.
- Do not engage in horseplay with a tool in your hand.
- Do not engage in discussions with your co-workers while you are using a sharp tool. Stop cutting if you need to look up or focus on something else.
- Do not carry tools while carrying other objects.
- Do not carry an open tool in your pocket.

- Do not drop or leave a sharp tool in a place where it cannot be seen; for example, by placing other items on top of the tool.
- Do not pass or throw a tool to someone else. Place the tool or knife on the counter and let the other person pick it up

6.1.2 What do I need to know about the safe use of power tools with sharp blades?

- Follow the manufacturer's instruction manual when you operate, clean, and maintain the equipment.
- Make sure that proper lock out/tag out procedures are in place and followed (e.g., unplug any broken or unsafe equipment, attach a warning tag, take it out of use, and tell your supervisor).
- Make sure that all guards and safety devices are in place and functioning properly.
- Make sure cutting blades are sharp.
- Keep your hands away from all moving parts and avoid cleaning or brushing off moving parts such as cutting blades.
- Turn off and unplug the equipment before trying to dislodge items, and before disassembling and cleaning.
- Put all guards and safety devices back in place after cleaning.
- If there are moving parts, cover or tie back your hair, tuck in loose or frayed clothing and remove your gloves and jewellery. All of these items can get caught in the equipment when it is moving or rotating.
- Keep the floor and work area around the equipment clear of debris or items you might trip over.
- Do not try reach into any part of the equipment with your fingers.
- Do not bypass any guards or safety devices.
- Do not operate the equipment if you feel tired or unwell.

6.2 Types of circular sawblades

Circular sawblades can be categorized into diameter number and form of teeth and kind of material which will be cut

6.2.1 Single piece sawblade

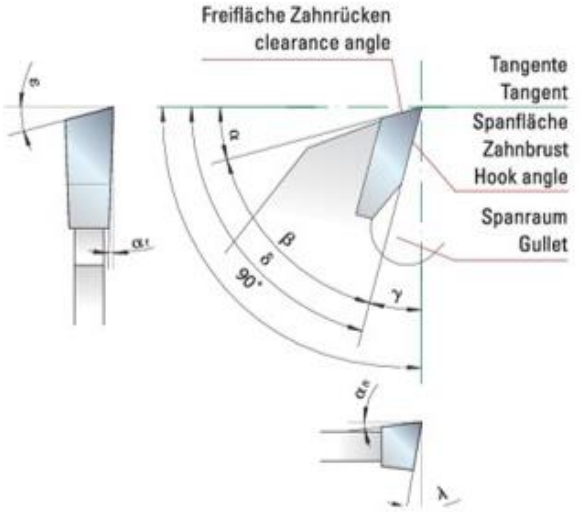
This sawblade is made out of one piece they will only be used for solid wood and get dull very fast. Different teeth form can be applied and body and teeth have the same thickness. These sawblades always need to be swaged

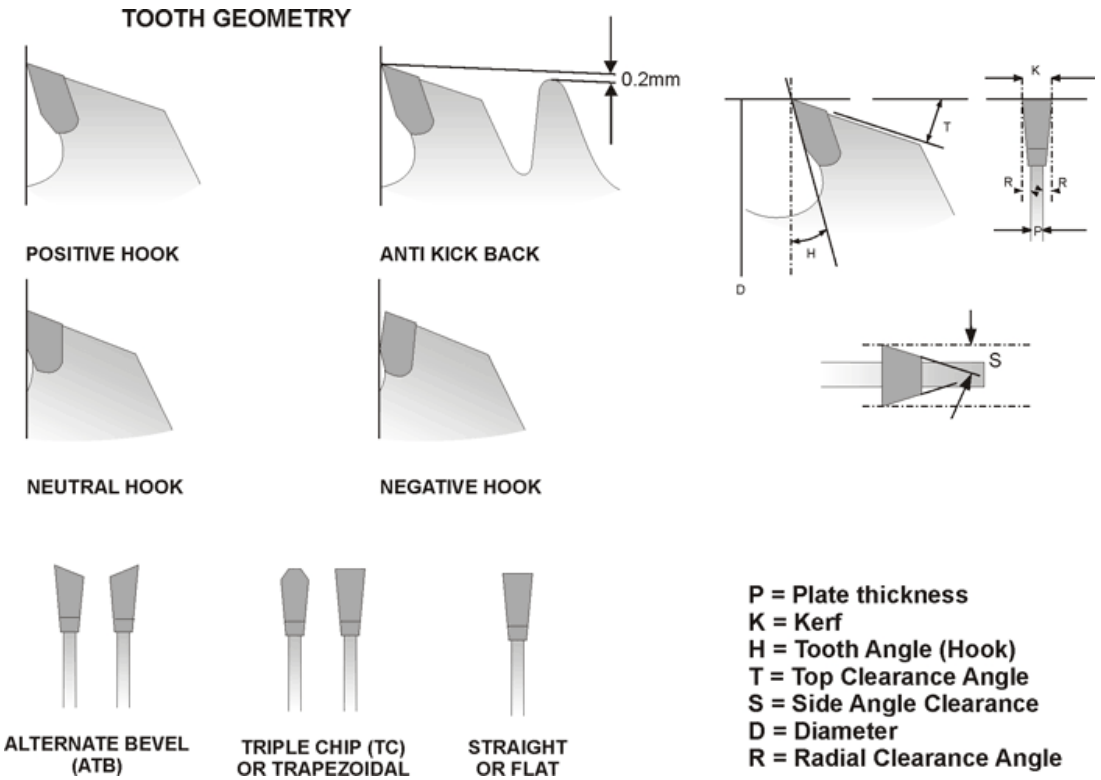
6.2.2 Compound sawblade

A compound sawblade has the teeth welded form hard metal or carbide tip. the teeth are always thicker than the blade body. They are not swaged for that reason. Different types of teeth geometries are used. the advantages of this excellent type of sawblade can only be used if the correct blade for the correct operation is chosen

6.2.3 Cutting geometries

- **Number of teeth**: in general the more teeth the smoother the cut
- **Cutting angle**: defines the material to cut
- Hook angle
- **Clearance angle**: hinders friction
- **Gullet**: takes out chips from the kerf





6.3 How to choose the right saw blade?

Making smooth, safe cuts with your table saw, radial-arm saw, chop saw or sliding compound miter saw depends on having the right blade for the tool and for the type of cut you want to make. A good way to narrow your options and focus your search is to answer a few key questions:

- **In what type of saw will the blade be used?** Some blades are designed to be used in particular saws, so you'll want to be sure to get the right blade for the tool. Using the wrong type of blade for the saw is likely to produce poor results and might in some cases be dangerous.
- **What materials will the blade be used to cut?** If you need to cut a wide range of materials, that will affect your choice. If you cut a lot of a single type of material (melamine, for example) that specialization also might affect your choice.
- **What types of cuts will the blade be used to make**? Will it be used exclusively for crosscutting (cutting across the woodgrain)? Will it be used only for ripping (cutting with the grain)? Will it need to produce good results in all types of cuts?
- Do you want to build a collection of specialized blades, or do you want one blade that can make all kinds of cuts? Are you willing to change the blade every time you switch from one cut to another?
- How powerful is the saw on which the blade will be used, and what size blade does the manufacturer recommend? Is it a 3 hp cabinet table saw or a portable job-site saw?

6.3.1 Number of teeth

In general, blades with more teeth yield a smoother cut, and blades with fewer teeth remove material faster. A 250-blade designed for ripping lumber, for example, usually has as few as 24 teeth and is designed to quickly remove material along the length of the grain. A rip blade isn't designed to yield a mirror-smooth cut, but a good rip blade will move through hardwood with little effort and leave a clean cut with minimal scoring.

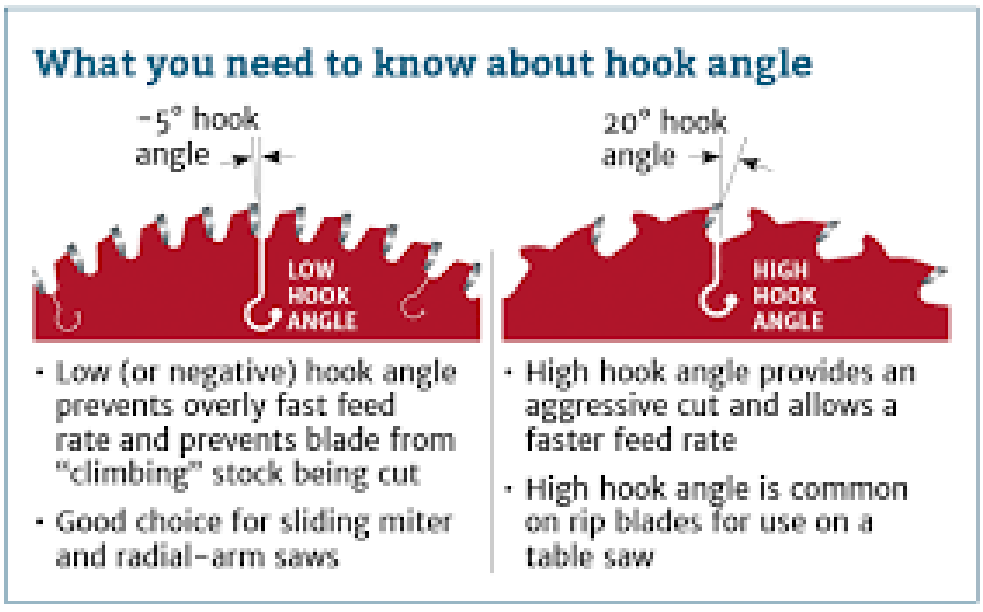
A crosscut blade, on the other hand, is designed to produce a smooth cut across the grain of the wood, without splintering or tearing. This type of blade will usually have 60 to 80 teeth, and the higher tooth count means that each tooth has to remove less material. A crosscut blade makes many more individual cuts as it moves through the stock than a ripping blade and, as a result, requires a slower feed rate. The result is a cleaner cut on edges and a smoother cut surface. With a top-quality crosscut blade, the cut surface will appear polished.

6.3.2 Gullet

The gullet is the space in front of each tooth to allow for chip removal. In a ripping operation, the feed rate is faster and the chip size is bigger, so the gullet needs to be deep enough for the large amount of material it has to handle. In a crosscutting blade, the chips are smaller and fewer per tooth, so the gullet is much smaller. The gullets on some crosscutting blades also are purposely sized small to inhibit a too-fast feed rate, which can be a problem especially on radial-arm and sliding saws. The gullets of a combination blade are designed to handle both ripping and crosscutting. The large gullets between the groups of teeth help clear out the larger amounts of material generated in ripping. The smaller gullets between the grouped teeth inhibit a too-fast feed rate in crosscutting.

6.3.3 Hook Angle

Hook angle has an important effect on blade operation. A blade with high positive hook angle (say, 20°) will yield a very aggressive cut and a fast feed rate. A low or negative hook angle will slow the feed rate and will also inhibit the blade's tendency to "climb" the material being cut. A blade for ripping lumber on a table saw will generally have a high hook angle, where an aggressive, fast cut is usually what you want. Radial-arm saws and sliding compound miter saws, on the other hand, require a blade with a very low or negative hook angle to inhibit overly fast feed rate, binding and the blade's tendency to "climb" the material.



EXERCISE 20'

Situation: Discuss with the group
You have a company for solid wood chair production. Your business needs to order new circular and band sawblades. What kind of blades do you order?
Circular saw: big hook angle, ripping and crosscut for final cut carbide tipped alternate tooth
Band saw: small blade for curved cut at back legs

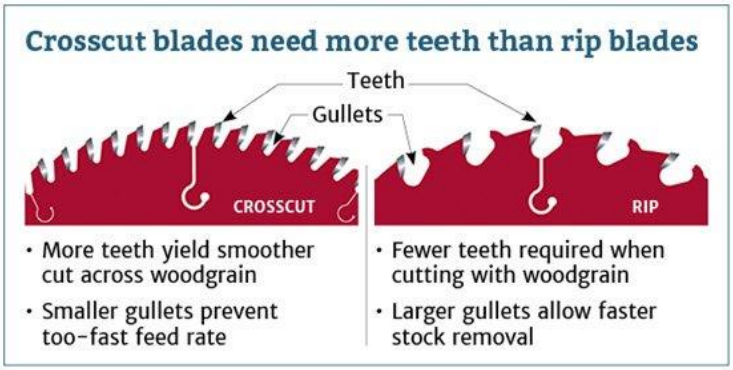
Saw Blade Teeth Quality The teeth on most high-quality saw blades are thick carbide tips that have been fused (or brazed) to the steel blade plate. How long the blade will stay sharp, how cleanly it will cut and how many re-sharpening it will take all depend on the quality of the cutting tips. On some of the best blades, the carbide is formulated specifically for the application of the blade, and a tri-metal brazing process is used to attach the carbide cutters to the blade plate. This process, in which a layer of copper alloy is sandwiched between layers of silver alloy, provides extra flexibility and impact resistance. At a minimum, look for a blade with C3 grade micro-grain carbide teeth, which are thick enough to allow a number of re-sharpening.

6.4 Types of blades and their uses

6.4.1 Ripping blades

Ripping blades are designed to cut along the grain of the wood to achieve rough fast cuts

- ✓ Few teeth 14 – 24
- ✓ Alternate bevel teeth
- ✓ Deep gullet
- ✓ Chip limiter
- ✓ Positive cutting angle



6.4.2 Crosscutting blade

Crosscutting blades are used to cut across the grain of the wood. They cut more slowly but produce a smoother, cleaner result.

- ✓ They have more teeth
- ✓ Shallower gullet.

6.4.3 Plywood blade

Since plywood chips and splinters easily, these blades are designed for use on fine material and will help minimize splintering of the wood as you cut

- ✓ 40 or more teeth

6.4.4 Combination/general purpose blades

These blades are somewhere between ripping and crosscutting blades. They are a good choice if you need one blade for a variety of uses,

- ✓ Positive cutting angel
- ✓ Many teeth
- ✓ Alternate bevel tooth

6.4.5 Finishing blade

Finishing blades are designed for making clean and precise cuts on parts of the wood that will be visible when the job is completed. making extra-smooth cuts that don't damage the wood.

- ✓ larger number of teeth

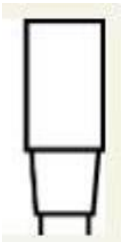
6.4.6 Plastics/aluminium

Many blades for cutting wood can also be used to cut plastic.

- ✓ Between 40 and 60 teeth
- ✓ Negative cutting angle

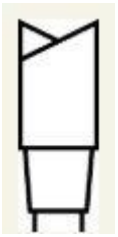
6.5 Blade Tooth Configuration (TIP)

The shape of the saw blade tooth and the way the teeth are grouped also affect the way the blade cuts. The configuration of the teeth on a saw blade has a lot to do with whether the blade will work best for ripping, crosscutting or laminates.



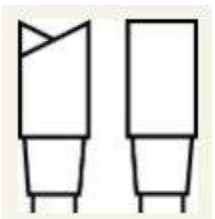
Flat-Top (FT)

Flat-top teeth are used on blades for ripping hard and soft woods. Because wood is much less likely to chip and splinter when it is being cut with the grain, a rip blade is designed to quickly and efficiently remove material. The flat-top tooth is the most efficient design for cutting and raking material out of the cut.



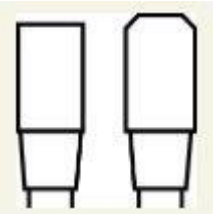
Alternate Top Bevel (ATB)

This means that the blade teeth alternate between a right- and left-hand bevel. This configuration yields a smoother cut when crosscutting natural woods and veneered plywood. The alternating beveled teeth form a knife-like edge on either side of the blade and make a cleaner cut than flat-top teeth. It is also named universal sawblade because it can be used for multiple cuts and materials Mdf, plywood, block board



Combination Tooth (Comb)

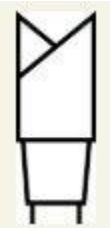
Combination blades are designed to do both crosscutting and ripping. The teeth are arranged in groups of five – four ATB teeth and one FT – with a large gullet between the groups.



Triple Chip Grind

The TCG configuration excels at cutting hard materials such as laminates, MDF and plastics. Teeth alternate between a flat "raking" tooth and a higher "trapeze" tooth. The TCG configuration is also used for non-ferrous metal cutting blades. Trapezoid Flat teeth

The teeth edges are inclined. Cutting for ready finished material or polymer or laminated MDF boards



High Alternate Top Bevel (Hi-ATB)

The Hi-ATB configuration is used for extra-fine crosscutting and to cut materials surfaced with melamine, which is prone to chipping. The high bevel angle increases the knife-like action at the edge of the blade.

6.6 Care and maintenance

Play a major role in the service life of a saw blade, so saw blades must be subjected to regular checks. saw blades with bad or missing teeth must be removed from the machine immediately, as the quality of the cut is no longer guaranteed. Hardened blades must also be removed, as the adhering dirt affects the quality of the cut.

☞ ***Regular cleaning prolongs the cutting properties and the tool life.***

In addition, the tool must be inspected regularly for hairline cracks and damage. If this occurs, it can no longer be used.

Circular saw blades are manufactured under pretension. It is able to compensate for the tension that occurs when flank pressure and frictional heat occur. The pretension is important for the running smoothness. Circular saw blades that have lost their pretension due to excessive heating exhibit unstable running and poor cutting quality.

- These saw blades can no longer be used.
- Sharpening can be done up to a residual thickness of 3 mm.

EXERCISE 20'

Inspect sawblades

- Q1: What is the function of the deflector between the saw teeth?
- Q2: What is the cutting geometry of the saw tooth?
- Q3: Why do tool cutting edges on compound blades not have to be set?
- Q4: From what residual thickness may compound saw blades no longer be used?
- Q5: Describe different types of circular saws
- Q6: Describe different types of cutting tips

- Q1: Chip limiter and safety device
- Q2: Defined by number of teeth, cutting angle, hook angle, clearance angle
- Q3: They have alternating carbide tipped teeth
- Q4: Min 3mm
- Q5: Ripping crosscutting, combination, metal, finishing
- Q6: Flat, alternate bevel, triple chip grind, carbide, bandsaw: regular, skip, hook variable pitch tooth

6.7 Bandsaw blade

Bandsaw blades are the blades on a power saw with continuous lengths of teeth used to cut various materials such as wood or metal. So, how do you choose the right bandsaw blade?

How to choose the correct band saw blade:

- Length of the blade
- Width of the blade
- Teeth style
- The material you are sawing

- The type of project you are working on
- The TPI you need
- The material your blade is made out of

Length of bandsaw blade:

How to measure a band saw blade's length?

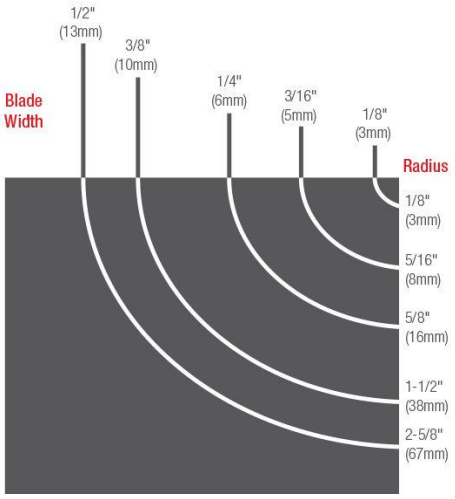
(2xA) + (3.14xB)

A = distance in inches between band saw wheel centres when the upper wheel is midway in its adjustment range.

B = band saw wheel diameter.

Many bandsaw blades can even take blades within a 5cm allowable mistake in sizing.

Width of bandsaw blade:



If the purpose of using your bandsaw is to resaw something or cut something off, you'll want to pay closer attention to the larger blade width. This will help prevent breaking your blade off while you're working and let you cut in a way that is free from jagged sides.

If you want to do something called "contour sawing," make sure to find a blade that is more on the narrow side. This will help you cut in a size that is more favourable in terms of its radius.

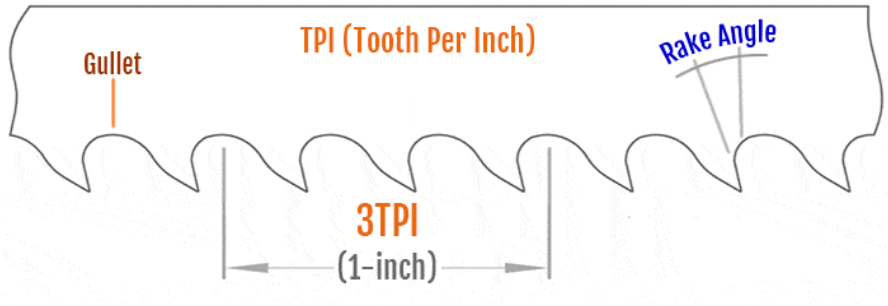
The chart next shows the width of the blades in inches depending on the radius of the project.

6.7 Thickness of sawblade

If you are mostly doing straight cutting and not a lot of curved angles, a thicker blade would be better. If you need to do little touches, you don't need such a large blade.

WHEEL WIDTH	BLADE THICKNESS
4-6	.014
6-8	.018
8-10	.020
11-18	.025
18-24	.032
24-30	.035
30+	.042, .050, .063

6.8 How Many Teeth Do You Need on Your Blade?



Teeth come in a conversion called TPI which can be explained as how many teeth a blade has per inch. If you pick a blade with a lot of teeth, you will have a smoother finish to it but the time it takes to cut it will be longer.

If you have fewer teeth on your blade, it cuts more quickly; however, it's a rougher end result.

The type of project you pick will influence the number of teeth you need.

If you are sawing something really thick or resawing a project, you want fewer teeth. Anywhere from two to three TPI is fine for this type of work. Around five TPI is suitable for quicker, general woodcutting. Around fifteen TPI is for paced out, level cutting, and you will use up to the thirties for thin materials.

Types of teeth:

- Regular

- Skip
- Hook
- Variable Pitch
- Raker
- Alternate
- Wavy

Soft Wood	Course Blade	2 – 6 TPI
Hardwood, Aluminium	General purpose blade	6 – 10 TPI
Steel	Fine Blade	10 – 18 TPI
Thin Sheets	Fine Blade	14 – 24 TPI

Regular teeth

Have an evenly spread out TPI. They are good in most regular or common settings. They can also be used around the curves of your cutting material.

Skip teeth

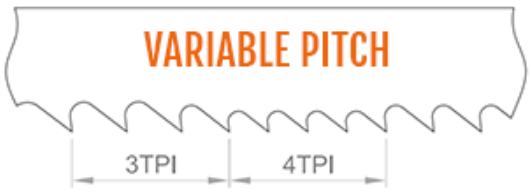
Are more widely spread out. They are at an angle so that if you cut softer wood, they won't get stuck.

Hook teeth

Are deep like a fishing hook. They are bigger than the other teeth and also have an angle. The purpose of the angle of the teeth and the hooked-up style is to cut your material faster and cut into thicker mediums.

Variable pitch teeth

Feature alternating sizes of teeth. Thus, the variable part of the name. It gives a smooth result. It is good for rounded parts or joints.



Set of Tooth

The teeth of a blade are slightly bent (offset) towards left and right to provide clearance to the back of the blade. This is known as tooth set. Because of this the resulting cut width will be wider than the blade thickness. This is known as the kerf width.

There are several types of tooth set for various applications. Some of them are,

Alternate Set: If one tooth is offset towards the left and the next towards right and so on, it is an alternate set of tooth.

A raker is one tooth pointing one way and the next the opposite followed by a straight blade.

Raker Set: Blades with raker set have 3 tooth sequences with one offset towards left, next to the right and the third tooth straight (or unset)

The alternate teethstyle is similar; however, there's no raker in this one. That's pretty much all this style: a raker without the straight blade.

Wavy teeth blades

Are groups of blades that are pointed in opposite directions from each other, joined with rakers. They are usually small and for thin projects.

6.9 The different materials of bandsaw blades

When you pick your bandsaw blade you might want to know what type of material is in it.

The two most common styles are carbon band and bimetal band.

Carbon Band Saw Blades	Bimetal Band Saw Blades
Aluminium	Aluminium/ Nonferrous
Carbon	Alloy steels
Brass	Carbon steels
Graphite	Stainless steels
Bronze	Tool steels
Plastics	
Copper	
Mild steels	
Fiberglass	

- Hardness: must be maintained at high heat levels
- Toughness: must prevent chipping or fracturing
- Wear resistance: must last an acceptable amount of time before replacement
- Purpose: must consider the product to be cut (the right blade for the material)

For Milling operation, you have to choose between 3 types of blades:

- ***Set tooth blades*** - are easier to fabricate, and the initial investment is smaller. Moreover, they are easy to maintain.
- ***Swage tooth blades*** - offer high cut efficiencies, but their maintenance in an expensive technology.
  Stellite tooth blades - offer the highest cut efficiency, and because of this reason as well as from an economical point of view they are the best, especially due to the increased cutting speed and durability while cutting. On the other hand, the cut surfaces also have a higher quality

Choosing the correct dimensions of the band saw blade depends only on the band saw. The initial blade width, measured from the top of the tooth to the back of the blade, has to be equal to the width of the wheel plus the height of the tooth plus 3 mm, representing the gap between the bottom of the gullet and the edge of the wheel. The thickness of the blade is chosen based on the diameter of the wheel and it has to be approximately 1/1000 from the diameter of the wheel. The length of the blade is generally recommended by the machine producer; the generally recommended tooth space, the number of teeth and the minimum and maximum constructive lengths are given.

The saw tooth characteristics are very important in order for the cut to offer optimal results. The durability of the cutting edge, the cutting force and the feed speed are only a few of the characteristics that require attention. Regardless of the type of wood being cut, the gullet area has to be as big as possible for the elimination of sawdust to be efficient. For the soft wood it is generally recommended to use a bigger pitch, and for a harder wood a smaller pitch, in order for more teeth to be simultaneously engaged in the cut.

Therefore, the most important parameters when choosing the pitch and shape are:

- The type of wood that is being cut
- The diameter of the log or cutting height
- The speed of the cut

6.10 Testing Your Bandsaw Blade

6.10.1 Fluttering and de-tensioning.

Fluttering is running your bandsaw while correcting the amount of tension the blade has.

You need to see if reducing the vibration from the saw is required and try to get it to a place where it can function at its best level. You want to increase or decrease tension until the "fluttering" stops.

De-tensioning is preventing your blade from being run down too early by taking all the tension off your blade when you're done the cutting.

You want to slack it before you leave for the workday so that the pressure of your bearings isn't too much on the blade while it's just sitting still.

6.11 Band Saw Blade Problems and Solutions

Many band saws (and other kinds of saws) are ruined because the person attempted to cut through a certain kind of material with the wrong kind of blade.

6.11.1 Blade getting dull too soon

Check the blade speed. Running at higher than optimum speed will cause blade cutting teeth to lose the sharpness quicker. Reduce the speed.

Increase the feed. If the feed pressure is too light, the blade can get dull faster

6.11.2 Clogging

The gullets will get loaded fast when it there is not enough space for the sawdust. Use a coarse blade with deeper gullet. Also, reduce the blade speed.

6.11.3 Blade breakage

Premature blade breakage can occur due to numerous reasons but mainly caused by improper tuning. You should make sure that the blade is properly loaded on the wheels and aligned straight. Check the blade for proper blade tension. Poor welding can result in breakage

EXERCISE 20'

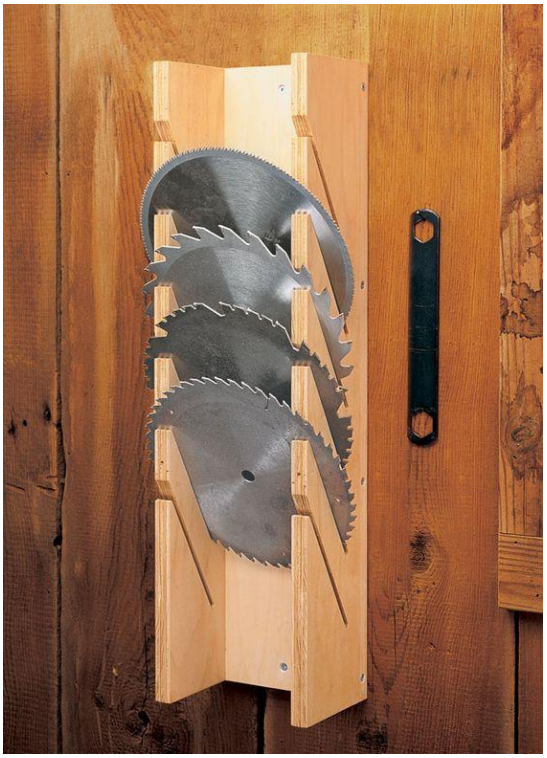
Q1: Describe different types of band sawblade
Q2: What is the options for milling blades
Q3: Which blades are easy to maintain and cheaper
Q4: Blades are getting dull very fast what is the reason?

Q1: Regular tooth, skip tooth, hook tooth, straight cutting, curved cutting
Q2: Set tooth blades; swage tooth blades; satellite tooth blades
Q3: Set tooth blades
Q4: Speed to high; feed to low;

6.12 Storage items

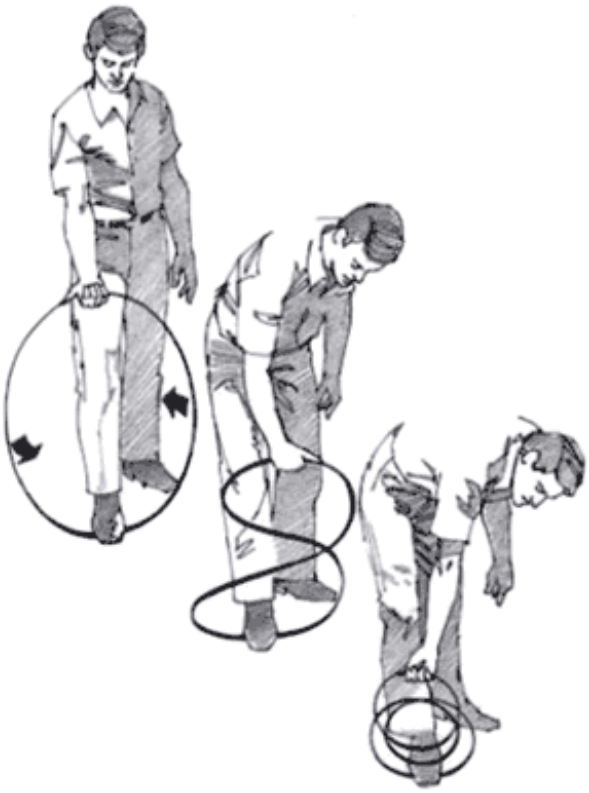
Inside you workshop you need to prepare proper storage area for all tools, cutter, blades which can be damaged and loose the sharpness due to damages. All metal cutter has to be stored without touching any metal, stone or being affected to unintended damage.

If you store all your cutter in one cabinet you can easily see all your option and will never misplace it again. Use the www. get inspired to build your own storage according to your need. The storing of big blades and knifes will be shown in the machine sharpening area.



Source: woodsmith.com

Source: instructables



Source: wood magazine

LEARNING UNIT 7: SHARPEN HAND TOOLS

7.1 Cutter knives blades and bits

7.1.1 Sharpen drill bits

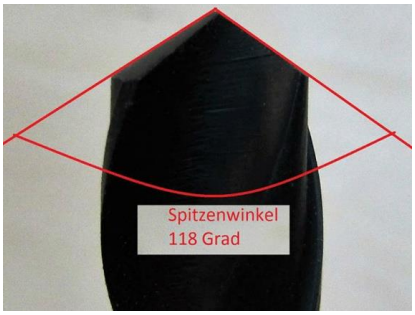
➢ Twist drill bits

To sharpen a blunt drill bit use a bench grinder equipped with two stone wheels, course and fine, in different grain sizes (K60 and K32). To sharpen drill bits use the fine wheel. To ensure that the drill bit does not wear out and becomes unusable, you should keep some water handy for cooling. Be sure not to overheat the metal resulting in destroyed cutter

The theory of drill grinding

To do this, we will first look at a drill bit with different cutting edges. A twist drill bit has basically two and sometimes three cutting edges

Primary cutting edge

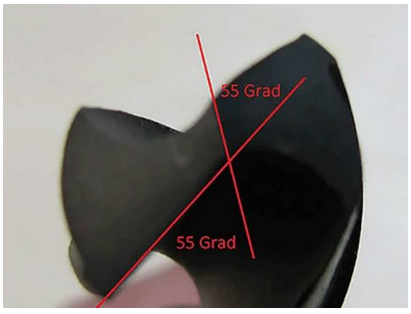


These are the two longest edges and are meant for cutting into the material. They take up the main task and in general are the first to get affected. They are at an angle of around 118 degrees to each other (point angle / cutting angel)

The secondary cutting edges

It is the outermost edge and not always there in all twist drill bits. It takes care that the drill bit makes a clean hole and supports it (smooth running).

The chisel cutting edge



It is placed on the material and twists into the material. It is this cutting edge that causes the drill bit to drift on a smooth surface. That is why, when drilling through metal or steel, you must pre drill or at least centre punch before

actually beginning to drill. The chisel edge must be at an angle of 55 degrees to the main cutting edge.

➢ Step by step to a sharp drill

- Start with the largest possible drill bits. Hold the drill bit in your right hand and place it on your left index finger. Press it on the index finger using your left thumb. Now stand at a little angle on the left-hand side of the bench grinder and put your left index finger on the grinder's tray (also called spark deflector), so that you can comfortably place the drill bit on the grinder.
- It now gets a bit tricky because you have to combine two movements. You place the drill bit with its left main cutting edge on the moving grinder wheel, and immediately and gently bring down the rear part (right hand), gently raise the front part (left hand) and simultaneously turn the drill bit in clockwise direction around one-eighth of a rotation. You do not have to put too much pressure, but you must be careful, that when you are turning it, the drill bit continues to remains in contact with the grinder wheel.
- After every one-eighth rotation remove the drill bit and look at the tip. From this you can see whether you are holding the drill bit correctly or you need to correct something. If you put too much pressure or hold the drill bit too long against the grinder wheel, the drill bit becomes too hot. Before it glows or starts to acquire colour, you must cool it with water. If the main cutting edge shows a smooth edge, change to the second main cutting edge by turning the drill bit and proceed just as you did with the first one. Now all that you have to ensure is that the drill bit is centred, and both the main cutting edges are the same length

Twist drill that has lost its edge. While dull bits still drill ok in woods on a drill press, they won't cut very clean and also get too hot. For drilling in metal, a dull drill just plain won't drill.

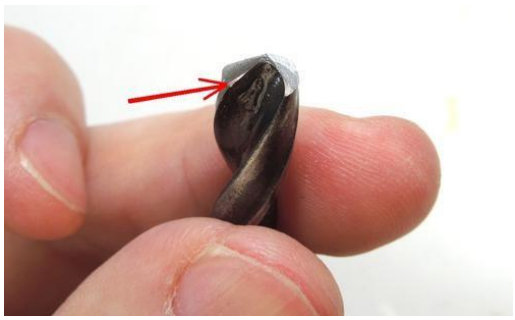
There are all kinds of complicated jigs and gadgets for sharpening drill bits. But the fact is, twist drill bits are actually quite easy to sharpen by hand. And if you mess up, the worst that can happen is that you grind away a few millimeter of drill until you get it right. Start with

the drill held against the wheel, so that the cutting edge is horizontal and against the bench grinder wheel. Then, while grinding, I turn the drill clockwise to make sure I cut away material behind the cutting edge.

The important thing is that the cutting edge ends up the most forward part of the drill, that the point stays centred, and that it's symmetrical. Work on alternate sides, keeping the drill held in right hand, while flipping it 180 degrees with my left hand. That way, keep a consistent hold going from side to side, which should maintain symmetry.

What NOT to do

An easy mistake to make is to sweep away too much towards the back, and accidentally nick the opposite, just sharpened cutting edge of the drill. See red arrow.



The left bit was ground away the cutting edge, without relieving towards the back.

Now the cutting edge is actually not the most forward thin, so drill is basically unusable.

The drill at right is sharpened at an odd angle - 45 degrees swept back, but it should still be usable. Just not ideal.

Always test the result of the sharpening:

- Easy cutting into solid wood
- Centered while applying pressure
- No overheating

EXERCISE 30'

- Q1: What are the cutting geometries of twist drill?
- Q2: If drill bits loose the edge and get dull, what is the effect?
- Q3: What happens if you ground away the cutting edge
- Q4: Drill bit is sharpened to an angle of 45 degrees what happens?

- Q1: Primary cutting angle 118°; chisel cutting edge 55°
- Q2: Cut is not clean, needs a lot of pressure; overheats
- Q3: The bit is unusable
- Q4: Not ideal because thin and easy to overhead but can cut

7.1.2 Sharpening Forstner bits

Sharpen the main cutting edge from the side and from the front. When sharpening from the front, you have to be careful not to nick the cutting teeth around the perimeter with the file. But it's best to sharpen from the front - there's much more depth in that direction, so it can be sharpened more often.

The teeth on these drills are best sharpened with a Dremel tool and a cut-off disk.
If your drill has no teeth, then a small stone on the end of a Dremel is best. You can also use a larger cut-off wheel to sharpen the main edge, similar to what I did with the file.

EXERCISE 0'

- Q1: What do you need for sharpening hand tools?
- Q2: What are the steps of sharpening for a planer knife?
- Q3: Why is the chisel blue coloured after grinding at bench grinder

- Q1: Oil stone, oil, water stone water, grinder and grinding wheel
- Q2: Grind of the damages with the bench grinder first
  - ✓ Use the water stone to grind the bevel
  - ✓ Take the recess from the flat side
  - ✓ Test the sharpness with a piece of wood
- Q3: The metal is overheating due to long contact of grinding without cooling it lost the hardness. If you want to use it all blue coloured area has to be ground of

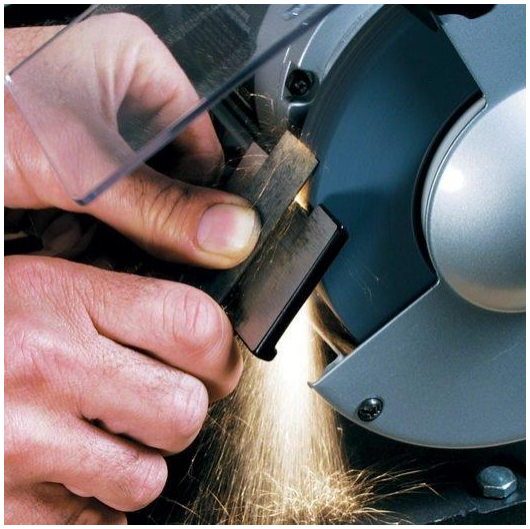
8.1 Sharpen hand tools

☞ ***Always use PPE when working at grinder***

- Inspect your water or oilstone on damages course, cupping and replace if to dull.
- Soak the water stones for several minutes
- Use petroleum-based oil for oil stones

Chisel and planer knives

- Carefully match the correct angel for your chisel depending on the use between 25 and 30 degrees. (30 heavy work, 25 in between) hone the bevel first. Then take of the recess on the flat side. Clean the chisel proper and test the clear cut on a piece of solid soft wood.
- If the chisel has too many cuts and damages you have to grind it first on a bench grinder. followed by the honing procedure as described.
- Take care to cool it down with water avoiding overheating



LEARNNG UNIT 8: MAINTAIN PORTABLE POWER TOOLS

8.1 Personal Protective Equipment

Common safety

- Use working cloth which is closed to the body. Jewellery and watches are not allowed to wear.
- Do not work in danger zones
- Always clean your workplace
- Use a container for cut offs
- Shut down machines before you maintain or clean machines
- Don’t talk with persons who are operating machines.
- Stop the machine when you are finished
- Wearing gloves is not allowed at machines with turning tools.
- Jigs and safety devices must be stored closed to the machine.

☞ *Use a broom*

☞ *Never blow of surfaces*

Ear protection

While operation at machines for

- Sewing
- Planning
- Thicknessing
- Routing
- Sanding

Safety shoes

In the workshop and on construction sides

Eye protection

While working with Metal and Miter cut-off saw and any overhead working

Face mask

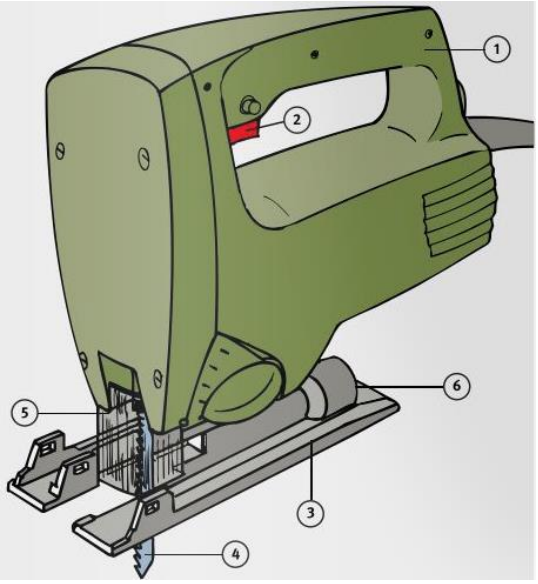
While changing of sawdust bags, grinding sanding or finishing spray works

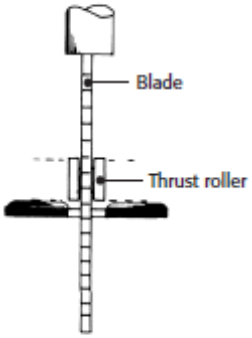
Cap tying hair

If working on rotating machines use a tie to keep your hair

Source: All pictures SUVA

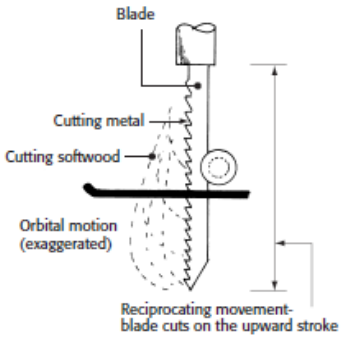
8.2 Jig saw



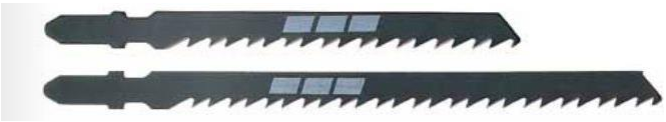


Front elevation

1. Handle
2. On/off switch with lock
3. Jig saw table
4. Saw blade
5. Saw blade cover
6. Dust collector connector



Side elevation



Solid wood
Big cutting angle big teeth altering

Ply wood
small cutting angle small teeth altering

Synthetic material
middle teeth size, middle cutting angle

Metal
very small teeth altering arrangement small cutting angle / bimetal

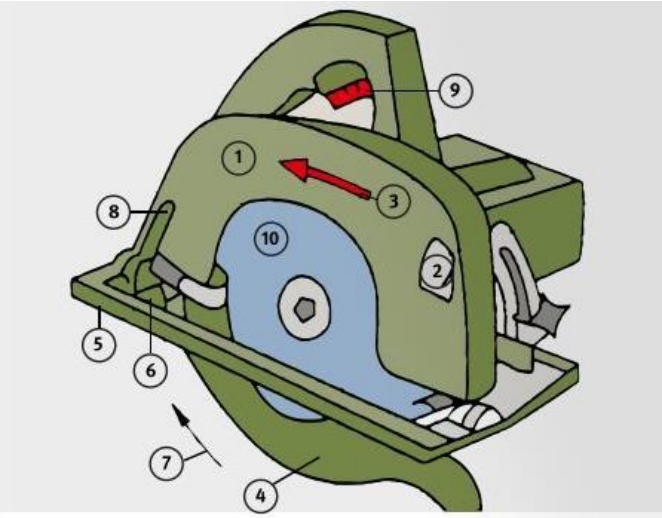
Set jigsaw:

- Inspect switches, handle, wire and clamping devise table should be 90° to cutter
- Clean the clamping area before inserting the sawblade
- Check blade and table setting with try square
- Lubricate thrust roller/guard wheel/shank
- Keep ventilation slots free from dust
- Make a test cut measure result

Troubleshoot

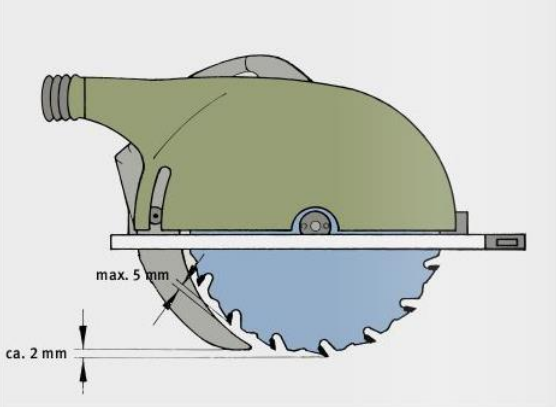
- Cut not straight cut is bend ------ blade is dull; pushing too hard; wrong blade
- Blade is wandering --------- you don't hold it straight

8.3 Circular saw



1. Upper sawblade cover
2. Opening screw
3. Turning direction
4. Lower sawblade cover
5. Circular saw table/fence
6. Splitting knife
7. Movement of cover blade
8. On-off switch
9. sawblade

Setting



- All portable circular saw need a splitting knife
- The thickness of the splitting knife is the same size than the teeth thickness
- Distance splitting knife – sawblade
  =max 5mm
- Splitting knife 2mm higher than
  the saw blade

Maintenance circular saw

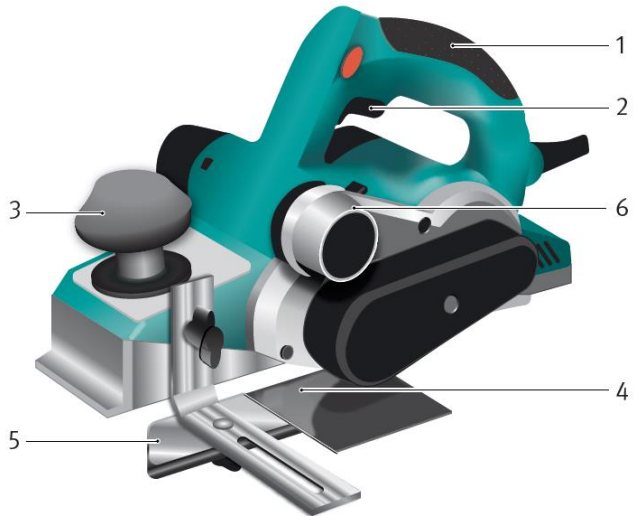
- Clean from resin and chips
- Check the cord
- Check the blade (is it still ok, is it the right for the job)
- Check blade cover for easy flipping back
- Check brushes, if ¼ is cut of replace it
- Observe vibration and sound
- Lubricate

EXERCISE 30'

Set a circular saw for cross cutting of solid wood 4 cm

- Inspection done prior to setting (sawblade, arbour switch cord)
- Correct sawblade
- Splitting knife adjusted
- Table adjusted
- Cover servicing proper

8.4 Planer



1. Handle
2. On/off switch
3. Setting cutter depth
4. Cutter block
5. Parallel fence
6. Dust collector connector
7. Cutter block guard
8. Side cover cutter

Cutter block


- Only round cutter block is allowed
- Maximum knife distance 1.1mm
- The knifes must be formfitting

Maintain planer:

- Check cord, handle, guards
- Check blades for dames and sharpness
- Check brushes replace if needed
- Check bearing and shank of cutter bock

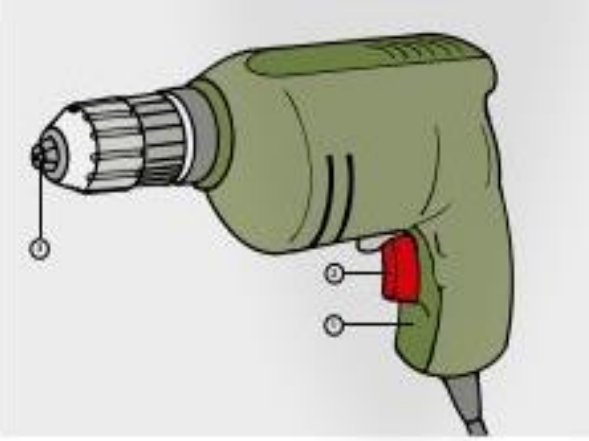
- Check bolts and nuts
- Lubricate to reduce friction and take of rust

Trouble shoot:

• Planer overheats →	machine is dirty →	clean ventilation holes
• Sparking occurs	worn brushes	replace brush
• Does not operate	check fuse	replace fuse
• Waste is not extracted	bag is blocked	remove and empty dust bag

8.5 Drilling machine

Electric cord drill



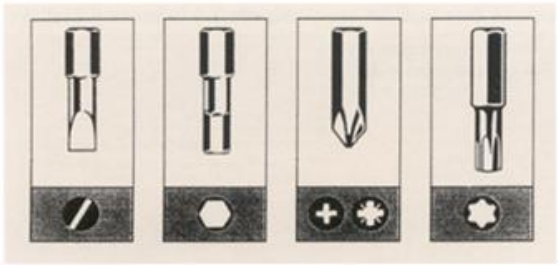
- Chuck
- On off switch
- Right left turning
- Handle

Handling

- Always use the correct drill bit for the specific job
- Use the correct speed for the specific material
- Used the correct pressure for the specific material

Cordless drill

Often used for drilling screws and small holes



- Slot
- Allen
- Phillips
- Star

Use the correct bit for the specific screw

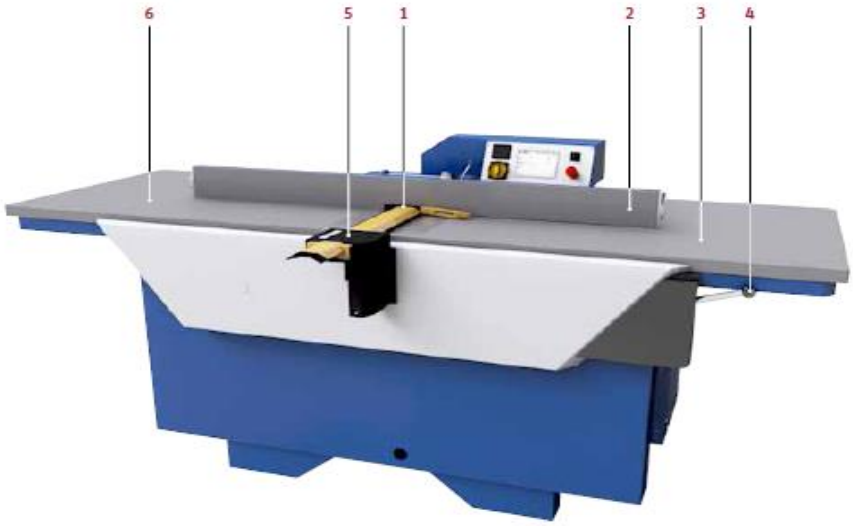
Maintain drilling machine:

- Check cord, handle, guards
- Check bits for dames and sharpness
- Check brushes replace if needed
- Check bearing and shank
- Check bolts and nuts
- Lubricate chuck carefully and dry clamping area too much lubricant will affect the clamping function
- Lubricate to reduce friction and take of rust

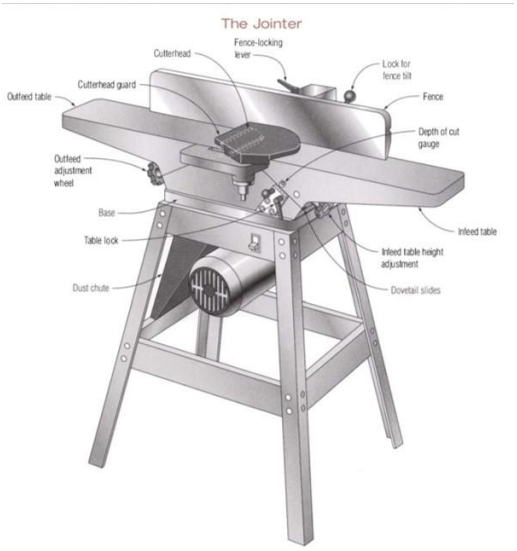
LEARNING UNIT 9: MAINTAIN STATIONARY WOOD WORKING MACHINES

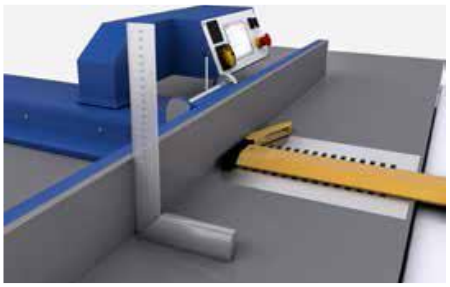
☞ ***Maintenance of wood processing machines should only be carried out by professional staff with excellent knowledge about machine anatomy and operation.***

9.1 Surface Planer machine/ jointer



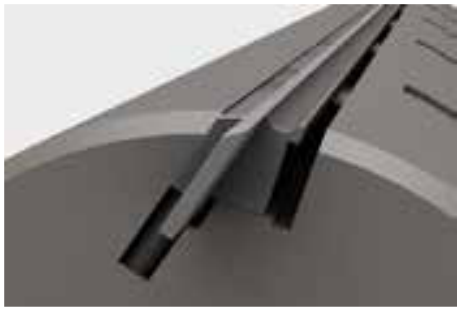
1. Cutter block
2. Fence
3. Infeed table
4. Height adjustment
5. Cutter block guard
6. Outfeed table





Pictures by SUVA

Cutter block

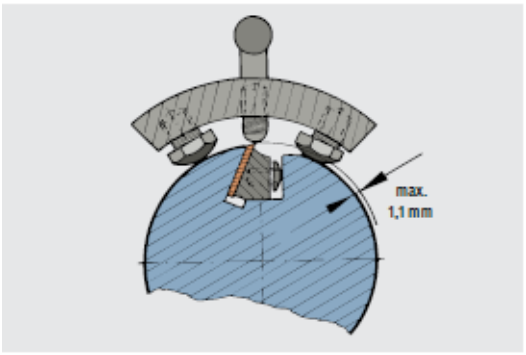


Fixed by force: wedge bar+ screw

Fixed by form: groove (TERSA)

Setting of cutter/knife

- Only experience operator should do
- Use always the magnetic setting tool from the machine original supply
- Clean the knifes before you fix them
- Fix the screws starting from the center to the corner
- Do a trial run after setting
- Do a recalibration if needed



- Check if the cutter knife is exactly same height with the outfeed table
- Inspect and check if the fences and guards are set

☞ *ALWAYS TURN OFF MACHINE FIRST*

Maintenance scheme for planer:

1. Clean the machine, lubricate the machine
2. Check the cutter head bearing
3. Check the table for flatness _ use machinist straightedge
4. Install new knives _ use feeler gauge/magnetic gauge

5. Set the outfeed table to cutter height

Trouble shooting:

The edge of the board is concave →
- Outfeed table or infeed table low reset table
- Worn slides, warped table

The edge of a board is convex →
- Dull knifes
- Outfeed table to high
- Table is warped or caked

Set the machine

- Remove the fences
- Remove the cutter guards
- Remove sawdust from jointer
- Be careful to use compressed air because dust and chips may be forced into bearing and sides and cause trouble

Check the bearing

- Check cutter head bearing replace if bad
- Check drive pulley by rotating shaft if there is clicking sound bearings or pulley is loose and need tightening
- Rotate a couple of revolutions no noise no roughness sticking
- If the belt makes it hard to judge remove it

Lubrication

- On table height adjuster use grease
- Use wd 4o onto the slides to revive old grease
- Spray oil onto on thread of adjusting screws
- If the slides are not working the table must be removed
- Worst case is paint thinner to remove old grease and dust

Disassemble table

- If nothing works you have to disassemble the table
- Use brush and steel wool for cleaning of slides
- Apply grease on the e dovetails
- Check the gib if it has marks from screws if so, file it off!

Reassemble

- Fit the dovetail and slide table back
- Enter the glib flush with the end of the base casting
- Secure the table

Adjust the table

- Use machinist steel straight edge not builder level
- Move both tables up and check the crosswise alignment of the table with straight edge and feeler gauge.
- Lift according to feeler gauge
- If alignment is not possible use shims from drinking can
- In this case place them between sliding surface of table and casting do it at outfeed table since this is not used often

Lengthwise alignment of the table

- Because of weight and long overhang, the table ends often drop causing concave cut at the end of boards
- Long master bar is needed in the length pf the planer
- Bring the table up to saw level
- Use a feeler gauge to measure the gab. More than 1.5 mm shim the table to level

Fence alignment

- Mount it
- Square it up
- Test it by good flat surface board
- Check the edge

Setting and replacing knives

- Planer knives cutting edge must be even with outfeed table
- The knives setting is done by gauge ideally or block of wood on outfeed table or dial indicator
- With disposable knives take care to remove all gum and pitch from the slot and knife locking wedge
- Most are spring backed knifes which are pushed down by magnetic gauge or piece of wood

Change knives

- Remove the knives and the lock bar and clean the slot with solvent to remove pitch and dirt using steel wool
- Burred and distorted lock bolt head need to be cleaned file removing burr
- Smooth and slightly round the bolt head
- Check that the wrench is good fit
- Insert the new knives and lock the bolts starring in in the center
- If there is no manual the height is set by using a straight edge, lifting the table 0.4 mm higher than cutter block surface and then adjust the knives level to the outfeed table

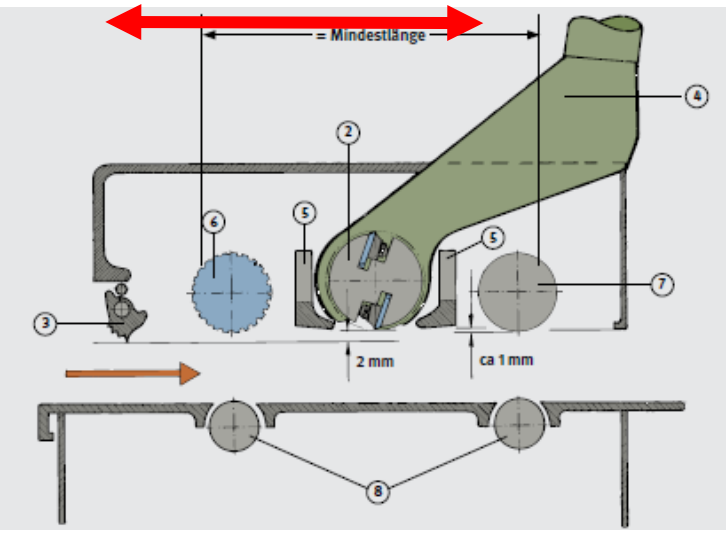
Testing the machine

- Check that you have tighten the knives lock screws
- Reattach the guard
- Plug in the jointer
- Remove all tools
- Adjust the outfeed table (to low, snipe in the trailing end,)
- Take a board without twist 150 cm and width 10cm
- Test straight edges by placing two planed boards to each other
- Set the fence checking the 90 degrees

9.2 Thickness planer

1. Cutterblock
2. Working table
3. Cutterblock with roller:
   - 3.1. Cutterblock
   - 3.1. Infeed roller
   - 3.1. Pressure bar
   - 3.1. Outfeed roller
4. Height adjustment

Source: SUVA

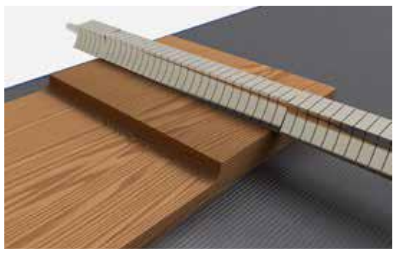


1. Minimum length of work piece
2. Cutterblock
3. Kick back devise
4. Dust collecting hose
5. Pressure bar
6. Infeed roller

7. Outfeeed roller
8. T able roller

Function of the machine devices

Kickback device



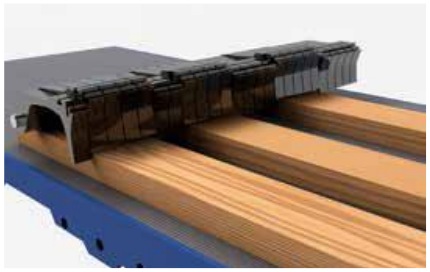
The special bars are installed to avoid the work piece to kick back. Only forward movement is possible

Infeed roller

Depending on the machine design, the infeed roller is made out of rubber or single pieces.

Infeed roller can leave marks on the surface

Pressure bar



This bar is pressing down the work piece direct after the cutter block. It will reduce the cutting marks

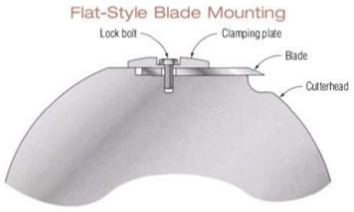
Outfeed roller

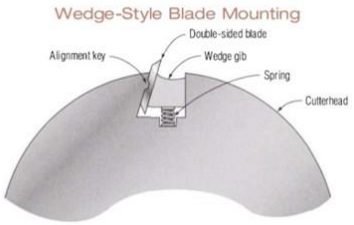
It is moving the work piece out of the thicknesses.

Depending on the distance between in feed and outfeed roller is the minimum length of a work piece

Knives attachment to cutter head:

- Gib bar /spring backed
- Flat mount (portable machines)
- Wedge style
- Knifes: Disposable /Tersa
- Standard blades/ re sharpen



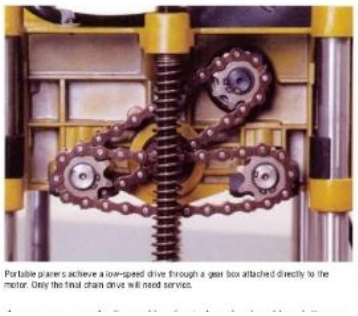


Transport of work piece

- In feed out feed roller
- Bed roller in table below feed roller
- Chip breaker
- Pressure bar

Drive system

- Clean it regular
- Spray penetrating oil to clean from old grease and sawdust
- Cutter head / v belt
- Feeding step pulley or transmission/chain drive
- Drive chain and sprocket assembly
- Check the belt tension (max 1,5 cm)


Portable planers achieve a low-speed drive through a gear box attached directly to the motor. Only the final chain drive will need service.

☞ ***ALWAYS TURN OFF MACHINE FIRST***

- Drain and replace the oil (80 w 90) from a gear box at least once a year
- Take care for clogging! worst case it could cause a Fire (friction causes chips burning)

☞ ***Always check for losses and wear***

Setting of Thicknesses planer:

- Level the floor!
- Floor has to be strong

Adjust table:

- Check gibs or split bushing s for proper tighten (just loose enough to slide smoothly)
- Check and eliminate play
- Check flatness:
    - ✓ Table flat or bowed or twisted?
    - ✓ Check pressure bar if does not bear down evenly leading end of board lift and cause nipes
    - ✓ Use straight edge checking across length width diagonals tolerance 0.1 mm
- Extension table must be level to slightly upwards
- Check alignment of cutter (all same height)
- Sharpen all knives in one run
- When locking the knives back; start form center to outside tightening the bolt
- Use only perfect fitting wrenches
- Place knifes and bolt and wedge bar to same position than bevor!
- Inspect wedge bar and file off the burr
- Bolt head should have slight conical point for tightening
- Check bolt threat
- Check table height indicator

Sharpening blades:

- Sharpen only as much as needed
- Check the reshaped result on uniform with and straightness with calliper
- Poorly sharpened will result rounded inwards ends
- Clean up the burr on a fine honing stone
- If discoloured means overheated and lost temper
- Clean the bar careful bevor resetting
- Set the height using a setting tool
- Tighten the bolt staring center direction edge. Once the bolts snug go back and repeat progressively tighten in the same patter in 3 steps

☞ ***Don't over tighten lock bolts***

Cutter head alignment:

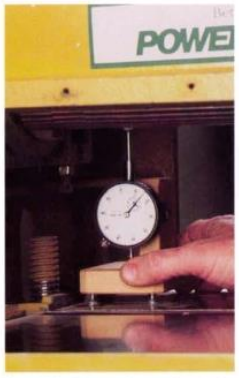
- Use dial indicator on a base
- Check if cutter head is parallel to table
- Rotate the head knife dead center position and measure right and left side

Infeed outfeed roller

Infeed roller should be slightly closer to the table than the arc of the knives (check manual for tolerances; if no manual infeed roller 0,7 mm closer than knifes for solid roller and 1,4mm closer for segment roller)

To check cutterhead alignment, start by adjusting the table to bring the indicator's hand to the vertical position after it has made a couple of turns.

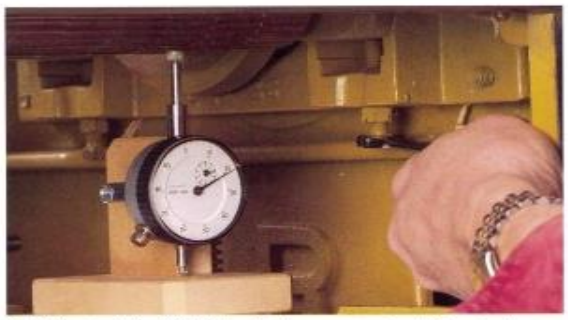
Move the indicator to one side of the cutterhead and adjust it so it reads zero.



Move the indicator to the opposite end of the cutterhead and take another reading. Here the head is out of parallel by 0.005 in.

Chip breaker

Slightly below arc of knives
Without manual set on 0,7 mm



Set infeed and outfeed roller height by adjusting screws at each end of the rollers after taking a measurement with a dial indicator.

Pressure bar

- Holds stock as it leaves cutter head
- To high: snipe ends of board
- Prevent jamming set it precisely (0.02.mm higher than the arc of knives

Bed roller adjustment

- Few thousands of mm above table
- Check the edge and midpoint if there is a difference it might be bend
- Perfect height can only be determined by experiment
- If snipe acours readjust

Running test

- Take a min 1,5 m board and test the setting
- Use softwood knot free, not twisted cupped or bowed
- Check the surface
- Check the thickness (if one edge is thicker, readjust the table to head alignment)

EXERCISE 3 h

A solid wood board needs to be cut in 1200mm length, 170mm width. One edge needs 45 degrees cutting. Right and left end will be cut in one of 90 degree and one 45 degrees.

Task:

Inspect, set the machine, calibrate where needed replace where needed.

- Inspection done
- Cleaning done
- Belt adjusted
- Alignment of fences checked
- Correct saw blade set
- Test run performed

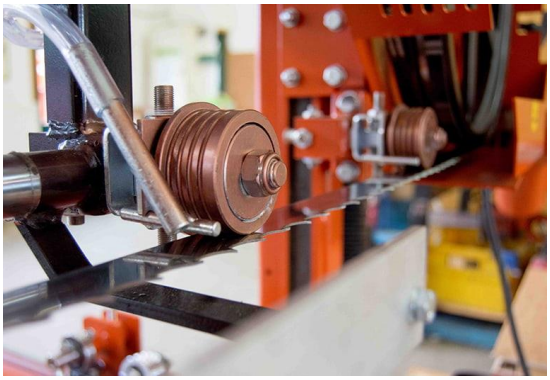
EXERCISE 2 h

A planer needs preventive maintenance. Perform complete check and lubrication and adjusting where needed

- Cover, fence, deflector, motor, checked
- Blade checked
- Transmission chain checked, belt checked, tension ok
- Cutter block checked ok

Maintain Band saw from sawmill to carpenters' shop

In order to maximise the sawing time regular maintenance and replacement of spare parts have to be done to avoid downtime.



1. Check the drive chain and belt
   - ✓ Clean chains from sawdust and dirt

- ✓ inspect tension of drive transmission and adjust
- ✓ Grease if necessary
- ✓ If you notice broken pins or links replace immediately

2. Adjust blade guides
    - ✓ Check deflection of guide roller (user manual)
    - ✓ Check alignment of blade using straight edge blade alignment tool
    - ✓ check condition of roller wear of collar, dept of grooves and condition of bearings
    - ✓ Replace roller if irregular shape or scratches
3. Check condition and tension of belt drives and adjust tension
4. Inspect the rod shield if the felt is sufficient greased and condition of sawdust scraper
5. Check oil level regularly and the condition of the hydraulic system

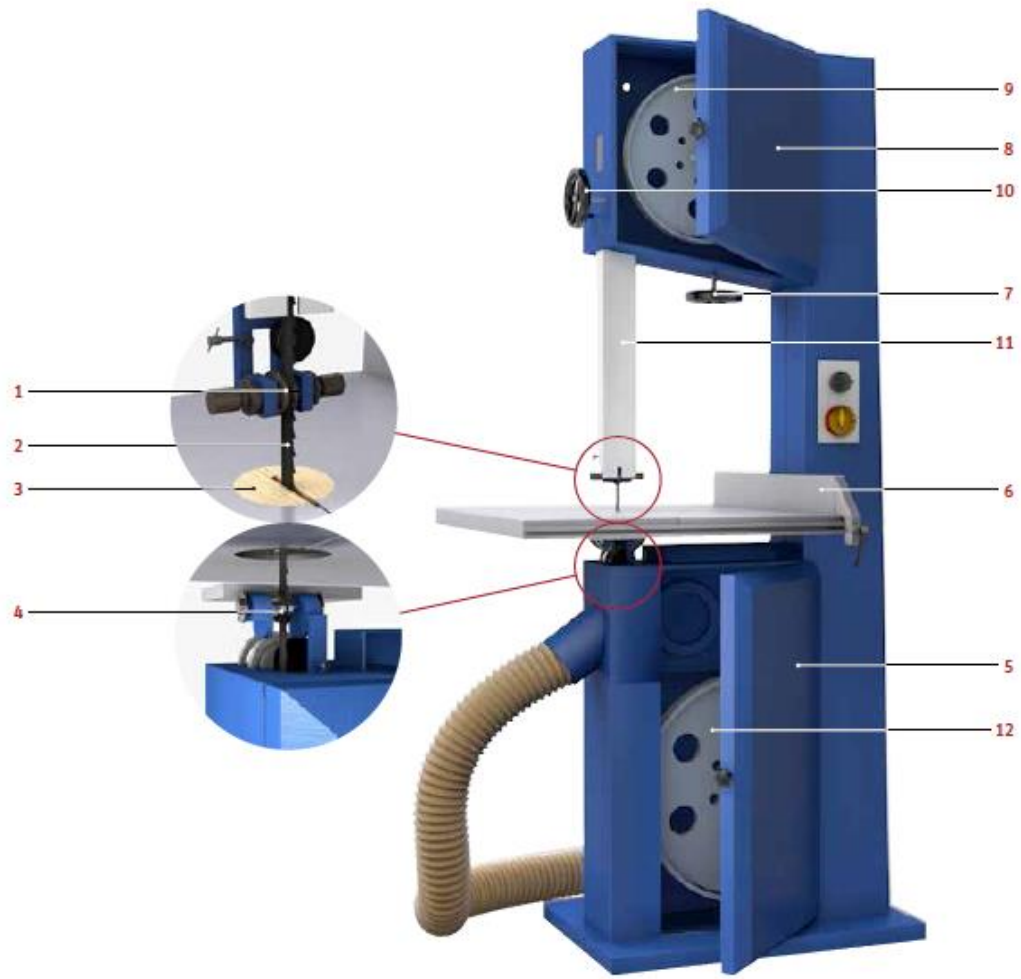
Standard spare part for sawmill/band saw:

- Belt
- Blade guide roller bearing
- Brushes
- Felt pad
- Roller bearings
- Fuses
- Blades

9.3 Bandsaw

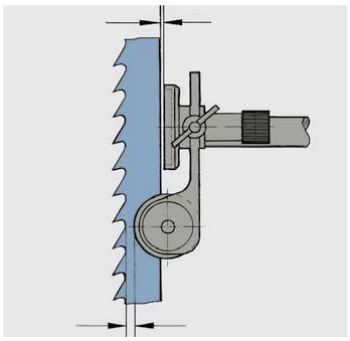
The band saw can do all cuttings in solid wood. But the quality of the cut is very low because of the slow cutting speed.

1. Upper bearing guide
2. Saw blade
3. Table mouth piece
4. Lower bearing guide
5. Wheel cover
6. Parallel fence
7. Hand wheel for sawblade tensioning
8. Upper wheel
9. Hand wheel saw blade cover
10. Sawblade cover



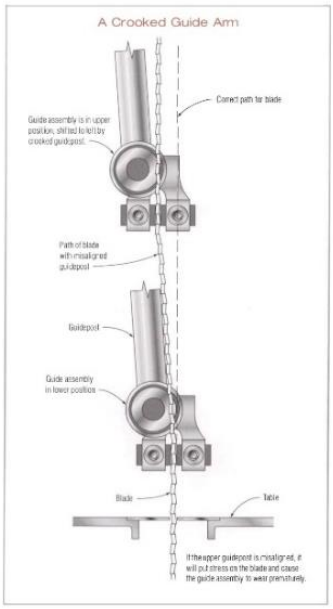
Set up: clean smooth adjusts:

- Bearing, belt, tracking assembly
- frame joint
- table trunnings
- lower blade guides
- wheel alignment
- table alignment



Setting of upper and lower guard

1. Lower sawblade guard
2. Machine table
3. Upper sawblade guard
4. Back bearing guard
5. Side bearing guard



Setting

Both bearings have to be as closed as possible to the sawblade to avoid twisting.

The bearing in the back has to avoid movement of the sawblade while pushing.

The sawblade is not touching the bearing without cutting operation.

Table mouth piece

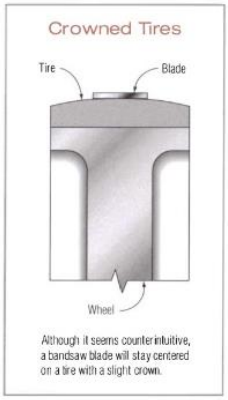
- Small opening
- No contact to the sawblade
- Cut off chips should not get stuck and overheat the sawblade by friction

Causes of blade cracking

- Badly brazed or more than 2 welded areas
- Cracked sawblade
- Twisting of sawblade in the cut
- Incorrect setting of guides
- Cut offs get stuck
- Incorrect alignment of the blade
- To fast force and to small radius

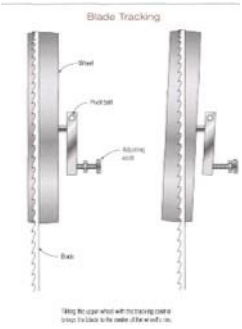
Wheels

- From steel plate of cast aluminium iron
- Rims of a wheel covered by rubber or cork with slight curve on surface called crown
- To pull blade to center
- Blade tracking by tilting to upper wheel
- Examine and clean remove sawdust and gum



Move the blade

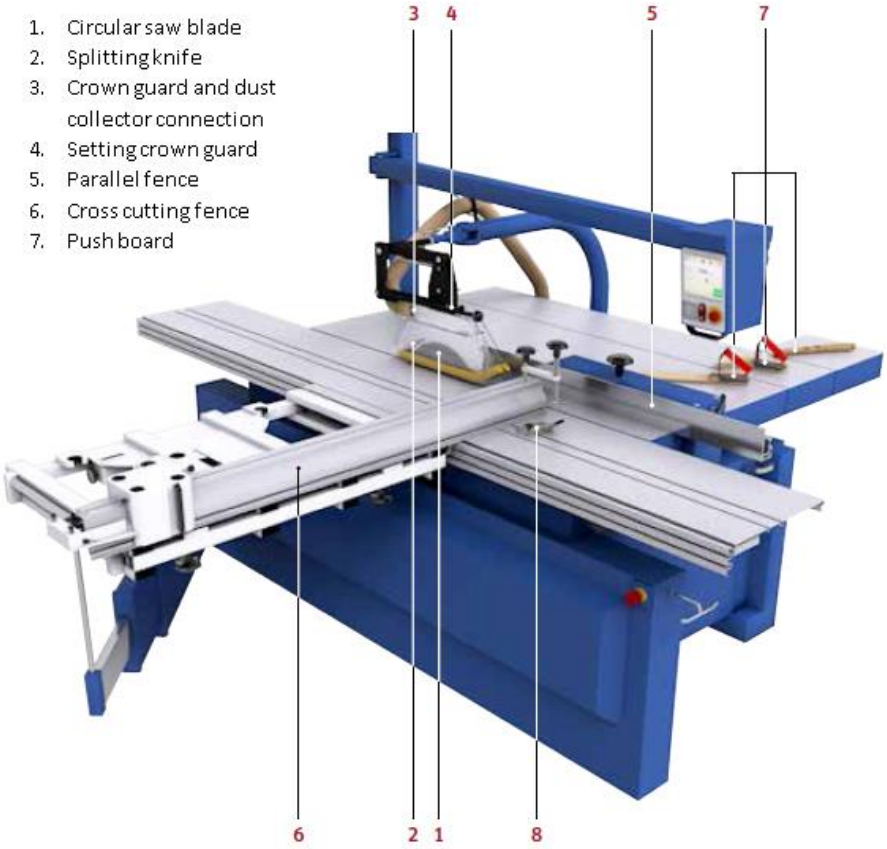
- Check belt drive
- Direct drive

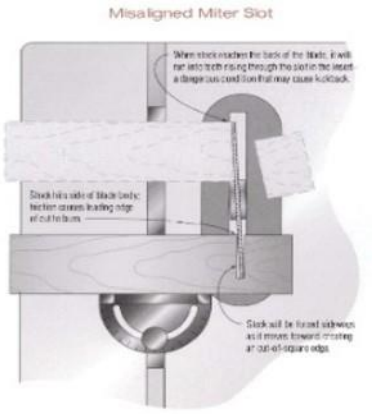


Guiding the blade

- Change when damaged
- Replace wood guides when worn

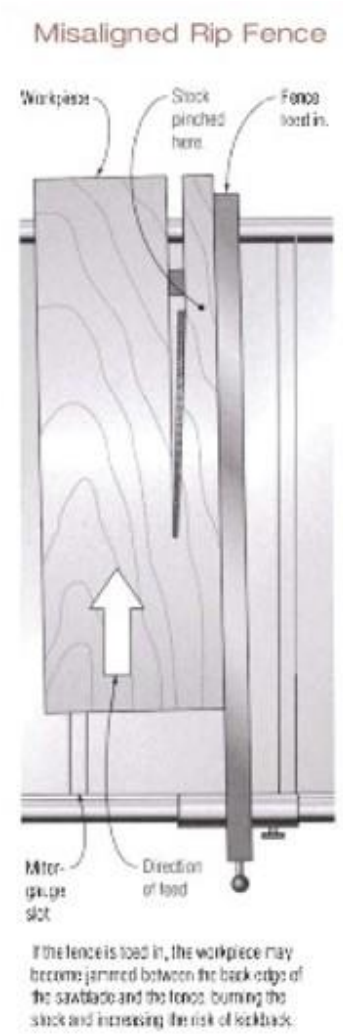
9.4 Circular saw





Inspect table saw:

- Clean and lubricate all movable parts
- Inspect belt pulley bearings
- Lubricate them
- Check table insert and replace if needed
- Check pulley belt bearing
- Align blade and miter gauge
- Align rip fence
- Blade tilt setting
- Miter gauge stops

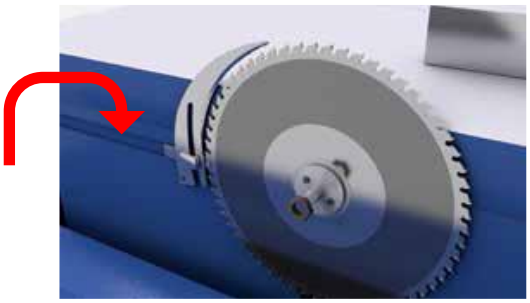


Picture by SUVA

Replace sawblades

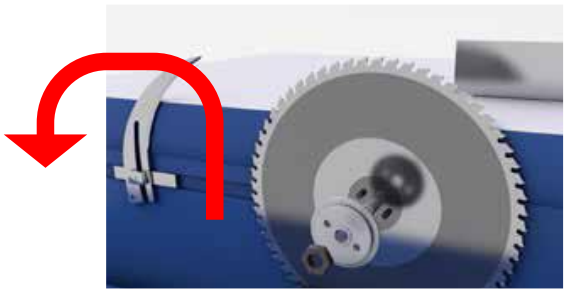
Remove the sawblade

- Switch off the machine or emergency switch
- Move the sawblade to the highest adjustment
- Block the collar
- open the nut in running direction
- Take off the sawblade
- Never place the blade on the machine table, it will damage the teeth



Fix the sawblade

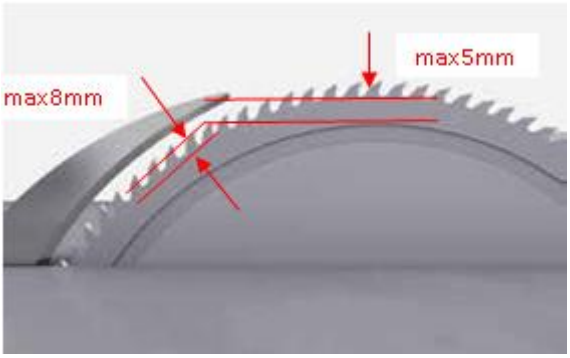
- Open the fixtures of the splitting knife and push it back
- Place the new blade on the spindle. Draw attention on the correct running direction
- Nut and washer will be fixed against the running direction.
- Release the spindle blocking element
- choose the correct splitting knife

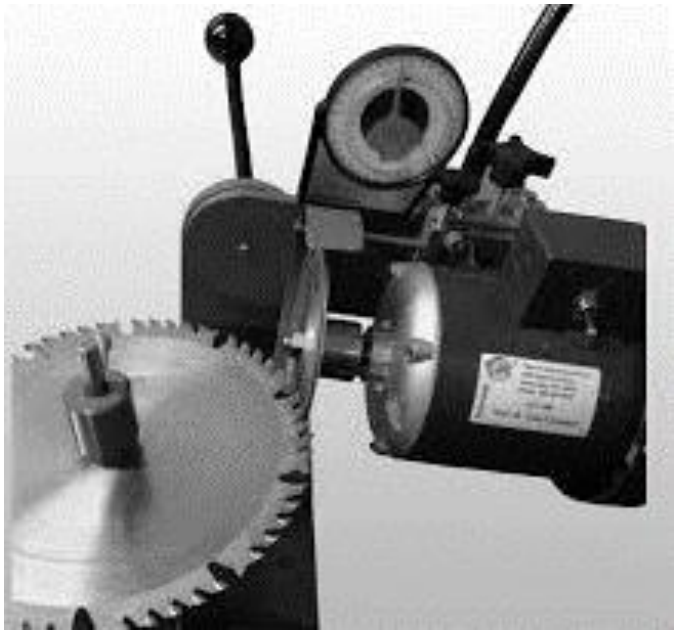


Splitting knife /riving knife

- The splitting or riving knife is fixed behind the sawblade. It keeps the cutting kerf open, to avoid kickback and clamping.
  The Kerf is getting closed if the splitting knife is not installed.
  The teeth will get clamped in the wood and move it in turning direction, causing a kick back
- The splitting knife has to be thinner than the teeth and thicker than the blade body

- Distance maximum 8mm
- Height max 5 mm below teeth
- Open the cutting kerf
- Hinder kick back
- Safe guard the back of the sawblade





LEARNING UNIT 10: OPERATE SHARPENING MACHINES FOR SAWBLADE AND CUTTER

10.1 Sharpening band saw blade – profile grinding

The difference of sawblades for sawmill or carpentry is mainly the moisture content of the material to be sawn. Milling Blades have to cut through green and wet wood. For sharpening process means the swaging needs to be wider than for carpenters' band saw. As a rule of the thumb swage, it twice the thickness of the plate and the sharpening wheel should be around half the length of the tooth pitch in thickness.

Band saws are highly sensitive. If maintained incorrectly, they may break. The reason for this is that band saws are subject to a constant bending cycle. This can cause hairline cracks to form in the tooth gullet, the area of highest tensile stress.

Cause of breakage:

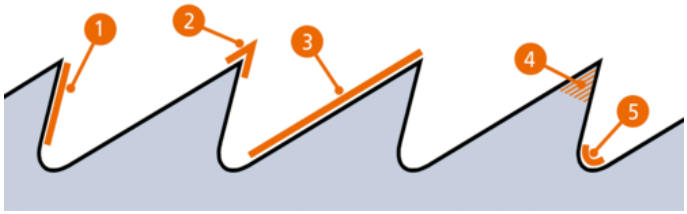
- Dull teeth
- Damaged teeth
- Feeding to fast
- Running bad saw without using
- Using wrong tooth pitch
- Not adjust or aligning blade

If the saw is not resharpened on time, these cracks grow and cause breakages. To prevent this, the whole profile, i.e., all of the teeth (irrespective of their shape) of band saws made of CV steel and stellated band saws must be regularly resharpened – even when the usual degree of bluntness has not been reached in some places. Regular profile grinding can prevent premature breaking of the band saws.

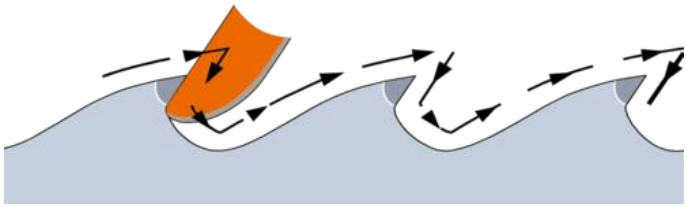
If profile grinding is not carried out professionally, problematic scratches and grooves form, while excessive chip removal hardens the tooth gullet. However, with the right profile grinding machines this is not a problem.

In order to prevent saws from becoming stuck during use, you need a side projection. Therefore, band saws made of CV steel must still be set, or alternatively, swaged and

levelled after profile grinding. In contrast, stellited band saws and carbide-tipped band saws require side grinding.

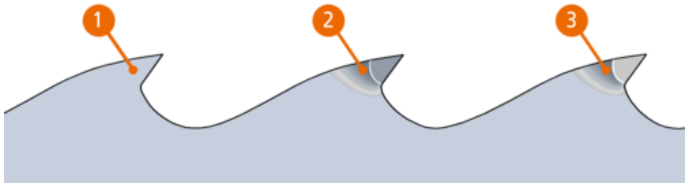


1 Tooth face 2. Tooth tip 3. Clearance surface (tooth top) 4. Tooth flank 5. Tooth gullet



Profile grinding sequence

Stellite band saws



1. Raw tooth 2. Tooth stellited into shape 3. Annealed and ground tooth

Stelliting refers to the process of applying Stellite® to the saw teeth and thereby hardening them. This increases the abrasion resistance of the saw cutting edges, which in turn leads to longer machine service life, increased cutting accuracy and reduced set-up times.

Stelliting is especially advantageous when particularly abrasive and hard woods are to be sawn. Stellite® no. 12 (containing 59 % Cobalt, 29 % chrome, 9 % tungsten and 1.8 % carbon) has proved to be extremely successful for machining wood. It is wear-resistant while not being too brittle, and can be ground without problems. In some cases, Stellite® no. 1 is used: This is an extremely hard alloy, which is primarily used for sawing wood with a high proportion of silicate.

In addition to painstaking manual stelliting, there are two types of machine stelliting: The resistive and the plasma welding process. During the latter, the saw tooth is heated and the required amount of stellite is melted. The liquid Stellite® is guided into forming jaws, where

the raw tooth is shaped into a finished tooth. The grinding work required is therefore reduced to a minimum. In contrast to the resistive process, fully automated plasma welding has the advantage that it forms a completely solid compound layer between the Stellite® and the base material. Last but not least, repairs or replacements are cost-effective, as new Stellite® is simply applied to the existing tooth, and the costly process of grinding off leftover Stellite® is not required.

EXERCISE 30'

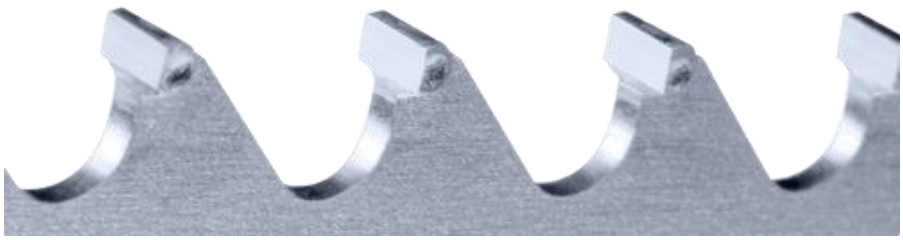
- Q1: how do you inspect sawblades?
- Q2: Why do sawblades break
- Q3: Why do you have to set the sawblade

- Q1: Check teeth, check for cracks check for bent, check alignment test run
- Q2: Dull teeth, damages teeth, feeding to fast, running machine without use, wrong pitch, blade not aligned
- Q3: Sawdust needs to be carried out

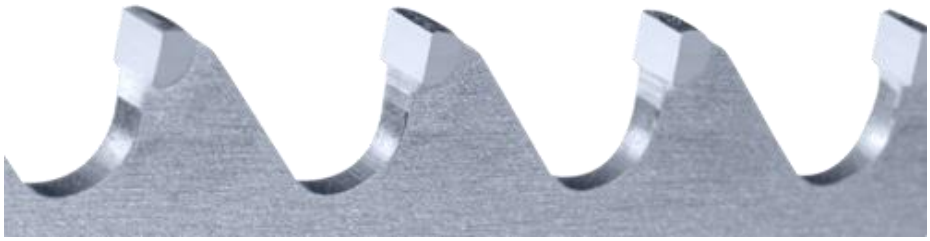
Sharpening carbide-tipped band saws

For carbide-tipped band saws, only the carbide-tipped tooth tips are ground. When doing this, the following sequence must be observed: First the tooth face, then the flank surface and then the tooth top.

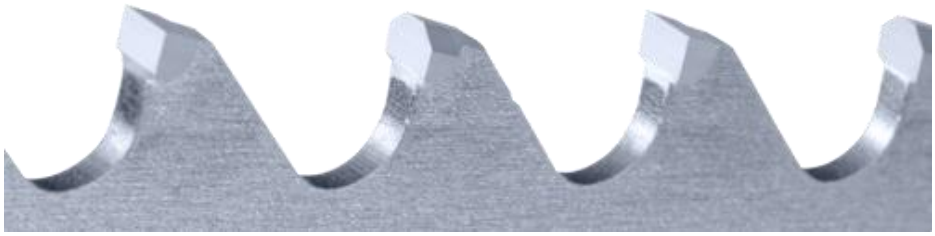
Unmachined saw blade



Machined tooth face



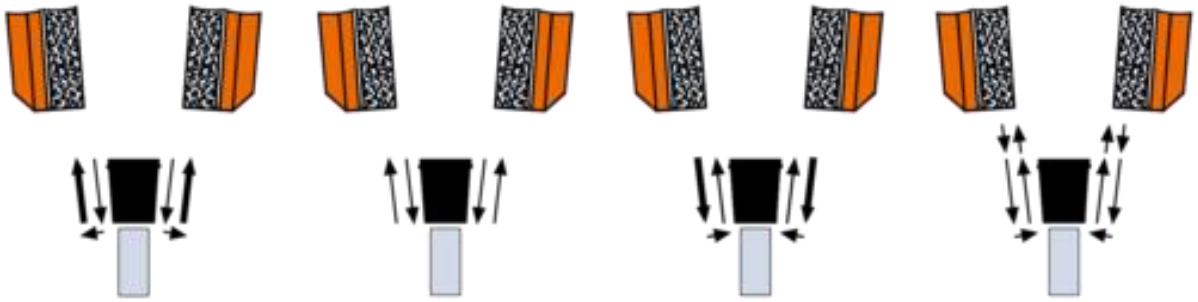
Machined flank



Machined tooth top

Side grinding band saws

Stellited saws must also be ground on the flanks after profile grinding. Even carbide-tipped band saws require side grinding. Irrespective of which tipping your band saws have, with the right grinding machines, you can machine the flanks correctly and extremely efficiently.



Four possible grinding programs

1. Sharpen downwards, lift, rapid movement back
2. Sharpen downwards, without lifting and back
3. Sharpen downwards, with feed and back
4. Oscillation grinding with free choice of number of feeds and strokes

Setting the band saw

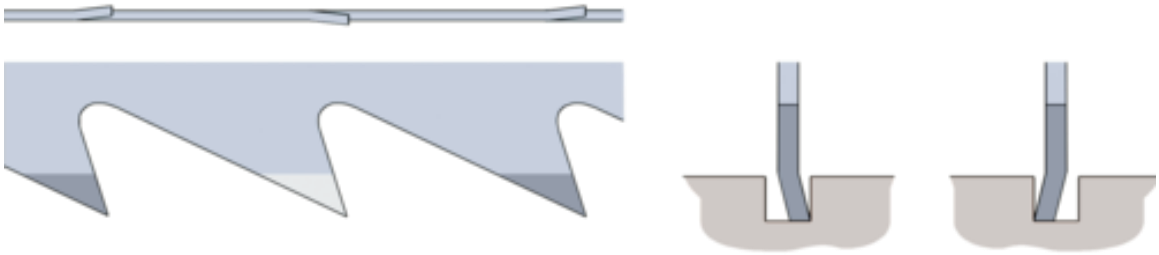
In order for a CV saw to be able to cut freely during machining, the saw kerf must be wider than the body. One possibility is to set the saw teeth, and therefore the alternating bending. When doing this, it must be ensured that the teeth are not set too much, otherwise the

cutting quality will be reduced. However, if the teeth are not set enough, the saw heats up, develops burn marks and loses tension.

☞ ***As a general rule, only the top third of the teeth should be set.***

However, the set width depends on various factors:

- Type of wood: The softer the wood, the greater the set width
- Wood moisture: The wetter the wood, the greater the set width
- Resin content: The higher the resin content, the greater the set width
- State of the wood: Frozen wood requires less set
- Type of wood fibre: Types of wood with extremely smooth fibres require more set

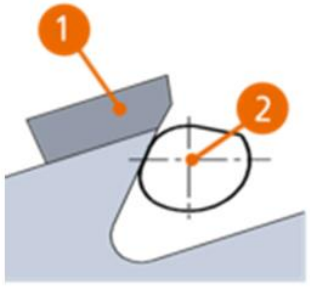


Swaging and levelling the band saw

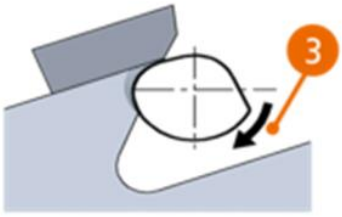
Swaging saw teeth is another possibility, along with setting, for ensuring that the band saw can cut freely during machining. For the swaging process, a swaging bolt is placed in front of the saw tooth. The saw tooth is held in place with an anvil. By turning the eccentric swaging bolt, the sawing material is pushed towards the tooth tip. When the swaging process has ended, the swaging bolt turns back to its starting position.

Levelling takes place after swaging, i.e. the material which was pushed towards the tooth flanks is pressed together with the appropriate equalising jaws, so that the tooth tip is conically tapered downwards and backwards. As the swaged saw tooth works on the entire kerf width, it carries out the same work which would be carried out by two teeth on a set saw. The cutting power is increased thanks to the greater number of main and minor cutting edges. In addition, the hardness grade of the base material is increased thanks to the swaging process.

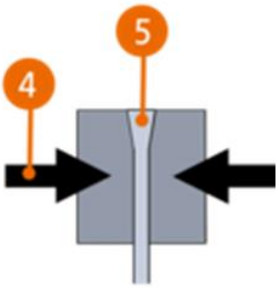
The swage must be adjusted for different types of wood in order to achieve the best possible performance.



1. Anvil 2. Swaging bolts



3. Swaging curve



4. Equalising jaws 5. Saw tooth

Levelling, tensioning and straightening band saw blades

Levelling refers to the process of eliminating irregularities (dents/bumps) in the band saw blade. This is usually carried out as the first maintenance work. After being located with a straight edge, dents can be "hammered out" using a ball or club hammer, whereby the weight of the hammer must be matched to the blade thickness.

The following guidelines apply when doing this:

- Hammer weighing 1250 g for blade thicknesses ≤ 1.65 mm
- Hammer weighing 1500 g for blade thicknesses > 1.65 mm

Hammers should have soft, rounded striking surfaces so that they do not leave any imprints on the band saw blades, as this could negatively impact on the service life of the blade.

Tensioning or stretching means extending the middle zone of the band saw blade. This is carried out by rolling using a rolling machine. By stretching the middle zone, the toothing side and the rear edge become shorter in relation to the middle. As a result, when fitting the saw blade to the rollers in the sawing machine, the compressive stresses are released and the saw blade forms a curve in the middle. This prevents the saw blade from shifting back and forth at the most convex contact surface of the roller.

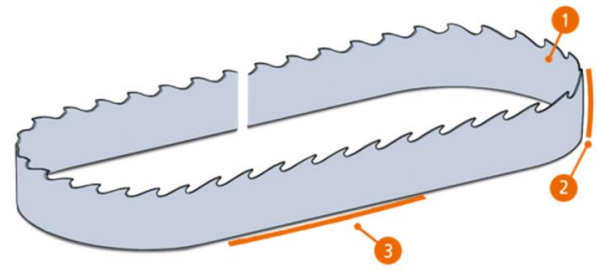
When tensioning is carried out correctly, the blade has the following characteristics:

- The tooth edge is rigid and runs especially quietly during operation.
- The blade lies correctly on the rollers and withstands the stresses caused by high feed rates.

- The blade is not prone to drifting. Cutting quality and accuracy is maintained thanks to correct tensioning.

During straightening, the top of the band saw receives a slightly convex bowed shape using rollers. This balances out the extension of the toothing side when the saw is used. The final grinding process for the tooth gullet also causes the tooth baseline to be extended compared with the top. The condition of the saw blade must be checked along the entire top edge.

Measuring, straightening, tensioning and levelling: What used to be a labour-intensive manual task is now possible in one clamping operation.



1. Levelling **2. Tensioning** **3. Straightening**

Welding band saw blades

Welding is required to join band saw blades or repair cracks. The ends of the saw blades must be cut exactly square beforehand, and the cut surfaces must be cleaned. When this is done, the welding seam is laid on the top of the tooth. The point to be welded is then preheated to approx. 100 °C using a heating plate. After the welding operation, the blade must again be annealed to approx. 450 °C, so that the hardened structure returns to normal and the weld bead does not tear.

Source: wood mizer

Swaging bandsaw blade

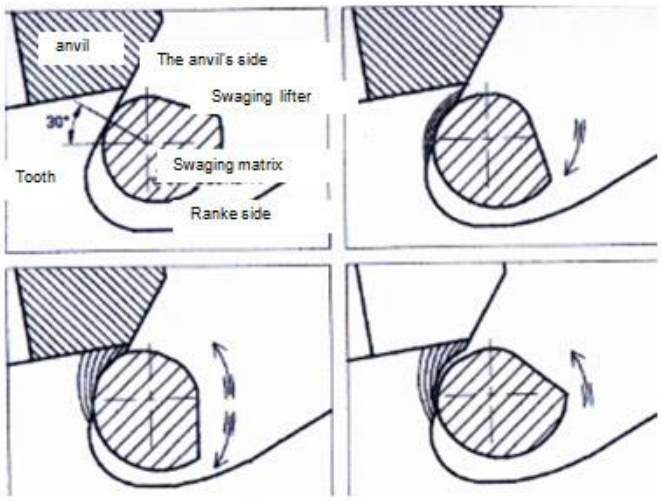
Swaging consists in widening the tooth upsetting metal equally on each part of the rake side.

The swaging is done with two tools:

- The swaging die that upset metal by rotating
- The anvil that prevents the metal from going on the upper side of the tooth.

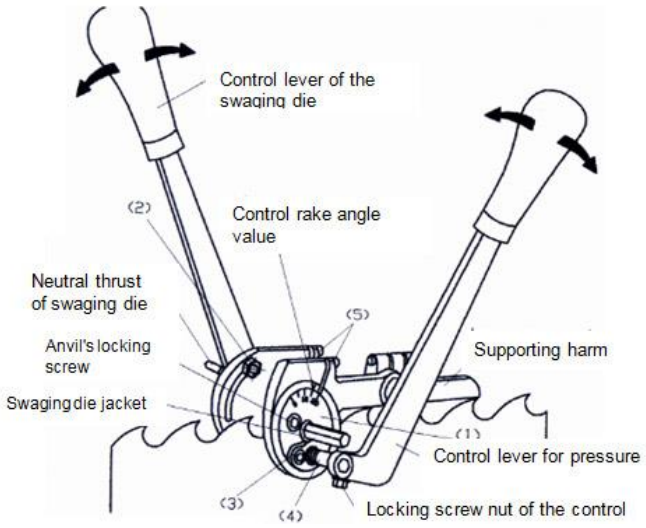
Those tools can be fixed on:

- A manual device
- A pneumatic device
- An automatic machine



Former devise type

They break chip at the end of the swaging but they loose some degrees on the rake angle (4° à 5°). To swage again with these devices, it is necessary to sharpen previously the blade to level it and to suppress a major part of the former swaging. Then, it is necessary to put chalk of greasepaint or swaging clay on all the rake areas.

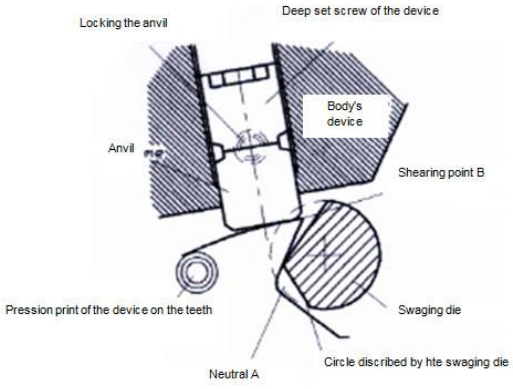


Functioning:

Choosing the anvil depends on the rake angle: more the rake angle is significant, more the chamfer of the anvil is small.

The swaging die varies according to the height of the rake side.

- Diameter 10 mm: height of rake side is minimum 7 mm.
- Diameter 12 mm: height of rake side is minimum 8.5 mm.



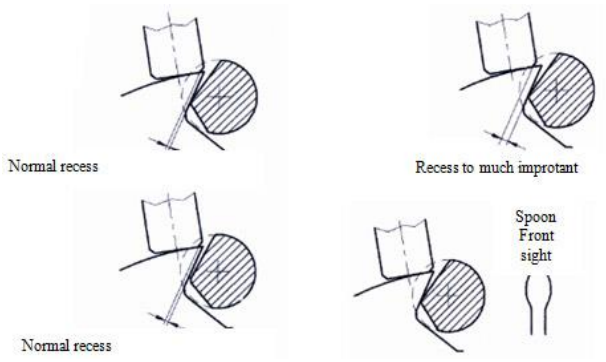
Settle the cutting point by coming down lightly the anvil and by rotating the swaging die until there is a small resistance. By forcing a bit more on the swaging die, it can be possible to go freely to the thrust of the swaging die haft. This thrust will be settled a few milimiters near the cutting point.

Then put the device on the blade to settle the clearance angle. It consists in positioning the anvil flat on the tooth's back.

On devices EUROPA MFLS type

There is not any cutting point, the anvil is buttressed onto the swaging die. The latter is in high position, the lever on the right. To adjust the device on the blade according to the clearance angle, it is necessary to withdraw the swaging die and to check thanks to its seating if the anvil is put flat on the tooth.

When reassembling, make sure the swaging die is in the right direction, for new blade it is necessary to swage the blade two time and to the swaging device between each removal. To swage again a blade, it is done on the former swaging, only one removal is necessary. Do not forget the chalk of greasepaint or swaging clay.



These devices are designed in order to lengthen the metal forward so that the rake angle is slightly reduced.

Before swaging make sure the blade is adjusted respect to the anvil by adjusting locking screws

Then swage the blade and check the kerf value on each side of the tooth.

Bad swaging reason is:

- The sharpening machine is badly adjusted.
- The device is badly adjusted on the blade.
- The swaging die or the anvil is damaged.
- Swaging device sleeve or the device’s body is worn.
- Locking screws are worn.

When the blade is swaged then the sides are dressed.

For a swaging without broke chip, it is necessary to sharpen two times to equalize and strengthen teeth's lines. Side dressing is used for giving the same removal value to all the teeth, a front and side clearance to the swaging and to strengthen the latter due to a side upsetting.

To adjust the device, put the anvils or jaws of side dressing against the blade and put the lever in clamping position. This adjustment is to be done each time there is a significant difference in blade's thickness. The side dressing value will be given by moving the buttress that position the device respect to the tooth side.

Dressing do not correct a bad adjusting of the swaging. To correct it, side dressing thanks to grinding wheels can be used after swaging manually which increase the quality and the regularity of the removal

Circular saw sharpening

Circular saw

A pre sharpened saw blade is clamped into the machine. The reciprocating mechanism for alternate slot cutting and the depth of the chip breaker slots are set by the means of adjusting screws. The values for alternate slot cutting can be checked by a dial gauge.

The built-in electronic teeth counter stops the machine automatically after the number of present teeth are completed. The machine is fitted with an air operated high speed grinding spindle. The standard grinder is for wet grinding. The machine is also suitable for sawblades with variable tooth pitch.

Depending on the desired wood cutting efficiency, choose between the following three types of blades:

Set tooth blades

Are easier to fabricate, and the initial investment is smaller. Moreover, they are easy to maintain.

Swage tooth blades

Offer high cut efficiencies, but their maintenance in an expensive technology.

Stellite tooth blades

Offer the highest cut efficiency, and because of this reason as well as from an economical point of view they are the best, especially due to the increased cutting speed and durability while cutting. On

EXERCISE 20'

- Q1: Describe swaging and why it is needed
- Q2: What are set tooth blades?
- Q3: What is the effect on improper swaging
- Q 4: Why do teeth need shaping
- Q5: What is a commonly used shaper

- Q1: Swaging opens the cutting curve and offers high cut efficacy
- Q2: Set tooth blades are easy to fabricate, investment small, easy to maintain
- Q3: Machine is badly adjusted, die is damaged devise body is worn
- Q4: The tip has to be formed perfect for cutting operation tooth face, flank top
- Q5: Grinding stone for sharpening of sawblades

Planer knife sharpening

A heavy column of cast steel carries the guide rails for the mobile grinding unit and encloses the cooling tray with the grinding bed. The blades to be sharpened are fixed on the clamping plate mechanically or electromagnetically. The cooling liquid is supplied through the hollow shaft of the grinding motor. The sharpening wheel is fed automatically and steplessly.

Clean the clamping plate each time before a blade is to be mounted. Make sure that the guide rails for the sharpening unit are absolutely clean. Check the coolant cleaning system for operational reliability. Regularly lubricate and clean the machine.

Sharpen low tech manually using a homemade jig:

320 sandpapers glued with tension then honing with 8000 water stone

EXERCISE 120'

Task: Sharpen a planer knife at a planar sharpening machine

- Inspection of blade
- Inspection of machine
- Set of a cutter
- Set of a machine
- Correct coolant
- Sharpening is done according to manufacturer description
- Honing is done
- Result is tested
- All performance according to ohs and ppe

LEARNING UNIT 11: USE TROUBLESHOOTING TECHNIQUES FOR BREAKDOWN MAINTENANCE

11.1 Machine Trouble Shooting

Trouble-shooters are highly skilled workers, but unfortunately, they are becoming an increasingly rare breed in the workforce. Training courses can only teach the basics, while the real troubleshooting skills were learned on-the-job over a long time period from shadowing highly skilled, experienced maintenance personnel.

The real issue is that effective troubleshooting is essential for any manufacturer to stay competitive in today's tough markets. Quick and effective machine troubleshooting is vital to keep paper-thin profit margins from slipping into the red. This places a huge responsibility on technical instructors to prepare workers to hit the ground running on day one.

Since promising young trouble-shooters to take years acquiring troubleshooting skills on the job is not feasible, teaching these skills in a classroom environment is essential. Future technicians and operators must gain real-world troubleshooting experience before they reach the production floor.

Therefore, institutions such as community colleges and company training centers must be able to create equipment issues in many combinations to build troubleshooting expertise. Use of training equipment with the ability to insert a wide range of realistic faults into a system is critical so that workers can gain hands-on experience diagnosing and fixing the broad range of problems seen in the real world.

Effective troubleshooting, regardless of the specific technology, follows six basic steps:

1. Identify the symptoms.
2. Isolate the problem to a particular component.
3. Establish a theory for the cause
4. Test the suspected component.
5. Repair or replace the component.
6. Test the System

Identifying a malfunctioning machine's symptoms is absolutely critical because it can shorten the troubleshooting process by placing the focus on only those components capable of causing those particular problems.

Teaching future troubleshooters to *first ask the operator* to identify any observed symptoms in a malfunctioning machine is essential. Let's face it; no matter how well a troubleshooter is trained, the operator that daily runs and monitors that particular machine is vastly more familiar with its operation than anyone else and their input is critical at this stage. Too often, inexperienced troubleshooters assume they know the answer when they truly don't understand the question.

When training troubleshooters, it is important to teach them not to overlook this extremely valuable resource. Once the operator has identified the machine's specific symptoms, drawing useful conclusions concerning the fault that is causing the problem is much simpler.

For example:

A well-trained trouble-shooter should be able to quickly categorize the problem into:

- **Machine Sequence**: Relate to the order in which events occur including actuator movements, pressure changes, or speed changes
- **Machine Performance:** Refer to characteristics of an actuator's motion or output, such as speed or force output
- **System Related**: Denotes overall system characteristics such as vibration, fluid temperature, overall system pressure, fluid leaks, etc.

Once the problem is categorized, a testing methodology should be used to properly identify the failed component.

- **Shotgun** :Tests every component or connection in affected area until the problem is located movements, pressure changes, or speed changes
- **Half-Split**: Continually tests a point halfway between a known good test point and a known bad test point until problem is identified
- **Output-Back**: Starts testing the system outputs and systematically works back towards the inputs until problem is located

- **Symptom & Cause**: Isolates the problem according to whether or not the component could cause the observed symptoms

Trouble-shooters must not only understand a component's function, but how it operates internally to achieve that function.

EXERCISE 20'

- Q1: List the 6 steps of troubleshooting
- Q2: Why does trouble shooting need experience
- Q3: What can help to identify the trouble?

- Q1: Identify the symptoms. Isolate the problem to a particular component. establish a theory for the cause Test the suspected component. Repair or replace the component Test the System
- Q2: Massive knowledge on machine operation is needed and plenty years of mechanical maintenance performance to recognise problems and apply trouble shooting techniques
- Q3: Get information from the machine's operator

11.2 Band saw

- Poor quality cut
- Vibration
- Poor blade tracking

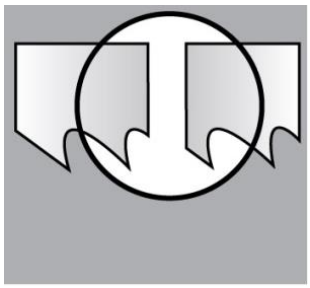
Bad cut

- Bow cut when sawing thick stock
- Blade wanders to one side
- Bowed blade binds in the cut and overheat blade
- Straight cut need widest blade
- Curved cut needs blade according to curve

The wheel rubber is damaged and worn dressing the wheel

Problem 1: Premature Band Saw Blade Breakage- Straight break indicates fatigue.

Cause of the problem:

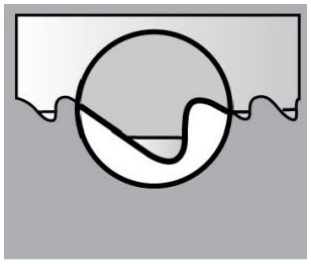


- Incorrect band saw blade- teeth too coarse
- Blade tension too high
- Side guides too tight
- Damaged or misadjusted band saw blade guides
- Excessive feed
- Incorrect cutting fluid
- Wheel diameter too small for band saw blade
- Band saw blade rubbing on wheel flanges
- Teeth in contact with work before starting saw
- incorrect blade speed
- Solutions:
- Use finer tooth pitch
- Reduce band saw blade tension
- Check side guide clearance
- Check all guides for alignment/damage
- Reduce feed pressure
- Check coolant

- Use thinner blade
- Adjust wheel alignment
- Allow 1/2" clearance before starting cut
- Increase or decrease blade speed.

Problem 2: Premature Dulling of Teeth

Cause of the Problem:

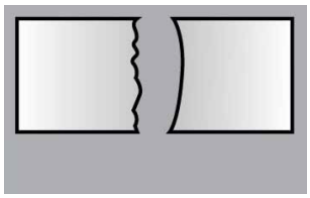


- Teeth pointing in the wrong direction/ band saw blade mounted backwards
- Improper or no blade break-in
- Hard spots in material
- Material work hardened
- Improper coolant
- Improper coolant concentration
- Speed too high
- Feed too light
- Teeth too small

Solutions:

- Install band saw blade correctly. If teeth are facing the wrong direction, flip blade inside out.
- Break in blade properly (maintain proper blade speed for the material being cut). Reduce blade feed pressure or feed rate by 50% for the first 50 to 100 square inches of material cut. Gradually increase feed pressure or feed rate after break-in to target proper feed rate.
- Check for hardness, or hard spots like scale or flame cut areas
- Increase feed pressure or feed rate
- Check coolant type and coolant mixture
- Check recommended blade speed
- Increase feed pressure
- Increase tooth size

Problem 3: Inaccurate Cut



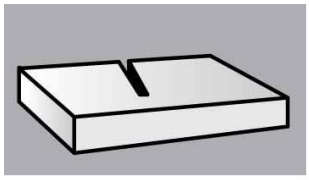
Cause of the Problem:

- Tooth set damage
- Excessive feed pressure
- Improper tooth size
- Cutting fluid not applied evenly
- Guides worn loose
- Insufficient blade tension

Solutions:

- Check for worn set on one side of blade
- Reduce feed pressure
- Check Tooth size chart
- Check coolant nozzles
- Tighten or replace guides, check for proper alignment
- Adjust to recommended tension

Problem 4: Band Leading in Cut



Cause of the Problem:

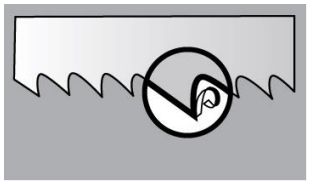
- Over-feed
- Insufficient blade tension
- Tooth set damage
- Guide arms loose or set too far apart
- Chips not being cleaned from gullets
- Teeth too small

Solutions:

- Reduce feed force
- Adjust recommended tension
- Check material for hard inclusions

- Position arms as close to work as possible and tighten
- Check chip brush
- Increase tooth size

Problem 5: Chip Welding



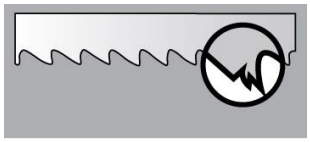
Cause of the Problem:

- Insufficient coolant flow
- Wrong coolant concentration
- Excessive speed and/ or pressure
- Tooth size too small
- Chip brush not working

Solutions:

- Check coolant level and flow
- Check coolant ratio
- Reduce speed and/or pressure
- Use coarse tooth pitch
- Repair or replace chip brush

Problem 6: Teeth Fracture- Back of tooth indicates work spinning in clamps



Cause of the Problem:

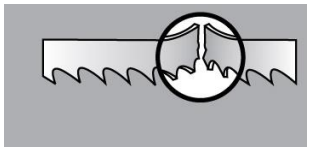
- Incorrect speed and/or feed
- Incorrect blade pitch
- Saw guides not adjusted properly
- Chip brush not working
- Work spinning or moving in vise

Solutions:

- Check the cutting chart (Cutting Chart)
- Check tooth size chart (Tooth Size Chart)
- Adjust or replace saw guides
- Repair or replace chip brush

- Check bundle configuration/ adjust vise pressure

Problem 7: Irregular Break



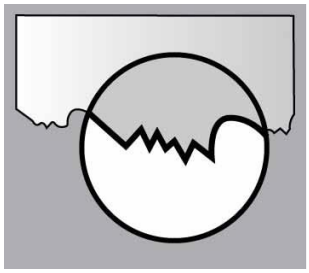
Cause of the Problem:

- Indexing out of sequence
- Material loose in vice

Solutions:

- Check proper machine movement
- Check vise or clamp

Problem 8: Teeth Stripping



Cause of the Problem:

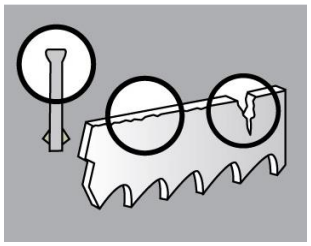
- Feed pressure too high
- Tooth stuck in cut
- Improper or insufficient coolant
- Incorrect tooth size
- Hard spots in material
- Work spinning in vise- lose nest or bundle
- Band saw blade speed too slow
- Blade teeth running backwards
- Chip brush not working

Solutions:

- Reduce feed pressure
- Do not enter old cut with a new blade
- Check coolant flow and concentration
- Check tooth size chart
- Check material for hard inclusions
- Check clamping pressure- be sure work is held firmly

- Increase blade speed
- Reverse blade (turn inside out)
- Repair or replace chip brush

Problem 9: Wear on Back of Band Saw Blades



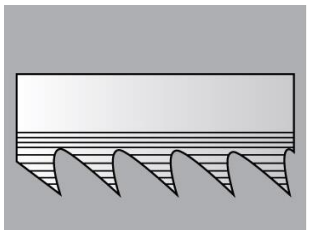
Cause of the Problem:

- Excessive feed pressure
- Insufficient blade tension
- Back-up guide roll frozen, damaged or worn
- Band saw blade rubbing on wheel flange

Solutions:

- Decrease feed pressure
- Increase blade tension and readjust guides
- Repair or replace back-up roll or guide
- Adjust wheel can't

Problem 10: Rough cut (Washboard surface, Vibration and or chatter)



Cause of the Problem:

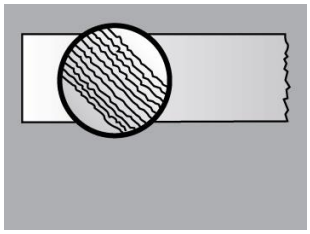
- Dull or damaged blade
- Incorrect speed or feed
- Insufficient blade support
- Incorrect tooth pitch
- Insufficient coolant

Solutions:

- Replace with new blade
- Increase speed or decrease feed

- Move guide arms as close as possible to the work
- Use finer pitch band saw blade
- Check coolant flow

Problem 11: Wear Lines, Loss of set



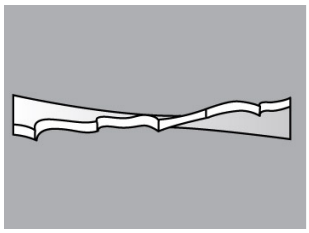
Cause of the Problem:

- Saw guide inserts or wheel flange are riding on teeth
- Insufficient blade tension
- Hard spots in material
- Back-up guide worn

Solutions:

- Check machine manual for correct blade width
- Tension blade properly
- Check material for inclusions
- Replace guide

Problem 12: Twisted Blade- Profile Sawing



Cause of the problem:

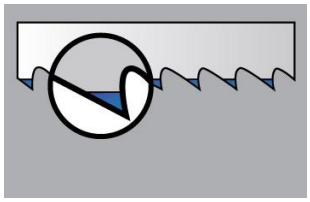
- Blade binding in cut
- Side guides too tight
- Radius too small for blade width
- Work not firmly held
- Erratic coolant flow
- Excessive blade tension

Solutions:

- Decrease feed pressure
- Adjust side guide gap

- Use narrower blade
- Check clamping pressure
- Check coolant nozzles
- Decrease blade tension

Problem 13: Blade wear- Teeth Blued



Cause of the Problem:

- Incorrect band saw blade
- Incorrect feed or speed
- Improper or insufficient coolant

Solutions:

- Use coarser tooth pitch
- Increase feed or decrease speed
- Check coolant flow

EXERCISE 20'

Problems:

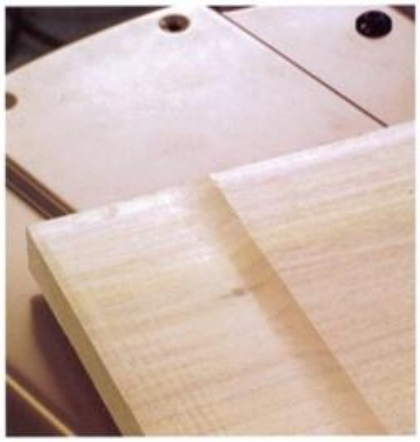
- Band leeding in cut
- Break of bandsaw
- Snipe at the end of surface
- Machine is not running
- Sawblade burns on rip fence side

Solution

- Check guide arms tension size of teeth
- Check tension, check guides, lower feed
- Check pressure bar, bedroller, support of board at end
- Check fures
- Check free cut align fence parallel

11.3 Planer surface

Snipe:



- Stock lifts on the table allowing knives to cut too deep
- Long boards are not supported and lever end off
- Pressure bar adjustment
- Chip breaker alignment
- Bed roller adjustment (1 mm above table)
- Bed roller to high causes reverse snipe

Stock not feeding:

- Check condition of roller and table/dirt and pitch
- Wipe table surface
- Don’t scratch the table
- Take rust of with steel wool and oil and wax it
- Take a care not to was feed roller
- Check bed roller
- If outfeed roller is from rubber check if rubber is still soft
- Check bearing surface of chip breaker and pressure bar
- Dull knives try different area to check if this is the reason
- Check v belt if slipping
- Check pulley or chain drive if loose

Rough finish surface

- Dull knives

- Knick in the knives
- One knife is set higher than other (hear it at high-speed different sound)
- Small dings in the surface from chips under the blades

EXERCISE 20'

- Name the 6 principles of troubleshooting and describe how you apply it at a machine

1. Identify the symptoms.
2. Isolate the problem to a particular component.
3. establish a theory for the cause
4. Test the suspected component.
5. Repair or replace the component.
6. Test the System

11.4 Circular saw

Fault	Cause	Troubleshoot
Machine cannot be switched on	- Main switch off	- Switch on
	- Power failure	- Check factory fuse
	- Emergency stop button pressed	- Release stop bottom
	- Machine frame door opened	- Close the door
	- Control circuit fuse defect	- Check fuses replace
Machine switches off automatically	- Factory fuse	- Eliminate cause
	- Overload protection has responded due to blunt saw blade excessive feed speed	- Change blade or reduce feed speed - Cool down motor
Work piece jammed while feeding forward	- Blunts saw blade	- Fit sharp saw blade
	- Riving knife thickness does not match saw blade use	- Fit correct riving knife
The finished size of the work piece does not match the set cutting width	- Dimension scale for cutting width display is misadjusted... Incorrect calibration for DIGIT_X, CONTROL	- Reset the dimension scale: Cut a workpiece at the rip fence, precisely measure the cut width and position the measuring scale so that the measured cut-ting width is displayed on the fence edge
The finished size of the cut workpiece does not match the cutting width set on the crosscut stop.	- Dimension scale for cutting width display is misadjusted.	- Reset the dimension scale: cut a workpiece at the crosscut stop, precisely measure the cut width and position the measuring scale so that the magnifying glass display matches the measured cut width.
Sliding table has late-rail play.	- Sub-rollers incorrectly set.	- Set the sub-rollers.
In its end positions, the sliding table is higher than the machine table.	- Sub-rollers incorrectly set.	- Set the sub-rollers
Saw blade burns on the sliding table side.	- Insufficient free cut on sliding table Readjust the free cut. - Excessive free cut on the rip fence	- Readjust the free cut. - Readjust the rip fence.
Saw blade burns on the rip fence side.	- Insufficient free cut on rip fence	- Readjust the free cut.

Saw blade burns on both sides.	- Incorrect free cut set-ting. - Work piece jammed. - - Operating error	- Readjust the free cuts. - Insert a riving knife in the cutting line or use a wider riving knife - Guide the work piece either at the LH or the RH fence. Do not guide the work piece on the rip fence when cutting with the sliding table.
Work piece has burn marks.	- Blunt saw blade - Feed too low - Saw blade has too many teeth. Incorrect free cut	- Change the saw blade. - Increase the feed rate - Change the saw blade - readjust the free cut
Break outs in spite of scorer	- Scorer not aligned with the main saw blade - Scoring blade to narrow	- Readjust fee cut the free cut should be almost 0 - Adjust saw width
Work piece rises when cut with the scorer	- Blunt scoring blade - Cutting height to low	- Exchange the sawing blade - Set scoring blade higher