
Basic Machine Shop Training

Missouri S&T
SDEL

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General Metal Working Safety

What are some basic tips to know when using metalworking machines?

Metalworking machines can be dangerous if not used properly. Read the owner's manuals carefully. Make sure you receive complete instructions and are properly trained before using any tool or machine.

- Check and adjust all safety devices before each job.
- Ensure that the guards are in position and in good working condition before operating.
- Ensure that all stationary equipment is anchored securely to the floor.
- Ensure all machines have a start/stop button within easy reach of the operator.
- Each machine should have only one operator at one time. However, everyone should know how to stop the machine in an emergency.
- Ensure that keys and adjusting wrenches have been removed from the machine before turning on the power. Provide a convenient tool rack.
- Ensure that all cutting tools and blades are clean and sharp. They should be able to cut freely without being forced.
- Stop the machine before measuring, cleaning or making any adjustments.
- Use a vacuum, brush or rake to remove cuttings. Do not handle cuttings by hand because they are very sharp.
- Keep hands away from the cutting head and all moving parts.
- Avoid awkward operations and hand positions. A sudden slip could cause the hand to move into the cutting tool or blade.
- Return all portable tooling to their proper storage place after use.
- Clean all tools after use.
- Keep work area clean, well swept, and well lit. Floors should be level and have a non-slip surface.
- Ensure there is enough room around the machine to do the job safely.
- Obtain first aid immediately for all injuries.
- Understand that the health and fire hazards can vary from material to material. Make sure all appropriate precautions are taken.

What should you avoid doing when using metalworking machines?

- Do not distract an operator. Horseplay can lead to injuries and should be strictly prohibited.
- Do not wear loose clothing, gloves, neckties, rings, bracelets or other jewelry that can become entangled in moving parts. Confine long hair.
- Do not remove cuttings by hand. Wait until the machine has stopped running to clear cuttings with a vacuum, brush or rake.
- Do not leave machines running unattended. Turn power off.
- Do not free a stalled cutter without turning the power off first.
- Do not clean hands with cutting fluids.
- Do not use rags near moving parts of machines.
- Do not use compressed air to blow debris from machines or to clean dirt from clothes.

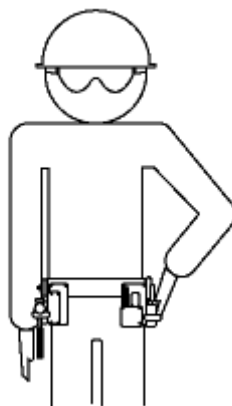
What personal protective equipment might I need?

- Use the appropriate safety equipment for the job. Wear ANSI Z-87 certified safety glasses with side shields or goggles. Prescription eye glasses are not substitutes for safety glasses.
- Wear respiratory protection where required.
- Wear hearing protection when required. If you have trouble hearing someone speak from one meter (three feet) away, the noise level from the machine is too high. Damage to hearing may occur.

Hand Tools

What are some basic tips when using hand tools?

- Always provide training on how to choose the right tool for the job, how to correctly use each tool, and how to identify when tools need repair.
- Select the right tool for the job. Substitutes increase the chance of having an accident.
- Use tools designed to allow wrist to stay straight. Avoid using hand tools with your wrist bent.
- Ensure that employees are properly trained in the safe use of hand tools.
- Use good quality tools.
- Keep tools in good condition at all times.
- Inspect tools for defects before use. Replace or repair defective tools.
- Keep cutting tools sharp and cover sharp edges with suitable covering to protect the tool and to prevent injuries from unintended contact.
- Replace cracked, splintered, or broken handles on files, hammers, screwdrivers, or sledges.
- Ensure that the handles of tools like hammers and axes fit tightly into the head of the tool.
- Replace worn jaws on wrenches, pipe tools and pliers.
- Redress burred or mushroomed heads of striking tools.
- Pull on a wrench or pliers. Never push unless you hold the tool with your palm open.
- Point sharp tools (e.g., saws, chisels, knives) laying on benches away from aisles and handles should not extend over the edge of the bench top.
- Maintain tools carefully. Keep them clean and dry, and store them properly after each use.
- Carry tools in a sturdy tool box to and from the worksite.
- Wear safety glasses or goggles, or face shield, and well-fitting gloves appropriate for the hazards to which you may be exposed when doing various tasks.
- Keep the work environment clean and tidy to avoid clutter which may cause accidents.
- Use a heavy belt or apron and hang tools at your sides, not behind your back.



What should I avoid when using hand tools?

- Do not use tools for jobs they are not intended to do. For example, do not use a slot screw drivers as a chisel, pry bar, wedge or punch or wrenches as hammers.
- Do not apply excessive force or pressure on tools.

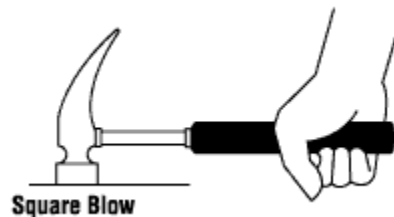
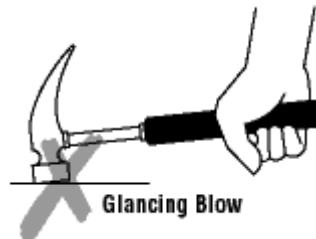
- Do not cut towards yourself when using cutting tools.
- Do not hold the stock in the palm of your hand when using a cutting tool or a screwdriver.
- Do not wear bulky gloves to operate hand tools.
- Do not throw tools. Hand them, handle first, directly to other workers.
- Do not carry tools in a way that interferes with using both hands on a ladder, while climbing on a structure, or when doing any hazardous work. If working on a ladder or scaffold, tools should be raised and lowered using a bucket and hand line.
- Do not carry a sharp tool in your pocket.

Hammers

What are some safety tips to know when using a hammer?

Hammers and other striking tools are widely used and often abused. Hammers are made for specific purposes in various types and sizes, and with striking surfaces of varying hardness. For example, hammers are used for general carpentry, framing, nail pulling, cabinet making, assembling furniture, upholstering, finishing, riveting, bending or shaping metal, striking masonry drill and steel chisels, and so on. Hammers are designed according to the intended purpose.

- Select a hammer that is comfortable for you and that is the proper size and weight for the job. Misuse can cause the striking face to chip, possibly causing a serious injury.
- Choose a hammer with a striking face diameter approximately 12 mm (0.5 inch) larger than the face of the tool being struck (e.g., chisels, punches, wedges, etc.).
- Ensure that the head of the hammer is firmly attached to the handle.
- Replace loose, cracked or splintered handles.
- Discard any hammer with mushroomed or chipped face or with cracks in the claw or eye sections.
- Wear safety glasses or goggles, or a face shield.
- Strike a hammer blow squarely with the striking face parallel to the surface being struck. Always avoid glancing blows and over and under strikes. (Hammers with beveled faces are less likely to chip or spall.)



- Look behind and above you before swinging the hammer.
- Watch the object you are hitting.
- Hold the hammer with your wrist straight and your hand firmly wrapped around the handle



What should I avoid doing?

- Do not use a hammer with a loose or damaged handle.
- Do not use handles that are rough, cracked, broken, splintered, sharp-edged or loosely attached to head.
- Do not use any hammer head with dents, cracks, chips, mushrooming, or excessive wear.
- Do not use a hammer for any purpose for which it was not designed or intended.
- Do not use one hammer to strike another hammer, other hard metal objects, stones or concrete.
- Do not redress, grind, weld or reheat-treat a hammer head.
- Do not strike with the side or cheek of the hammer.

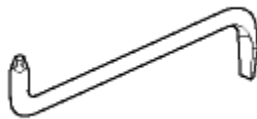


Screwdrivers

What are some general safety tips to know when using screwdrivers?

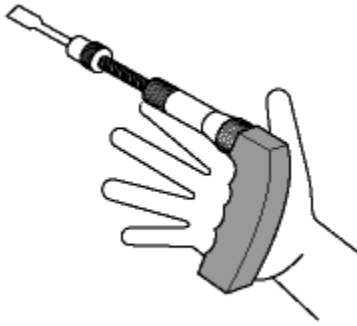
Screwdrivers are made in various shapes and sizes and for many uses. Use the correct screwdriver for the job.

- Always match the screwdriver to the screw head, both in terms of size and type.
- Choose contoured handles that fit the shank tightly, with a flange to keep the hand from slipping off the tool.
- Use a slot screwdriver with a blade tip width that is the same as the width of slotted screw head.
- For cross head screws, use the correct size and type of screwdriver: a Phillips screwdriver may slip out of a screw head designed for use with the slightly, flatter-tipped Pozidriv screwdriver.
- Use a vise or clamp to hold the stock if the piece is small or moves easily.
- Wear safety glasses or a face shield that is appropriate for the hazards of the work you are doing.
- Keep the screwdriver handle clean. A greasy handle could cause an injury or damage from unexpected slippage.
- Shut off electricity before beginning work on electrical equipment (lock out, de-energize and tag out).
- If work must be carried out on "live" equipment, use screwdrivers that have insulated handles designed for electrical work and a non-conducting shaft. Remember, most plastic handles are designed for grip and comfort.
- Use non-magnetic tools when working near strong magnets (e.g., in some laboratories).
- Use a screw-holding screwdriver (with screw-holding clips or magnetic blades) to get screws started in awkward, hard-to-reach areas. Square-tipped screwdrivers (e.g., Robertson) that hold screws with recessed square holes are also useful in such situations.
- Use an offset screwdriver in close quarters where a conventional screwdriver cannot be used.



Offset Screwdriver

- Use a screwdriver that incorporates the following features when continuous work is needed:
 - a pistol grip to provide for a straighter wrist and better leverage,
 - a "Yankee drill" mechanism (spiral ratchet screwdriver or push screwdriver) which rotates the blade when the tool is pushed forward,
 - a ratchet device to drive hard-to-move screws efficiently,
 - or use a powered screwdriver.



Yankee Drill Mechanism with a Pistol Grip

- File a rounded tip square making sure the edges are straight. A dull or rounded tip can slip out of the slot and cause hand injury or damage to materials.
- Store screwdrivers in a rack or partitioned pouch so that the proper screwdriver can be selected quickly.

What should I avoid doing?

- Do not lean or push on a screwdriver with any more force than necessary to keep contact with the screw. A screw properly piloted and fitted will draw itself into the right position when turned. Keep the shank directly over the screw being driven.
- Do not hold the stock in one hand while using the screwdriver with the other. If the screwdriver slips out of the slot, you may cut your hand.
- Do not hammer screws which cannot be turned.
- Do not grind the tip to fit all sizes of screw heads.
- Do not try to use screwdrivers on screw heads for which they are not designed (e.g., straight blade screwdrivers on Phillips, clutch head, Torx or multi-fluted spline screw heads).
- Do not use defective screwdrivers (i.e., ones with rounded or damaged edges or tips; split or broken handle; or bent shaft).
- Do not use a screwdriver for prying, punching, chiseling, scoring, scraping or stirring paint.
- Do not use pliers on the handle of a screwdriver for extra turning power. A wrench should only be used on the square screwdriver shank designed for that purpose.
- Do not expose a screwdriver blade to excessive heat. Heat can affect the temper of the metal and weaken the tool.
- Do not use a screwdriver to check if an electrical circuit is live. Use a suitable meter or other circuit testing device.
- Do not carry screwdrivers in your pockets.

Drill Press

What should you do before using a drill press?

Drill presses can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you understand the instructions and are properly trained before operating a drill press.

What are some safe work practices to know when using a drill press?

- Wear appropriate safety glasses.
- Ensure that the drill press has a start/stop button within easy reach of the operator.
- Use a vacuum, brush or rake to remove cuttings.
- Remove burrs and chips from a drilled hole. When making deep holes, clean out the hole frequently.
- Use a clamp or drill vise to prevent work from spinning.
- Lubricate drill bit when drilling metal.
- Reduce the drilling pressure when the drill begins to break through the workpiece. This action prevents drill from pulling into the work and breaking.
- Keep drill bits clean and sharp. Dull drills are a common cause of breakage.
- Keep floor around the drill press free of oil and grease.
- Keep the working surface clean of scraps, tools and materials.
- Keep guards in place and in good working order.

Refer to [portable hand drills](#) for additional information.

What are some things you should avoid doing?

- Do not wear any loose clothing or ties. Roll sleeves above the elbow to prevent them from being caught in revolving parts. Confine long hair.
- Do not wear gloves, rings, watches, or bracelets while working with a drill press.
- Do not set speeds, adjust, or measure work until machine is completely stopped.
- Do not leave chuck key in drill chuck. Make adjustments and remove key immediately.
- Do not hold work by hand when drilling holes larger than 12 mm (1/2 in.) in diameter.
- Do not place hands under the stock being drilled.
- Do not stop rotation of chuck and spindle with your hand.
- Do not remove a broken drill with a centre punch and hammer.
- Do not leave the drill press running unattended.

Cold Saw

What should you do before using a cold metal saw?

Metal saws can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you understand instructions and are properly trained before operating a metal saw.

What are some basic safety principles to follow?

- Wear appropriate safety glasses.
- Ensure the saw has a start/stop button within easy reach of the operator.
- Ensure that all guards are in place and working properly.
- Guard long material at both ends to prevent anyone from coming into contact with it.
- Ensure that the blade is completely stopped before removing the stock.
- Use cutting or lubricating fluid when cutting metals.
- Keep saw blades clean and sharp. Check blades regularly for wear or damage.
- Select the correct blade and saw speed for the material being cut. Follow the manufacturer's instructions.
- Use the stop gauge supplied with most cut-off saws when several pieces of the same length are required.
- Secure all work in a vise. Place the section to be cut such that the saw blade will clear the vise and table; however, do not place the section so far away from the vise that it will be unstable when being cut.
- Support long stock with a floor stand.
- Keep working surface clean of scraps, tools and materials.
- Keep floor around saw free of oil, grease and debris.

What should you avoid doing?

- Do not place, measure or remove work unless the saw is stopped.
- Do not apply extra force to the saw blade.
- Do not leave saw running unattended.

Abrasive Saw

What should you do before using a metal saw?

Hot metal saws can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you understand instructions and are properly trained before operating a hot metal saw. Refer to [Metalworking Machines - General](#) for general safety tips.

Hot metal saws, often referred to as cut-off saws or chop saws, use an abrasive cut-off wheel. The machine may operate dry or wet, at low or high speed, and in either manual or automatic mode.

What are some basic safety principles to follow?

- Wear appropriate safety glasses.
- Wear hearing protection.
- Wear respiratory protection when necessary.
- Handle and store wheels as directed by the manufacturer.
- Inspect all wheels for possible damage before mounting.
- Check machine speed against the maximum safe operating speed marked on the wheel.
- Ensure that mounting flanges are equal and the correct diameter (at least 1/4 of the wheel diameter).
- Use mounting blotters when they are supplied with wheels.
- Clamp work firmly in place when using non-reinforced cut-off wheels.
- Use a properly designed safety guard covering at least one half of the grinding wheel.
- Allow mounted wheels to run at operating speed, with guards in place, for one minute before cutting.
- Bring wheel into contact with the work without bumping on impact.
- Turn off coolant before stopping the wheel to avoid an out-of-balance condition.
- Keep working surface clean of scraps, tools and materials.
- Keep floor around saw clean and free of oil and grease.
- Ensure that the saw has a start/stop button within easy reach of the operator.

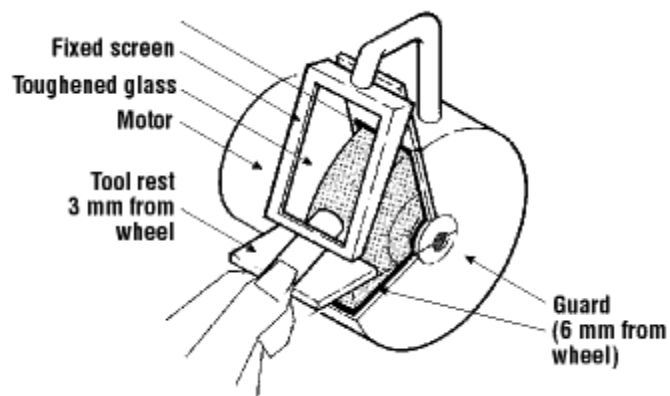
What should you avoid doing?

- Do not use a cracked wheel or one that has been dropped or damaged.
- Do not force a wheel onto the machine or alter the size of the mounting hole. If the wheel does not fit the machine properly, get one that will.
- Do not exceed the maximum operating speed marked on the wheel.
- Do not use mounting flanges whose bearing surfaces are not equal, clean, flat and free of burrs.
- Do not tighten the mounting nut excessively.
- Do not grind on the side of the wheel.
- Do not start machine until the wheel guard is in place.
- Do not stand directly in front of the cut-off wheel when starting a machine.
- Do not jam, bend or pinch the wheel.
- Do not force cutting such that the motor slows.
- Do not cut without proper ventilation.

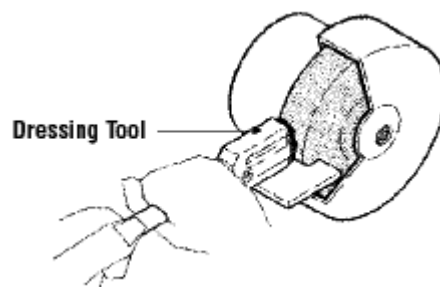
Bench Grinder

What safety procedures should you follow when using bench and pedestal grinders?

- Fasten pedestal and bench grinders securely.
- Ensure all the guards are in place and secure before using a grinder.
- Adjust tool rests to within 3 mm (1/8 in.) of wheels. Never adjust rests while wheels are moving. Work rest height should be on horizontal centre line of the machine spindle.
- Maintain 6 mm (1/4 in.) wheel exposure with a tongue guard or a movable guard.
- Check that wheels have blotters on each side.
- Check the wheel fits properly to the spindle when mounting. If it is loose, get another wheel.



- Stand to one side of the grinder until the wheel reaches operating speed.
- Bring work into contact with the grinding wheel slowly and smoothly, without bumping.
- Apply gradual pressure to allow the wheel to warm up evenly. Use only the pressure required to complete a job.
- Move the work back and forth across the face of the wheel. This movement prevents grooves from forming.
- Wheels are made only for grinding certain items. Do not grind rough forgings on a small precision grinding wheel.



- Dress wheels regularly. Do frequent, light dressings rather than one heavy dressings.

- Support dressing tools so you can apply leverage without undue effort. With revolving cutter dressing tools use the lugs as anchors.
- Replace worn wheels if you cannot dress it.
- Ensure the grinder speed does not exceed the operating speed marked on the wheel.
- Visually inspect wheels for possible damage before mounting.
- Wear proper personal protective equipment:
 - eye, ear and face protection,
 - metatarsal safety boots, where required,
 - respiratory protection may be required, depending on the work.
- Wear gloves only where necessary.

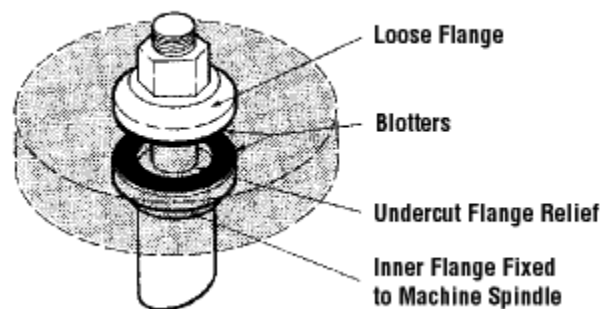
What should you avoid when using bench and pedestal grinders?

- Do not use a wheel that has been dropped.
- Do not use a wheel that does not fit properly to the spindle.
- Do not use excessive force to tighten the nut of the wheel. The force can crack the wheel.
- Do not grind wood, plastics and non-iron metals on ordinary wheels.
- Do not leave grinding wheels standing in liquids. The liquid can cause balance problems.
- Do not grind on the side of a regular wheel.

Portable Grinder

How should you mount straight wheels?

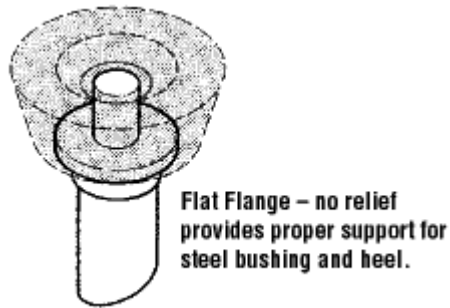
- Inspect and conduct "a ring test" to look for damages before mounting a wheel.
- Compare the machine speed to the speed marked on the wheel before mounting the wheel. Never exceed the speed marked on the cup wheel.
- Disconnect portable machines from their power source before you begin mounting or removing wheels.
- Check the flanges for distortion or abrasion. When flanges are distorted or warped, the contact area is reduced.
- Flanges must not be reversed.
- Use blotters to cushion flange pressure.
- Do not use flat washers, a nut, old blotters or other filler materials in place of flanges. This set-up will not support the wheel but rather it will damage the wheel and cause wheel to wobble, pull out the bushing, and break.
- The fixed and loose flanges should have the same diameter and have undercut relief. The minimum flange size is $\frac{1}{3}$ of the wheel diameter.
- Thread the wheel on the machine and hand tighten. Don't use power tools to put the wheel on, as removal will be difficult and the wheel can be damaged.
- Test wheel and machine by running it at operating speed in a protected area at least one minute before grinding.
- Wear all necessary personal protective equipment such as eye, face, hearing and respiratory protection and gloves, arm guards and safety shoes.



How should you mount cup wheels?

- Select the proper abrasive cup wheel for the application and tool you are using.
- Visually inspect all abrasive cup wheels for any damage as well as the package. Never use a damaged wheel.
- Compare the machine's speed to the speed marked on the wheel before mounting the wheel. Never exceed the speed marked on the cup wheel.
- Disconnect portable machines from their power source before you begin mounting or removing wheels.
- Inspect the machine and its wheel guard. Never use a machine that has been damaged or one that does not have a proper abrasive cup wheel guard.
- Inspect and clean the machine's back flange and mounting threads.

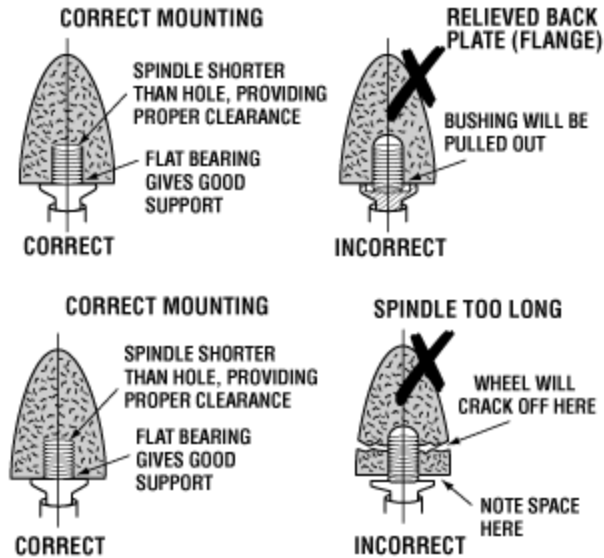
- For cup wheels, use a flat, unrelieved flange with a threaded hole mounting. This flange prevents strain on the bond that anchors the bushing to the wheel cup.
- Always follow the machine builder's and wheel manufacturer's instructions when mounting or using an abrasive cup wheel.
- Thread the wheel on the machine and hand tighten. Don't power the wheel on, as removal will be difficult and the wheel can be damaged.
- Wear all necessary personal protective equipment such as eye, face, hearing and respiratory protection and gloves, arm guards and safety shoes.
- Test the machine and wheel by placing the open end of the wheel guard under a workbench or into a steel drum and start the machine. Run the machine/wheel at operating speed for one minute.
- Do not allow anyone to stand near or inline with the guard's opening. If a wheel was damaged during storage or transportation, it will most likely break during this test.
- If you notice any unusual vibrations or noises, STOP. Examine the grinder and fix the problem immediately.
- For cup wheels, use a flat unrelieved flange with a threaded hole mounting. This flange prevents strain on the bond that anchors the bushing to the wheel cup.



What should you watch for when mounting cone and plug wheels?

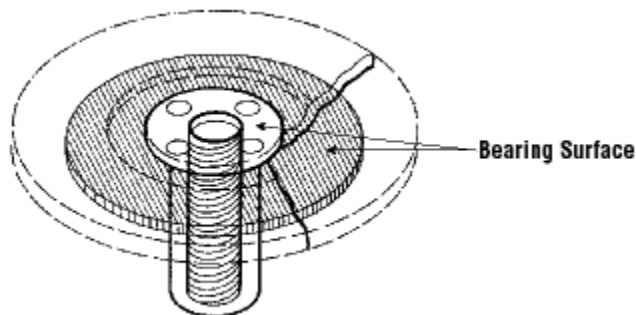
For cone and plug wheels, the common cause of breakage occurs when that the spindle threads are either too short or too long for the tapped hole in the wheel.

The wheels are mounted against a back flange that is flat, securely fastened and square to the spindle axis and able to properly support the wheel.



How should you mount depressed centre wheels?

- How should you mount depressed centered wheels?
- Use adapters suitable for the type of the wheel. E.g., type 27 and 28 wheels require specially designed adaptors because of their shape and usage.
- Replace any worn or bent reusable adapters. A damaged adapter will not mount properly.
- Do not reuse "throw away" adapters.
- Ensure that the grinder spindle shoulder runs true. The adapter must tighten against this shoulder. Use spacers provided with adapters if the spindle is too long.
- The wheel will wobble if the shoulder is not square with the spindle, or if the adapter does not tighten against the shoulder. This poor fit can result in wheel breakage and injuries to the operator or a nearby worker.



What safety precautions should you follow when using a portable grinder?

- Guards must be provided and adjusted to protect you. Replace damaged guards because if an abrasive wheel breaks while rotating, it can cause a serious injury.
- Clean and service grinders according to manufacturers' recommendations. Record all maintenance for grinders.
- Ensure that a machine will not operate when unattended by checking the dead-man (constant pressure) switch.

- Wear safety glasses, goggles, and face protection to protect against flying particles. Gloves, aprons, metatarsal safety boots, and respiratory protection may be required, depending on the work.
- Ensure the floor around the work area is clean.
- Do not use wheels that are cracked or those that excessively vibrate.
- Do not operate grinder on wet floors.
- Use both hands when holding the grinder.
- Keep the power cord away from the grinding wheel and the material being ground.

When and how should you check the speed of the wheel?

- The maximum speed in revolutions per minute (rpm) is marked on every wheel. Never exceed this speed.
- Check that the wheel speed marked on the wheel is equal to or greater than the maximum speed of the grinder.
- Measure the speed of any new machine. Take several readings.
- Measure the speed of governor-controlled air-driven grinders after twenty hours of use or every week, whichever comes first. Measure the speed after any repairs.
- Measure the speed of electrically driven grinders monthly and after repairs.

What should you do when using portable grinders?

- Check that grinders do not vibrate or operate roughly.
- Use racks or hooks to store portable grinders.
- Stand away from the wheel when starting grinders. Warn co-workers to do the same.
- Inspect all wheels for cracks and defects before mounting.
- Ensure that the mounting flange surfaces are clean and flat.
- Ensure the wheel guard is in place while operating the grinder.
- Use the mounting blotters supplied.
- Run newly mounted wheels at operating speed for 1 minute before grinding.
- Wear appropriate eye, ear and face protection. Use other personal protective equipment or clothing, as required under the circumstances.

What should you avoid when using portable grinders?

- Avoid using grinders near flammable materials.
- Do not clamp portable grinders in a vise for grinding hand-held work.
- Do not use any liquid coolants with portable grinders.
- Do not force wheels onto a grinder that is the wrong size or change mounting hole sizes.
- Do not tighten the mounting nut excessively.
- Do not put the grinder on the floor or working surface until the wheel has stopped turning.
- Do not keep any materials close to the grinding wheel when it is not in use.

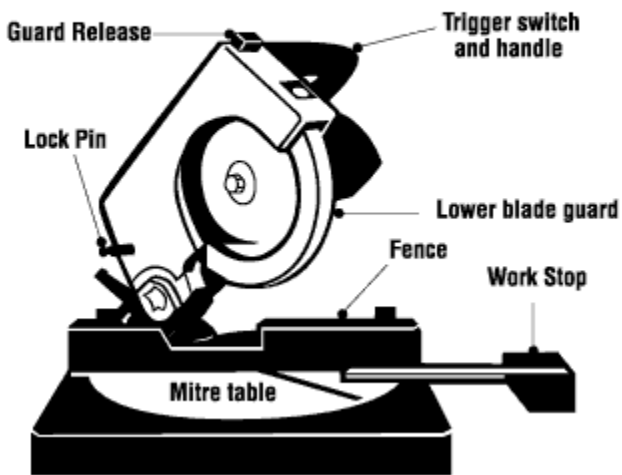
Miter Saws

Miter saws can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you know and understand the instructions before attempting to use any tool or machine.
- Learn the applications and limitations before use.

What safety precautions should you follow when using a miter saw?

- Wear safety glasses or a face shield. If work is dusty, use a respirator or dust mask.
- Wear appropriate hearing protection.
- Attach the saw firmly on a workbench or other rigid frame and operate saw at waist height. The saw can also be taken to remote locations by mounting it on a piece of plywood 13 mm (1/2 in.) or thicker. This must be clamped to a waist high work surface on the job site with large "C" clamps.
- Keep one hand on the trigger switch and handle and use the other hand to hold the stock against the fence.
- Keep hands out of the path of the blade.
- Keep guards in place and in working order.
- Remove adjusting keys and wrenches.
- Use a crosscut or combination blade.
- Ensure that the blade rotates in the correct direction.
- Ensure that the blade and arbor collars are secure and clean. Recessed sides of collars should be against blade.
- Keep blade tight, clean, sharp and properly set so that it cuts freely and easily.
- Allow motor to reach full speed before cutting.
- Follow instructions for lubricating and changing accessories.
- Keep the work area clean. Cluttered areas and benches invite accidents.
- Keep the work area well lit.
- Reduce the risk of unintentional startup. Make sure saw switch is in OFF position before plugging in.
- Unplug tools before servicing and when not in use.
- Check for damage. Repair or replace damaged parts.
- Keep motor air slots clean and free of chips.
- Use only the accessories designed for the specific saw and job.



What should you avoid when using a miter saw?

- Do not operate the saw on ground.
- Do not cut pieces smaller than 20 cm (8 in.) in length.
- Do not cut "free hand." The stock should lie solidly on the table against the fence.
- Do not reach around or behind the saw blade.
- Do not take your hand away from the trigger switch and handle until the blade is fully covered by the lower blade guard.
- Do not overreach. Keep proper footing and balance at all times.
- Do not force the saw. The saw cuts better and more safely at the rate for which it was designed.
- Do not leave the saw until it has stopped completely. Turn the power off and unplug the saw.
- Do not use electric tools in damp or wet locations.
- Do not operate electric tools near flammable liquids or in gaseous or explosive atmospheres. Sparks may ignite fumes.

Band Saws

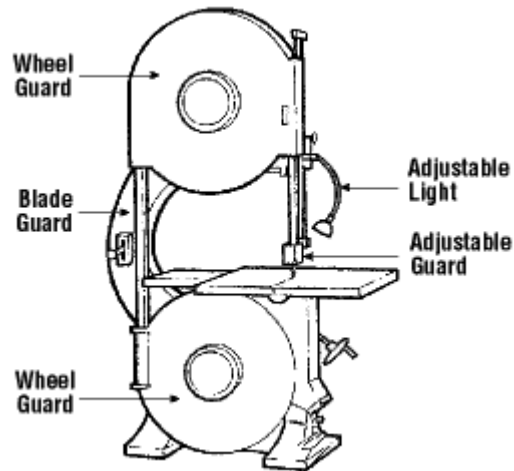
What should you do before using a band saw?

A band saw can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you understand the instructions before attempting to use any tool or machine.
- Learn the applications and limitations before use.

What safety procedures should you follow when using a band saw?

- Wear safety glasses or a face shield.
- Wear hearing protection that is suitable for the level and frequency of the noise you are exposed to in the woodworking area.
- Make sure all guards are in place and properly adjusted. Ensure all band wheels are enclosed.
- Adjust blade guard height to about 3 mm or 1/8 inch above the top of the material being cut.
- Ensure the blade is tracking correctly and runs freely in and against the upper and lower guide rollers.
- Ensure the blade is under proper tension. A band saw equipped with automatic tension control is desirable.
- Use band saw blades that are sharp, properly set and otherwise suitable for the job (e.g., the right tooth pitch; tooth form; blade width).
- Hold stock firmly and flat on the table to prevent the stock from turning and drawing your fingers against the blade. Keep hands braced against the table.
- Use a push stick when you remove cut pieces from between the fence and saw blade or when your hands are close to the blade. Keep your hands on either side of the blade - not in line with the cutting line and the blade.
- Make release (relief) cuts before tight curves when doing intricate scroll-type work.
- Keep the floor around a band saw clean and free of obstructions or clutter.
- Keep the machine properly oiled and serviced.
- Provide adequate lighting at the machine table. A light fixture with a flexible connection can provide essential lighting.
- Use C-clamp or V-block to hold round stock to keep stock from rotating while being cut.



What should you avoid when working with a band saw?

- Do not use excessive force when pushing the material past the blade.
- Do not back the stock away from the blade while the saw is in motion if the work piece binds or pinches on the blade.
- Do not stop a band saw by thrusting stock against the cutting edge or the side of a blade immediately after the power has been shut off.
- Do not remove sawdust or cuttings from the table by hand or with compressed air. Use a stick or brush.
- Do not leave a saw running unattended. Turn off the power and make sure the machine has stopped running before leaving the area.

Sanders

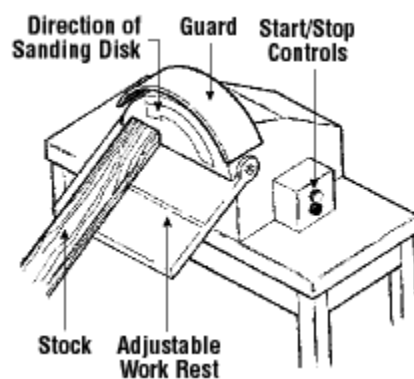
What should you do before using sanders?

Sanders can be dangerous if not used properly.

- Read the owner's manual carefully.
- Make sure you understand instructions before attempting to use any tool or machine.
- Learn the applications and limitations before use.

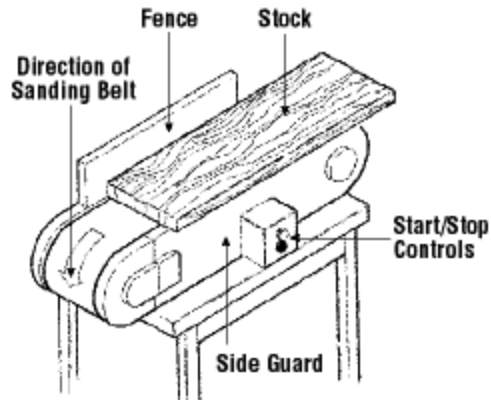
What safety procedures should you follow when using sanders?

- Wear goggles when operating sanders.
- Wear hearing protection that is suitable for the level and frequency of the noise you are exposed to in the woodworking area.
- Use sanders with the local exhaust ventilation turned on. The ventilation should be designed for the sander and well maintained to work effectively.
- Wear respiratory protection (e.g., dust masks) where required, during sanding operations and clean up.
- Keep hands away from the abrasive surface.
- Hold small or thin pieces of stock in a jig or holding device to prevent injuries to the fingers or hands.
- Inspect abrasive belts before using them. Replace belts worn, frayed, or excessively worn in spots.
- Sand on the downward side of a disc sander so that the wood is driven onto the table by the machine's rotation.
- Enclose all drums, disk or belt sanding machines with an exhaust dust hood that covers all portions of the machine but the portion designed for the work feed.
-



- Adjust work rests on all manually fed sanders to provide minimum clearance between the belt and the rest. The work rest should be secured properly.
- Install abrasive belts that are the same width as the pulley drum.
- Adjust abrasive belt tension to keep the belt running the same speed as pulley-drum when the wood is in contact with the belt.
- Guard feed rollers to allow boards to pass, but keep operators' fingers and arms out.

- Install guards to prevent contacts at:
 - in-running nip points,
 - power transmission,
 - feed roll parts, and
 - the unused portion of the abrasion belt on the operator's side of the machine.



What should you avoid when using sanders?

- Do not sand small or thin hand-held work pieces.
- Do not wear loose clothing or jewelry while using revolving power tools. Tie back long hair or wear appropriate hair protection. These measures will prevent hair, clothing, or jewelry (like dangling neck chains) from being caught and pulled by sander belts and pulleys that are in motion.
- Do not operate sanders without the exhaust system operating.
- Do not operate sanders unless adequately guarded.
- Do not operate sanders unless the work rest is properly adjusted.

Electric Tool Basic Safety

When and how should you inspect powered hand tools?

- Inspect tools for any damage prior to each use.
- Check the handle and body casing of the tool for cracks or other damage.
- If the tool has auxiliary or double handles, check to see that they installed securely.
- Inspect cords for defects: check the power cord for cracking, fraying, and other signs of wear or faults in the cord insulation.
- Check for damaged switches and ones with faulty trigger locks.
- Inspect the plug for cracks and for missing, loose or faulty prongs.

What should you do if you find a tool defective?

- If a tool is defective, remove it from service, and tag it clearly "Out of service for repair".
- Replace damaged equipment immediately - do not use defective tools "temporarily".
- Have tools repaired by a qualified person - do not attempt field repairs.

What should you do before using powered hand tools?

- Ensure that you have been properly trained to use the tool safely. Read the operator's manual before using the tool and operate the tool according to the manufacturer's instructions. Use only tested and approved tools.
- Ensure that the power tool has the correct guard, shield or other attachment that the manufacturer recommends.
- Prevent shocks. Ensure that the tools are properly grounded using a three-prong plug, are double-insulated (and are labeled as such), or are powered by a low-voltage isolation transformer: this will protect users from an electrical shock.
- Check electric tools to ensure that a tool with a 3-prong plug has an approved 3-wire cord and is grounded. The three-prong plug should be plugged in a properly grounded 3-pole outlet. If an adapter must be used to accommodate a two-hole receptacle, the adapter wire must be attached to a known, functioning ground. NEVER remove the third, grounding prong from a plug.



- Replace open front plugs with dead front plugs. Dead front plugs are sealed and present less danger of shock or short circuit.



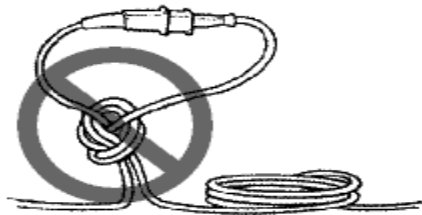
- Have a qualified electrician install a polarized outlet if the polarized, two-prong plug of a double-insulated tool does not fit in a two-hole receptacle. Double insulated tools use plugs having one prong that is visibly wider than the other.
- Test all tools for effective grounding with a continuity tester or a ground fault circuit interrupter (GFCI) before use.
- Use only the kind of battery that the tool manufacturer specifies for the battery-powered tool that you are using.
- Recharge a battery-powered tool only with a charger that is specifically intended for the battery in that tool.
- Remove the battery from the tool or ensure that the tool is switched off or locked off before changing accessories, making adjustments, or storing the tool.
- Store a battery pack safely so that no metal parts, nails, screws, wrenches and so on can come in contact with the battery terminals; this could result in shorting the battery and possibly cause sparks, fires or burns.
-

What should you do while using powered hand tools?

- Wear or use personal protective equipment (PPE) or clothing that is appropriate for the work you are doing; this may include items such as safety glasses or goggles, hearing protection, dust mask, gloves, safety boots or shoes, or rubber boots.
- Switch off the tools before connecting them to a power supply.
- If a power cord feels more than comfortably warm or if a tool is sparking, have it checked by an electrician or other qualified person.
- Disconnect the power supply before making adjustments or changing accessories.
- Remove any wrenches and adjusting tools before turning on a tool.
- Inspect the cord for fraying or damage before each use. Tag defective tools clearly with an "Out of service" tag and replace immediately with a tool in good running order.
- During use, keep power cords clear of tools and the path that the tool will take.
- Use clamps, a vice or other devices to hold and support the piece being worked on, when practical to do so. This will allow you to use both hands for better control of the tool and will help prevent injuries if a tool jams or binds in a work piece.
- Use only approved extension cords that have the proper wire size (gauge) for the length of cord and power requirements of the electric tool that you are using. This will prevent the cord from overheating.
- For outdoor work, use outdoor extension cords marked "W-A" or "W".
- Suspend power cords over aisles or work areas to eliminate stumbling or tripping hazards.
- Eliminate octopus connections: if more than one receptacle plug is needed, use a power bar or power distribution strip that has an integral power cord and a built-in overcurrent protection.
- Pull the plug, not the cord when unplugging a tool. Pulling the cord causes wear and may adversely affect the wiring to the plug and cause electrical shock to the operator.
- Follow good housekeeping procedures - keep the work area free of clutter and debris that could be tripping or slipping hazards.
- Keep power cords away from heat, water, oil, sharp edges and moving parts. They can damage the insulation and cause a shock.
- Ensure that cutting tools, drill bits, etc. are kept sharp, clean and well maintained.
- Store tools in a dry, secure location when they are not being used.

What should you avoid when using powered tools?

- Do not wear gloves, loose clothing or jewelry while using revolving power tools. Tie back long hair or wear appropriate hair protection to prevent hair from getting caught in moving parts of equipment.
- Do not use a tool unless you have been trained to use it safely and know its limitations and hazards.
- Avoid accidental starting by ensuring the tool is turned off before you plug it in. Also do not walk around with a plugged-in tool with your finger touching the switch.
- Do not bypass the ON/OFF switch and operate the tools by connecting and disconnecting the power cord.
- Do not disconnect the power supply of the tool by pulling or jerking the cord from the outlet.
- Do not leave a running tool unattended. Do not leave it until it has been turned off, has stopped running completely, and has been unplugged.
- Do not use electric tools in wet conditions or damp locations unless tool is connected to a ground fault circuit interrupter (GFCI).
- Do not expose electric power tools to rain or wet conditions; wet tools increase the likelihood of electric shock.
- Avoid body contact with grounded surfaces like refrigerators, pipes and radiators when using electric powered tools; this will reduce the likelihood of shock if the operator's body is grounded.
- Do not plug several power cords into one outlet by using single-to-multiple outlet adapters or converters ("cube taps").
- Do not use light duty power cords.
- Stop using an electric power tool if you feel a tingle in your fingers. This is a warning that the tool is faulty and needs repair.
- Do not connect or splice extension cords together to make a longer connection: the resulting extension cord may not be able to provide sufficient current or power safely.
- Do not carry electrical tools by the power cord.
- Do not tie power cords in knots. Knots can cause short circuits and shocks. Loop the cords or use a twist lock plug.



- Never break off the third prong on a plug: replace broken 3-prong plugs and make sure the third prong is properly grounded.
- Never use extension cords as permanent wiring: use extension cords only as a temporary power supply to an area that does not have a power outlet.
- Do not walk on or allow vehicles or other moving equipment to pass over unprotected power cords. Cords should be put in conduits or protected by placing planks on each side of them.
- Do not brush away sawdust, shavings or turnings while the tool is running. Never use compressed air for cleaning surfaces or removing sawdust, metal turnings, etc.
- Do not operate tools in an area containing explosive vapors or gases.
- Do not clean tools with flammable or toxic solvents.
- Do not surprise or touch anyone who is operating a tool. Startling a tool operator could end up causing an accident or injury.

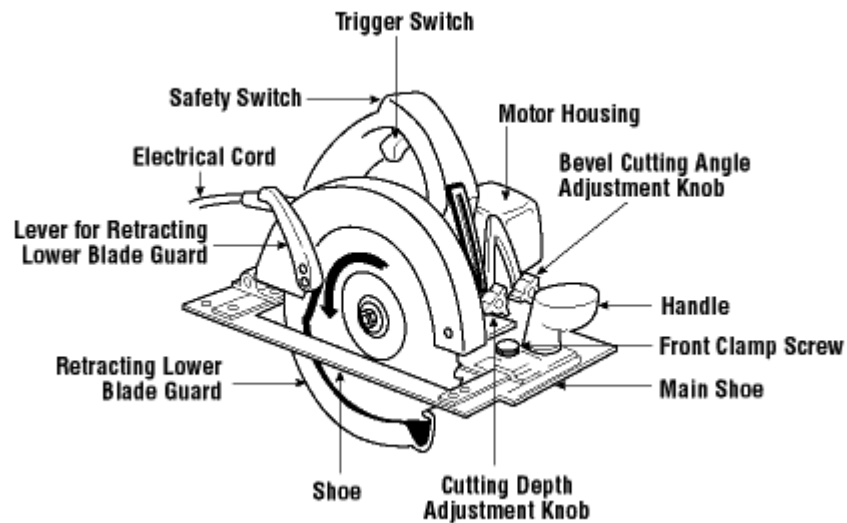
Circular Saw

What should you do before start cutting with a circular saw?

- Wear safety glasses or goggles, or a face shield.
- Wear an approved respirator or dust mask when exposed to harmful or nuisance dusts.
- Use appropriate hearing protection equipment in noisy areas.
- Check the retracting lower blade guard to make certain it works freely.
- Ensure that the blade that you have selected is sharp enough to do the job. Sharp blades work better and are safer.
- Check the saw for proper blade rotation.
- Set the depth of the blade, while the saw is unplugged, and lock it at a depth so that the lowest tooth does not extend more than about 0.3 cm or 1/8" beneath the wood.
- Keep all cords clear of cutting area.
- Circular saws are designed for right-hand operation; left-handed operation will demand more care to operate safely.

What should you do to work safely with a circular saw?

- Check the retracting lower blade guard frequently to make certain it works freely. It should enclose the teeth as completely as possible, and cover the unused portion of the blade when cutting.

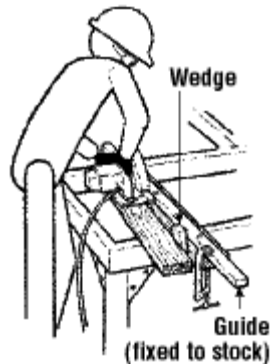


- Check that the retracting lower blade guard has returned to its starting position before laying down the saw.
- Keep upper and retracting lower blade guard clean and free of sawdust.
- Disconnect power supply before adjusting or changing the blade.
- Allow the saw to reach full power before starting to cut
- Use two hands to operate saws - one on a trigger switch and the other on a front knob handle.
- Keep motor free from accumulation of dust and chips.

- Select the correct blade for stock being cut and allow it to cut steadily. Do not force it.
- Secure stock being cut to avoid movement.

What should you avoid when cutting with a circular saw?

- Do not hold or force the retracting lower guard in the open position.
- Do not place hand under the shoe or guard of the saw.
- Do not over tighten the blade-locking nut.
- Do not twist the saw to change, cut or check alignment.
- Do not use a saw that vibrates or appears unsafe in any way.
- Do not force the saw during cutting.
- Do not cut materials without first checking for obstructions or other objects such as nails and screws.
- Do not carry the saw with a finger on the trigger switch.
- Do not overreach. Keep proper footing and balance.
- Do not rip stock without using a wedge or guide clamped or nailed to the stock.



Reciprocating Power Saws

What should you do before start cutting with powered hand saws?

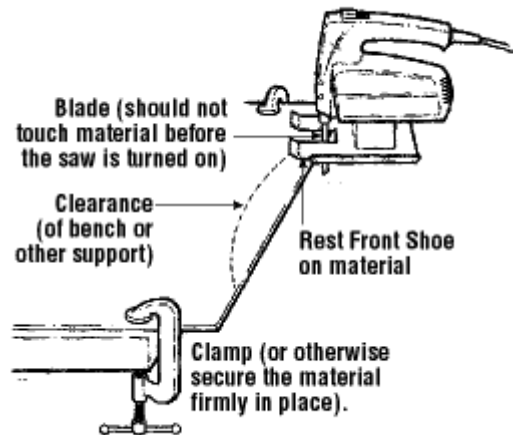
- Wear safety glasses or goggles, or a face shield.
- Disconnect power supply before changing or adjusting blades.
- Use lubricants when cutting metals.
- Keep all cords clear of cutting area.
- Position the saw beside the material before cutting and avoid entering the cut with a moving blade.
- Make sure guards, if present, are installed and are working properly.

What should you do to work with powered hand saws safely?

- Hold reciprocating saw with both hands.
- Remember sabre saws cut on the up stroke.
- Secure and support stock as close as possible to the cutting line to avoid vibration.
- Keep the base or shoe of the saw in firm contact with the stock being cut.
- Select the correct blade for the material being cut and allow it to cut steadily. Do not force it. Clean and sharp blades operate best.
- Set the blade to go no further than 0.32 to 0.64 cm (1/8 to 1/4 inch) deeper than the material being cut.
- Do not start cutting until the saw reaches its full power.
- Do not force a saw along or around a curve. Allow the machine to turn with ease.
- Do not insert a blade into or withdraw a blade from a cut or lead hole while the blade is moving.
- Do not put down a saw until the motor has stopped.
- Do not reach under or around the stock being cut.
- Maintain control of the saw always. Avoid cutting above shoulder height.

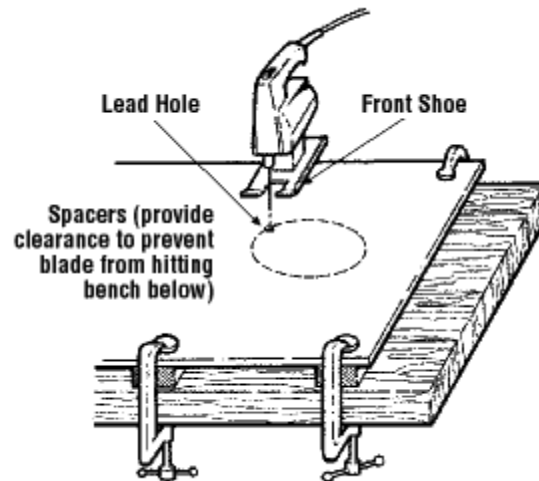
How should you start an external cut?

- Place the front of the shoe on the stock.
- Make sure that the blade is not in contact with the material or the saw will stall when the motor starts.
- Hold the saw firmly down against the material and switch the saw on.
- Feed the blade slowly into the stock maintaining an even forward pressure.



How should you start an inside cut?

- Drill a lead hole slightly larger than the saw blade. With the saw switched off, insert the blade in the hole until the shoe rests firmly on the stock.
- Do not let the blade touch the stock until the saw has been switched on.



Pneumatic Tool Basic Safety

What are pneumatic tools?

- Pneumatic tools are powered by compressed air. Common types of these air-powered hand tools that are used in industry include buffers, nailing and stapling guns, grinders, drills, jack hammers, chipping hammers, riveting guns, sanders and wrenches.

How do you use pneumatic tools safely?

- Review the manufacturer's instruction before using a tool.
- Wear safety glasses or goggles, or a face shield and, where necessary, safety shoes or boots and hearing protection.
- Post warning signs where pneumatic tools are used. Set up screens or shields in areas where nearby workers may be exposed to flying fragments, chips, dust, and excessive noise.
- Ensure that the compressed air supplied to the tool is clean and dry. Dust, moisture, and corrosive fumes can damage a tool. An in-line regulator filter and lubricator increases tool life.
- Keep tools clean and lubricated, and maintain them according to the manufacturers' instructions.
- Use only the attachments that the manufacturer recommends for the tools you are using.
- Be careful to prevent hands, feet, or body from injury in case the machine slips or the tool breaks.
- Reduce physical fatigue by supporting heavy tools with a counter-balance wherever possible.

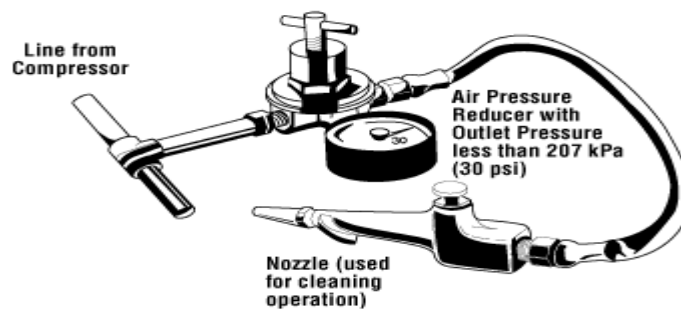
How should you handle air hoses?

- Use the proper hose and fittings of the correct diameter.
- Use hoses specifically designed to resist abrasion, cutting, crushing and failure from continuous flexing.
- Choose air-supply hoses that have a minimum working pressure rating of 1035 kPa (150 psig) or 150% of the maximum pressure produced in the system, whichever is higher.
- Check hoses regularly for cuts, bulges and abrasions. Tag and replace, if defective.
- Blow out the air line before connecting a tool. Hold hose firmly and blow away from yourself and others.
- Make sure that hose connections fit properly and are equipped with a mechanical means of securing the connection (e.g., chain, wire, or positive locking device).
- Install quick disconnects of a pressure-release type rather than a disengagement type. Attach the male end of the connector to the tool, NOT the hose.
- Do not operate the tool at a pressure above the manufacturer's rating.
- Turn off the air pressure to hose when not in use or when changing power tools.
- Do not carry a pneumatic tool by its hose.
- Avoid creating trip hazards caused by hoses laid across walkways or curled underfoot.
- Do not use compressed air to blow debris or to clean dirt from clothes.



What should you avoid with a compressed air?

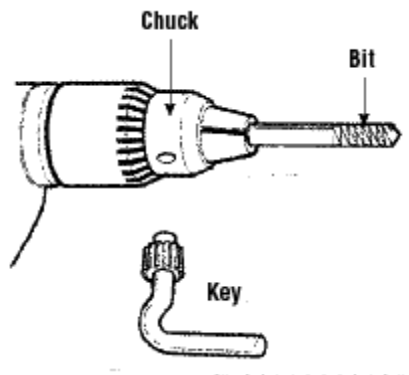
- **Cleaning with compressed air is dangerous.**
- Do not use compressed air for cleaning unless no alternate method of cleaning is available. The nozzle pressure **MUST** remain below 207 kPa (30 psi). Personal protective equipment and effective chip guarding techniques must be used.
- Two acceptable methods of meeting the "below 207 kPa (30 psi)" requirement are illustrated below.



Power Drill

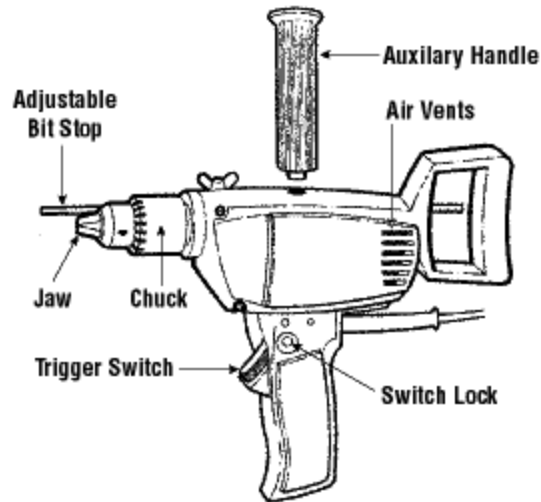
How do you select the proper bit or attachment?

- Follow manufacturers' instructions when selecting and using a bit or attachment, especially with unfamiliar drills or work.
- Select the bit or attachment suitable for the size of the drill and the work being done.
- Ensure that the bit or attachments are properly seated and tightened in the chuck.
- Use only bits and attachments that turn true.
- Use the auxiliary (second) handle for larger work or continuous operation.



What should you do when working with powered hand drills?

- Wear safety glasses or a face shield.
- Keep drill air vents clear to maintain adequate ventilation.
- Keep drill bits sharp always.
- Keep all cords clear of the cutting area during use. Inspect for frays or damage before each use.
- Disconnect power supply before changing or adjusting bit or attachments.
- Tighten the chuck securely. Remove chuck key before starting drill.
- Secure work piece being drilled to prevent movement.



- Slow the rate of feed just before breaking through the surface.
- Drill a small "pilot" hole before drilling large holes.

What should you do when working with small pieces?

- Clamp stock so work will not twist or spin.
- Do not drill with one hand while holding the material with the other.

What should you avoid when working with powered hand drills?

- Do not use a bent drill bit.
- Do not exceed the manufacturer's recommended maximum drilling capacities.
- Do not use a hole saw cutter without the pilot drill.
- Do not use high speed steel (HSS) bits without cooling or using lubrication.
- Do not attempt to free a jammed bit by starting and stopping the drill. Unplug the drill and then remove the bit from the work piece.
- Do not reach under or around stock being drilled.
- Do not overreach. Always keep proper footing and balance.
- Do not raise or lower the drill by its power cord.
- Do not use in wet or muddy locations. Use a non-powered drill instead.
- Do not use excessive force to drill into hard material. Reduce drill speed if possible.

Tubing Bender

The purpose of the safety section of this manual is to inform operators and maintenance personnel of the precautions to be taken while operating or servicing the machine. The following are a few basic guidelines to follow, but as with any type of machinery good judgment and a safe attitude should be applied at all times.

1. Always disconnect power, lock-out and tag-out machine per OSHA regulations before attempting to service this machine.
2. Always wear safety glasses or other approved eye protection while operating or servicing the machine.
3. Keep all body parts and any foreign objects away from moving parts. Do not reach into the machine without first disconnecting all power sources.
4. Do not attempt to override any safety device on the machine.
5. Do not operate the machine if it has been damaged or is not operating properly.
6. Do not wear jewelry (watches, rings, necklaces, etc.), or loose fitting clothing while operating or servicing the machine.
7. The machine should only be operated or serviced by properly trained, authorized personnel.
8. Replacement parts should have the same specification and operation as the original parts on the machine.
9. Before starting the machine be sure it is set up properly.
10. The machine and work area should be kept neat and clean.
11. Do not operate or service any machine while under the influence of drugs or alcohol.

NOTE: THESE SAFETY RULES ARE FOR YOUR BENEFIT TO HELP PREVENT INJURY TO YOURSELF AND/OR YOUR CO-WORKERS. REVIEW ALL SETUP AND OPERATING PROCEDURES, WHETHER COVERED OR NOT, IN THIS MANUAL TO HELP INSURE SAFE OPERATION OF THE MACHINE