

A Student Guide for Safety Instruction in Manufacturing/Metals Technology

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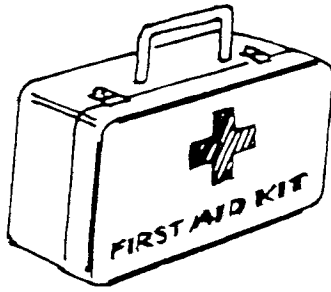
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Introduction to Shop Safety

Accidents do not just happen. Accidents are caused by people who do unsafe things or cause unsafe conditions by their attitudes. Actions and behaviors cause accidents.

This guide will help you to:

- Learn the safety rules.
- Work safely with tools, materials, and machines.
- Develop attitudes that help you to work safely.
- Cooperate with others for safe behavior.
- Avoid dangerous conditions.
- Use common sense and work safely in the shop and at home.

Safety in the shop is a *MUST*. If you cannot or will not work safely, *you will be removed from the class*.

Many of the tools, materials, and machines you will use in this class are different from the common tools you use at home. Your goal is to be safe. When you are in the shop, you must:

- Be alert. (Pay attention to the action around you.)
- Learn to use tools safely.
- Get instruction and ask permission before using tools, materials, or equipment.
- Obey rules and directions.
- Cooperate with others.
- Work safely and carefully.

Before using tools, materials, and shop equipment, you must show the teacher that you:

- Understand the safety rules.
- Know how to work safely.
- Care for tools correctly.
- Intend to be responsible for your own proper behavior.

You will show the teacher that you will work safely in the shop by:

- Taking a safety test and answering all the questions correctly.
- Correcting any wrong answer if you do not answer all questions correctly.
- Signing a statement of accountability. In this statement you will agree that you:

Have received instruction for the safe use of tools.

Understand the safety rules.

Will do your best to work in a safe manner.

If for any reason you do not understand the instructions or procedures, ask the teacher for help before you sign this statement.

All the machines in shop require the permission of the teacher before turning on the power. For some machines, permission will be granted when:

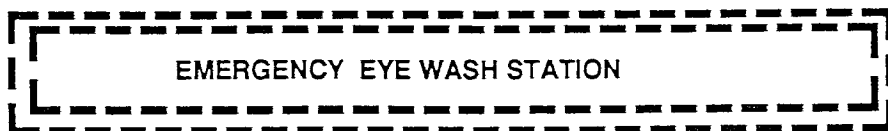
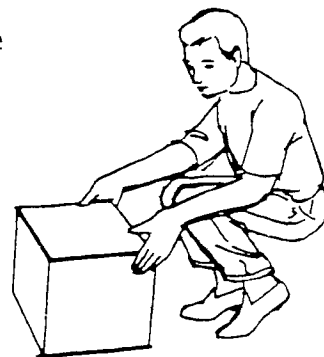
- The machine has been properly demonstrated by the teacher.
- The project being worked on is authorized by the teacher.

Other machines will be identified by the teacher as always requiring a setup check before turning on the power. A setup check is an inspection by the teacher to make sure that you are going to use the machine correctly and safely.

Safety is Everyone's Responsibility.

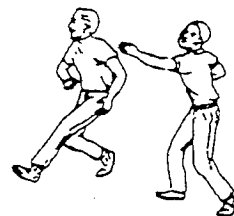
Part 2: General Safety Procedures and Practices

1. Be alert! Safety in the shop is important to everyone and is the responsibility of every person in the class.
2. Follow the safety rules in this guide, the rules posted in the shop, and all other rules given by your teacher.
3. Know the emergency procedures to follow in case of an earthquake, fire, or other disaster.
4. It is very important that the teacher know who is working in the shop. Get the teacher's permission before going to work. If you go into another shop, report to the teacher before you do anything else.
5. When in doubt about any operation in the shop, ask your teacher for help.
6. Never use any tools or equipment or start any job until the teacher has given you permission and shown you what to do.
7. If you see something in the shop that is dangerous, do not ignore it. Tell the teacher at once.
8. Do not make repairs. Repairs should be made by the teacher only.
9. Only the teacher and the person using the machine may be inside the working area of that machine. All others must stay outside the safety zones.
10. Warn other students if you see them doing something that might cause an accident.
11. Report every injury, no matter how small, to the teacher at once.
12. Lifting a heavy object can cause serious injury. Ask for help.
13. Do not carry sharp or pointed tools or materials in your clothing. Hold them with the points or edges down.
14. Avoid breathing the fumes when you use inks, rubber cement, paints, or solvents.
15. Know the location of the eyewash station and how to use it. If chemicals get in your eyes, immediately splash water in your eyes and continue for at least 15 minutes.

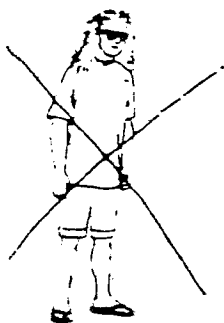


Behavior

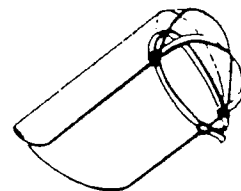
16. People are often injured by playing around. Never engage in horseplay (running and throwing things) in the shop.
17. Always walk when moving around the shop. Do not run or slide.
18. Never disturb another student when the student is working. It is dangerous to interrupt someone who is operating equipment.
19. There is only one safe way to sit on a chair or stool. Keep all of the legs on the floor. Do not tilt, rock, or lean back while you are sitting.
20. Always close the doors of lockers and cabinets. People can get cuts and bruises from bumping into them.
21. Never hold parts, such as washers, rivets, or screws, in your mouth.



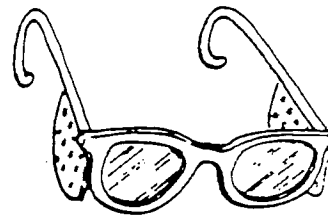
Clothing and Appearance



22. If you have long hair, always keep it out of the way by tying it back or covering it. Long hair can be dangerous in the shop. It can get caught in moving machinery and pull you in. Long hair can also get in your way and block your vision.
23. Do not wear loose clothing, jewelry, or gloves while working with power tools. Roll up long sleeves before operating equipment.
24. Wear regular leather shoes, not sandals or tennis shoes. Sandals will not protect your feet from falling tools, fragments of molten metal, hot metal shavings, or welding sparks.
25. Wear rubber gloves when working with certain chemicals. Other types of gloves are not to be worn in the shop.
26. You must wear approved safety glasses, goggles, or a face shield when working in the shop. Your teacher will tell you when and where to wear them.
27. Tell your teacher if you wear contact lenses.
28. Do not wear soft contact lenses in the shop. Goggles cannot protect soft lens wearers from eye damage caused by dust, particles, and chemicals and solvents and their fumes. Soft contact lenses are easily damaged by chemical fumes; solvents splashed into the eye may cause the lenses to stick to the eye tissue.



29. If you wear prescription eyeglasses, wear goggles with your eyeglasses when operating equipment.
30. If shop noise hurts your ears, see your teacher for the proper ear protection.



Tools

31. If you are unsure of how to use a machine or tool, always ask the teacher for help.
32. Select the right tool for the job. If a wrench or screwdriver is too small, get one that is the right size.
33. Tools that are used in the wrong way can cause injury. Always use a tool as it was designed to be used.
34. Read and obey all warning labels on tools or equipment.
35. Before using a tool, make sure that it is in good condition.
36. If you damage a tool, a machine, or other equipment, tell the teacher at once.
37. Put knives and other sharp or pointed tools away in a safe position so other students cannot get hurt.
38. Direct striking or cutting motions away from yourself and others.
39. When using hand tools, make sure that you have a good grip. Clean grease or oil from your hands before you begin.
40. Never use a tool that has a broken or missing handle.

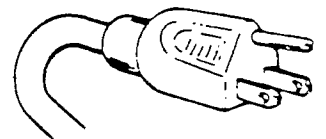
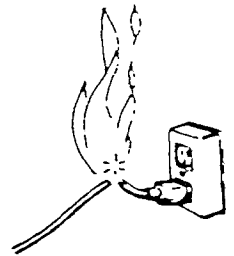
Equipment

41. You are responsible for using power equipment safely in the shop. Ask permission from the teacher before using power equipment.
42. Never "mess around" with shop equipment or use a machine unless the teacher has:
 - Shown you how to use it properly.
 - Given you permission.
43. Do not turn the main power switch in the shop on or off. This must be done only by the teacher.
44. Before working with power equipment, remove or secure all loose clothing, long hair, and jewelry.

45. Only one person at a time may operate power equipment.
46. Observe operating zones. The operator and the teacher are the only ones allowed in the operating zone around equipment.
47. Ask your teacher to check all special equipment setups before the power is turned on.
48. After checking to see that everyone is clear of the equipment, stand to one side before turning the equipment on.
49. Lay small pieces of power equipment on their sides before turning the equipment on.
50. Keep your hands as far away as possible from all moving parts on the machines.
51. Guards are on a machine to protect you. Do not remove or adjust guards or try to bypass them.
52. Never adjust or clean a machine by hand until it has stopped moving.
53. If you think there is something wrong with a machine, stop using it. If the machine is running, shut it off and tell the teacher at once.
54. Wait until equipment comes to a complete stop before you leave it.

Electrical Safety

55. You must observe safety rules when using electrical equipment to avoid electrical shock and possible death by electrocution.
56. Dry your hands before you touch electrical switches, plugs, or outlets.
57. Do not use electrical equipment near water or while you are standing in water.
58. Turn switches to the "off" position before plugging in electrical equipment.
59. Use extension cords when power cords are interfering with walkways.
60. Be sure the plug matches the outlet; do not force a plug into an outlet.
61. If electrical equipment smokes or smells, turn it off, unplug it, and tell the teacher at once.
62. Do not run over power cords with rolling equipment.
63. Be sure that power cords and plugs are in good condition before using electrical equipment. Never tape, splice or otherwise try to "repair" damaged electrical cords or plugs.

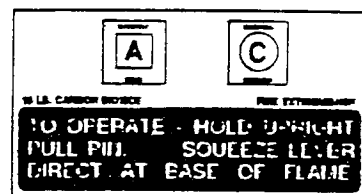


Fire Extinguishers

FIRES require three things in order to burn: heat, fuel, and oxygen (air). If you remove any one of these three necessary elements, the fire will go out.

Fire extinguishers work by cooling (removing heat), wetting the fuel, or smothering (removing oxygen). There are four classes or types of fire, and each should be put out with the right type or class of extinguisher. Some fire extinguishers will be safe for putting out more than one class of fire.

Read the label on a fire extinguisher to find out which type(s) of fire it will fight best. A high number is good, and a low number is poor. For example, an extinguisher labeled A:2, B:10, C:10 means that the extinguisher will work well on Class B and Class C fires, but will not have much effect on Class A fires.



CLASS



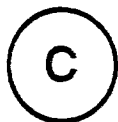
Combustible material fires. The fuel may be wood, paper, cloth, or other similar materials. Use **water** to put it out. Water cools and wets the burning fuel. Dry powder or CO₂ (carbon dioxide) may sometimes be used to smother this class of fire, but are not as effective as water.

CLASS



Flammable liquid fires. The fuel may be a burning liquid, such as gasoline, kerosene, thinners, ink, grease, or paint. Use CO₂ (carbon dioxide), dry powder, or foam-type extinguishers to put out the fire by smothering the flames. **Do not use a stream of water**, as it will cause the flames to spread out and make the fire larger.

CLASS



Fires started by electricity. The fuel may be anything that burns. Use an extinguisher that will not conduct (carry) electricity, such as CO₂ (carbon dioxide), or dry powder. **Never use water on an electrical fire.** It may cause you to be electrocuted.

CLASS

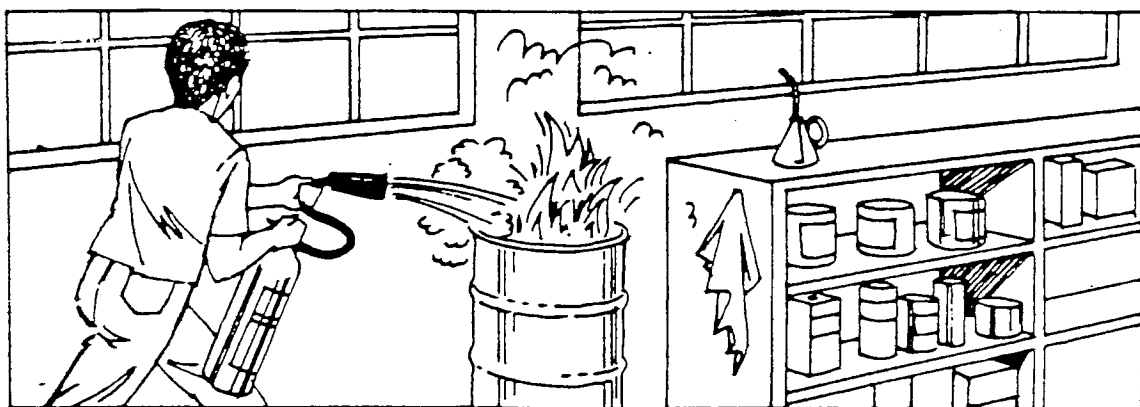
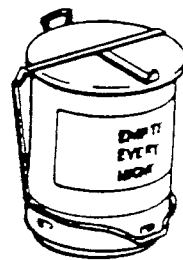
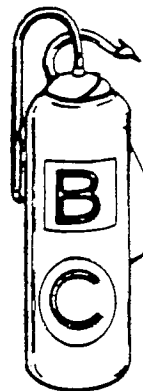


Burning metal fires. The fuel may be burnable metal such as magnesium or sodium. Extinguish this type of fire with a special Class D type of dry powder extinguisher.

Fire Safety

MOST fires are caused by carelessness. Fires can hurt and kill people. Learn and follow the safety rules to prevent fires.

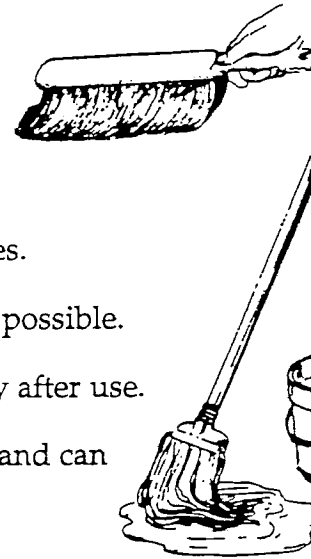
64. Know the proper fire drill procedure for leaving the shop.
65. Know where fire extinguishers and fire blankets are kept, and how to use them.
66. Nothing should be hung on fire extinguishers. Keep the area around them clear so that they may be reached without delay if a fire starts.
67. Do not play or fool around with fire extinguishers.
68. Never break a seal or remove the pin on the fire extinguisher unless you need to use the extinguisher to put out a fire.
69. CO₂ (carbon dioxide) can smother a person or freeze-burn the skin. Never use a CO₂ extinguisher on a person.
70. Never use matches or lighters in the shop.
71. Gasoline, kerosene, paints, lacquer thinners, and other finishing and cleaning materials are flammable (can burn). Never use or keep flammable chemicals near an open flame, sparks, or hot metals. Be sure to read the label on the container for instructions on proper use.
72. Use flammable liquids only in well-ventilated areas or outside.
73. If you spill any liquids that can burn, clean them up at once and ventilate the area.
74. Never leave solvent cans uncapped. Replace caps at once.
75. Cloths and rags with flammable (burnable) liquids on them are dangerous. They can catch fire by spontaneous combustion (without flames). Be sure to put them in a metal container with a lid.
76. Never roll up a shop coat or apron for storage. Store oily and greasy lab clothing in ventilated metal lockers.



77. To help prevent electrical fires, always disconnect equipment by pulling the plug, not the cord.
78. If a person's clothes catch on fire, smother the fire by rolling the person up with a blanket or coat. If none are available, just roll the person on the floor until the flames are out.

Cleaning

79. Every student in the class must help clean up the shop. Do your share.
80. Keep work areas and walkways clear of stock, tools, and materials for safe walking.
81. Keep locker doors, benches, and cabinet drawers closed.
82. Clean up scraps and litter as soon as possible.
83. Use a brush to clean scraps and particles from a work bench, light table, or desk. This will protect your bare hands from splinters.
84. Do not allow work or tools to hang over the edge of benches or tables.
85. Return stock, tools, and equipment to their proper places as soon as possible.
86. Never leave solvent cans uncapped. Place caps on cans immediately after use.
87. Wipe spills up at once. Spilled liquids make the floor very slippery and can cause accidents.



Chemicals and Solvents

88. Many chemicals in the shop are considered dangerous. They can cause pollution and physical injury if handled the wrong way. Be careful to follow your teacher's directions for chemical use.
89. If chemical wastes are disposed of in the wrong way, they will pollute the environment. Never pour them down the drain, onto the ground, or into the trash. Always get instructions and permission from your teacher before disposing of chemical wastes.
90. Some chemicals, when mixed together, will explode or cause poisonous gasses. If you are not sure it is safe, check with your teacher before mixing chemicals.
91. Read the labels on containers. They should list the chemical name and a hazard warning.
92. When you use a spray can, point the spray toward the object and away from yourself and others.
93. If you begin to feel sick or get a headache, you may be exposed to toxic (poison) materials by inhaling, swallowing, or touching them. Tell your teacher at once.



Part 2. Manufacturing/Metal Technology

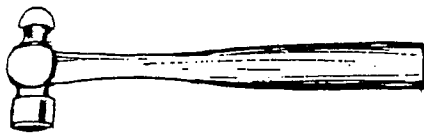
Safety Practices

1.0 Hand Tools

Hammers, knives, wrenches, files, screwdrivers, saws, snips, and other hand tools are often treated so casually that their danger is not realized.

- Firmly hold or clamp your work in a vise. *Never* hammer on a vise handle or use a piece of pipe to increase the pressure of the vise jaws.
- Make sure you have a good grip when using hand tools. Clean grease or oil from your hands before you begin. *Never* use a tool with a broken or missing handle.

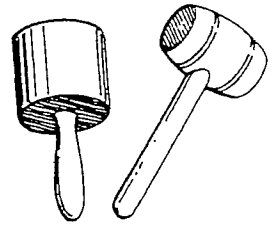
1.1 Hammers



ball peen



sledge



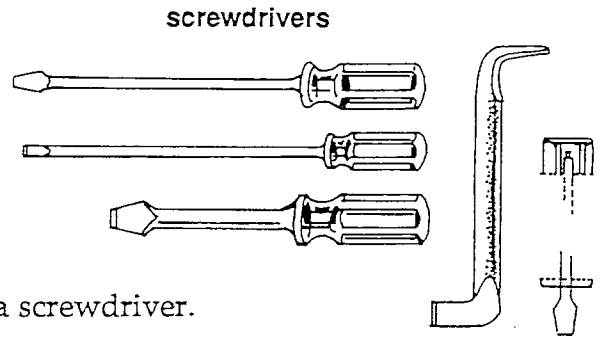
mallet

- *Always* wear safety goggles when hammering.
- Make sure the hammer is of suitable size and weight for the job.
- When hammering on machined, tempered, or hardened surfaces, use a hammer with a soft face (rawhide, lead, rubber, or copper).
- *Never* use a hammer with a damaged head that is spread apart or “mushroomed.” Make sure the handle is firm, free from cracks or splinters, and securely attached to the head.
- Before hammering, make sure your hands and the hammer handle are dry.
- *Never* strike two hammers together. The hardened surfaces may chip and cause serious injury.
- Grip or hold the hammer near the handle's end and use a normal swing.
- Direct the hammer swing away from yourself and other students.
- Strike squarely. *Never* strike with the side of a hammer head.

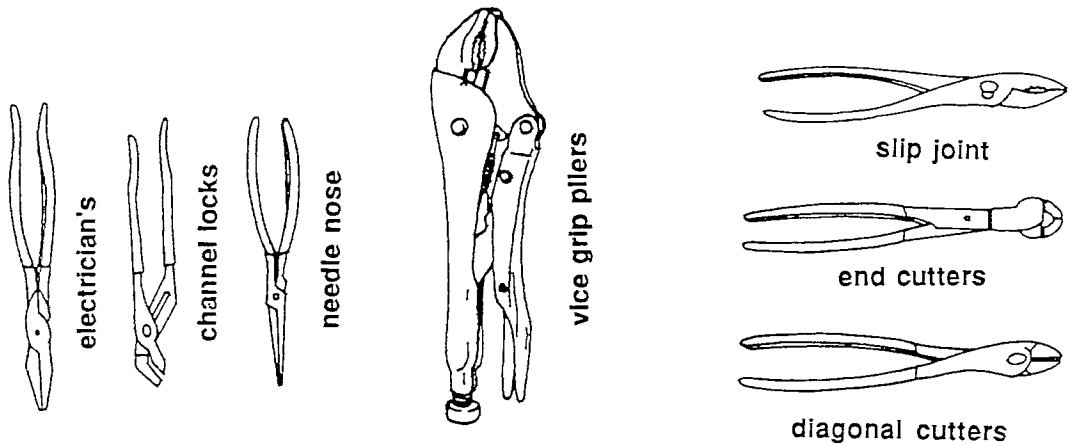
- The hammer head should be larger than the head of the tool (chisel, punch, wedge) that is being hit. For example, a 1/2-inch cold chisel requires a 1-inch diameter or larger hammer head.

1.2 Screwdrivers

- Before using a screwdriver, make sure the tip, shank, and handle are in good condition.
- *Never* hold work in your hand when using a screwdriver.
- Do not use a screwdriver for a chisel, punch, pry bar, or marking device.
- *Never* use a screwdriver for checking electrical equipment.
- Screwdrivers with insulated handles should be used when working around electrical equipment.
- *Never* use pliers to increase the twist of a screwdriver.
- Do not carry a screwdriver in your pocket or clothing.



1.3 Pliers



- When using pliers, be sure you have a firm grip.
- *Never* use pliers on moving machinery.
- *Never* use pliers when you should use a wrench or hammer.
- Remove vice grip pliers carefully to avoid injury to your hands.
- Pliers that have sprung or broken jaws, nicked cutting edges, or other damage should not be used.
- Do not use pliers on nuts or bolts.

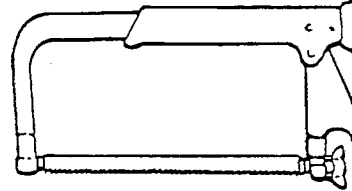
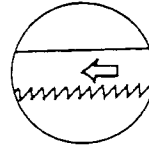
1.4 Files



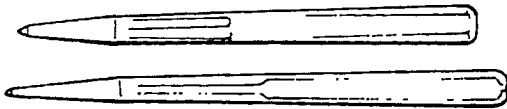
- Be sure the handle is properly secured to the file before using. *Never use a file without a handle.*
- Use a file card to keep the file clean. This will prevent the file from slipping.
- Do not strike an object or pry with a file. Files are brittle and can break easily.

1.5 Hacksaws

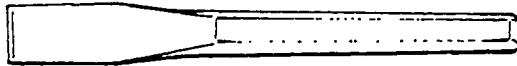
- Inspect the saw's frame to make sure the blade is properly installed. The teeth should be pointing away from the handle and there should be proper tension on the blade.
- *Never* force the saw during the cut. Hacksaw blades are made of hardened steel and can break easily.
- Ease up on the pressure and the stroke as you finish the cut.
- *Never* use a hacksaw as a hammer to knock off a piece of partially cut material.



1.6 Chisels/Punches and Scratch Awls/Scribers



punches



chisel



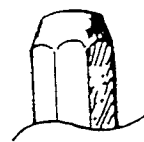
scratch awl

- Make sure the chisel or punch is in good condition before using. Keep the cutting edges properly ground. Do not use a chisel or punch with a "mushroomed" head (see below).

mushroomed head

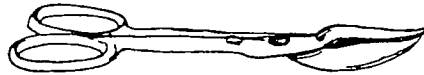


head in good condition

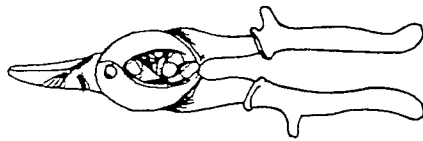


- *Never* attempt to harden the head of a chisel or punch.
- Wear goggles when chipping or cutting with a cold chisel. Before chipping or cutting, make sure other people are not in danger of being hit by flying chips.
- Hold your work in a vise or clamp.
- Scratch awls and scribes are sharp, pointed instruments, and should *only* be used as marking devices.
- *Never* carry a punch, scratch awl, or scribe in your pocket.

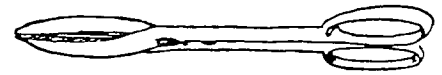
1.7 Combination Snips/Aviation Snips/End and Side Cutters



circular snips



aviation snips



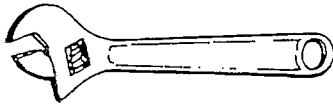
combination snips

- *Never* try to increase the leverage by slipping a piece of pipe over the handles.
- Mount the material to be cut in a vice, if necessary.
- *Never* use two hands to cut with snips or cutters.
- *Never* try to cut through more than the maximum thickness recommended by the manufacturer and/or your teacher.
- Do not use snips or cutters as pliers or as a prying device.
- *Never* attempt to use snips on moving machinery.

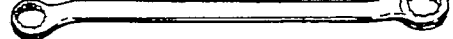
1.8 Wrenches



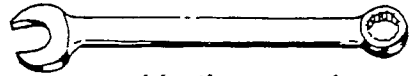
pipe wrench



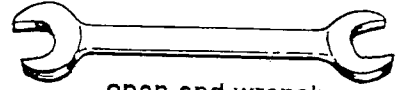
open-end adjustable wrench



box wrench



combination wrench

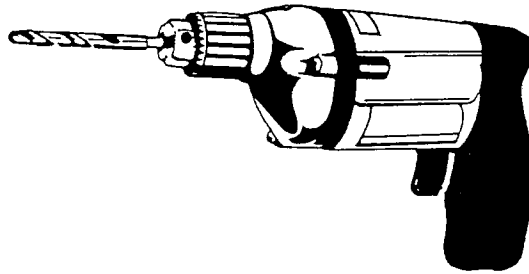


open-end wrench

- Wrench jaws should fit tightly around the bolt or nut.
- *Never* strike a wrench with a hammer.
- *Always* pull on a wrench, don't push. Stand so that you won't fall if the wrench should slip.
- Adjustable wrenches should be pulled so that the pressure is on the *fixed jaw*.
- Do not use adjustable wrenches on tightly frozen nuts or bolt heads.
- *Never* try to use a wrench on moving machinery.

2.0 Portable Power Tools

2.1 Portable Electric Drill

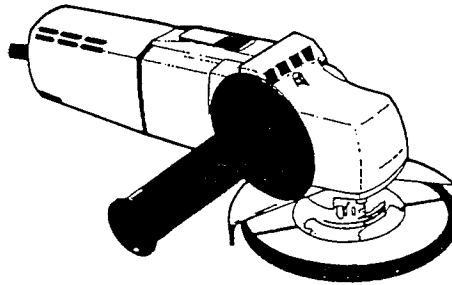


Most portable electric drills have a safety switch which automatically cuts off the power when the trigger is released.

- Obtain permission from your teacher before using the electric drill. Wear the proper goggles.
- Do not use an electric drill with a defective switch. Report the trouble to your teacher immediately.
- Do not use the trigger locking button.

- *Do not use a portable electric drill that has had the ground prong removed.* Most portable electric drills have a three-pronged plug or a double-insulated, polarized plug and cord. Use only the electrical outlets that match the end of the drill cord.
- *Always* use the right-sized drill bit for the job. Do not try to enlarge a hole with a small bit.
- *Always* insert and remove drill bits at your workbench.
- Before drilling, make sure the drill bit is sharp and straight and is held tightly in the chuck.
- Before using the electric drill, remove the chuck key from the chuck.
- Apply a straight and steady pressure when drilling. Do not ram or weave.
- Disconnect the drill from the outlet before removing or replacing a drill bit.
- Let up on feed pressure as the drill breaks through the other side of the work.
- When finished with your work, coil the cord loosely and return the drill to its proper place.

2.2 Portable Electric Grinder-Sander

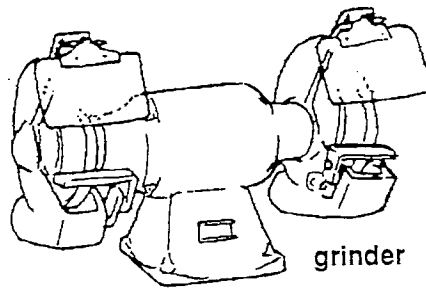


- Ask your teacher before using the portable grinder-sander.
- *Always* wear safety goggles or face shield protection when using the grinder-sander. Use this tool in a well-ventilated area.
- Check the condition of the cord, sanding disk, grinding wheel, and pad. Report damaged parts to the teacher immediately.
- *Never* use a portable electric grinder-sander that is not grounded.
- Be sure the switch is off before plugging the grinder-sander into an electrical outlet.
- Clamp your work securely in a vise while using the grinder-sander.

- Keep the electric cord and plug dry at all times.
- When using the grinder-sander, apply only light pressure.
- When not grinding, place the grinder-sander on a stable surface with the disc side up.
- *Never* stop the grinder with your hands or with the project on which you are working.
- Put up a shield when working around other people. Have spectators stand at a safe distance to prevent injury from flying particles or a shattered disc.
- When finished grinding, clean the grinder-sander, return it to the proper place, and coil the cord.

3.0 Power Tools and Equipment

3.1 Grinder

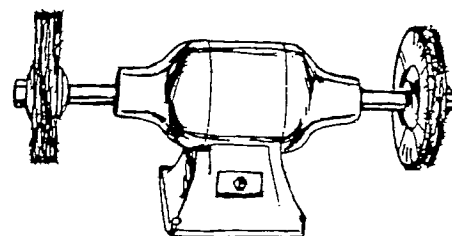


- Ask your teacher's permission before using the grinder.
- Wear goggles at all times. Make sure the safety shield on the grinder is adjusted and fastened tightly to protect your face from flying metal.
- Make sure the tool rest is set as close to the wheel as possible, *never more than 1/8 inch away*.
- Check the grinding wheel before you use it. *Never* use a grinding wheel that is cracked or out of balance.
- When starting the grinder, do not stand in front of it.
- Do not grind on the sides of the wheel. This could cause the wheel to break or become unbalanced.

- Use light pressure on the work. *Never* slow down the speed of the motor by forcing the work into the wheel.
- Check with your teacher before grinding small pieces.
- *Never* hold your work with a rag when grinding.
- If a grinder is running improperly or making unusual sounds, turn off the switch and notify your teacher at once.
- *Never* change the grinding wheel unless you are asked to do so by your teacher.
- *Always* use the tool rest to stabilize your work while grinding.

3.2 Buffer

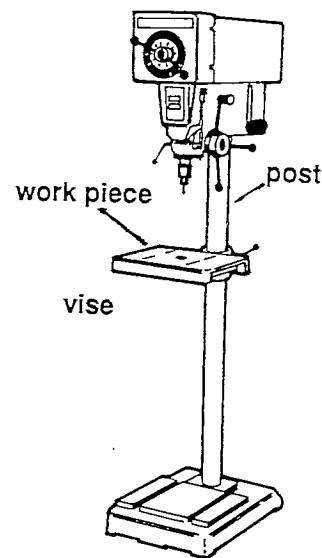
- Ask your teacher before using the buffer.
- *Always* wear a face shield when using the buffer.
- *Always* hold the work below the center line of the buffing wheel. Hold the object to be buffed so that the buffing wheel will not catch on the sharp edge of the work.
- *Never* hold your work with a rag when buffing.
- Use a back-up board when buffing objects made of sheet metal.
- If a buffer is running improperly or making unusual sounds, turn off the power and notify your teacher at once.
- Buffed objects become quite hot. *Always* wear gloves to protect your hands.



buffer

3.3 Drill Press

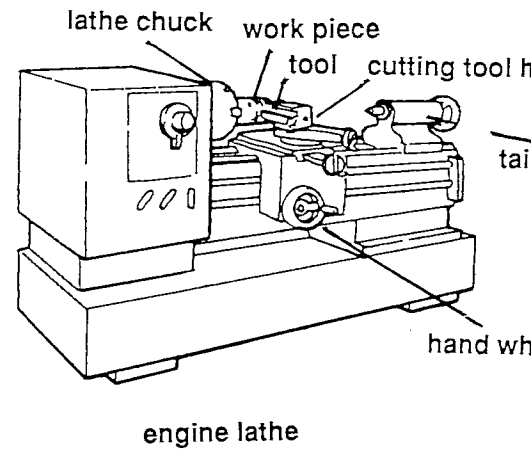
- Ask permission from your teacher before using the drill press.
- Wear safety goggles when using the drill press.
- All work to be drilled must be center-punched and securely held in place with a drill press vise, C-clamp, or V-block. Line up the center-punch mark with the drill before turning the drill press on.
- Roll up long sleeves and keep long hair confined when using the drill press.



drill press

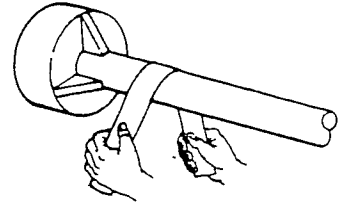
3.4 Engine Lathe

- Ask your teacher for permission before using the lathe.
- Wear safety goggles or a face shield. Be sure to adjust loose clothing and confine long hair before using the lathe. This will prevent clothing and hair from being caught in the lathe.
- Before turning on the power, be sure your work is secure and that all moving parts on the lathe move freely. Make one complete turn by hand.
- To avoid crushing your hands, *always use* a wooden block under the chuck for support when removing or replacing a chuck.
- Take the chuck wrench out of the chuck before turning the lathe on.
- See that all guards are in place before starting the lathe. Make sure all parts of the carriage will clear any moving parts or materials during the entire cut.
- Ask your teacher to check the setup before you start the lathe. Use only the levers and controls you have been instructed to use.
- Only one person may *start, stop, or operate* the lathe. Always look to see that others are not in danger before starting the lathe.
- If you must leave the lathe for any reason, turn the power switch off.
- When turning between centers, clamp the tailstock securely and keep the dead center properly adjusted and lubricated.
- Do not make adjustments, clean, or oil the lathe when it is in motion.
- Allow the lathe to come to a complete stop before measuring the work.
- Use the hand feed to finish a cut near the chuck or when cutting to a shoulder.
- *Remove the tool post* before filing or polishing any work in the lathe.
- Use a bench brush to clean away metal chips. Never clean with your bare hands.
- Do not allow the carriage to come in contact with the chuck.

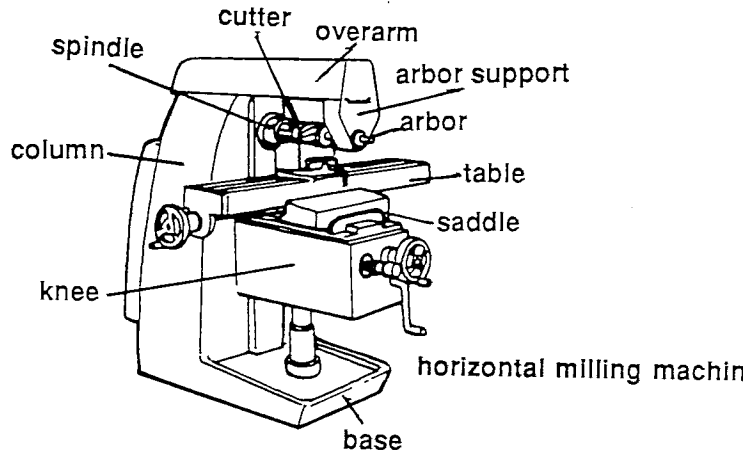
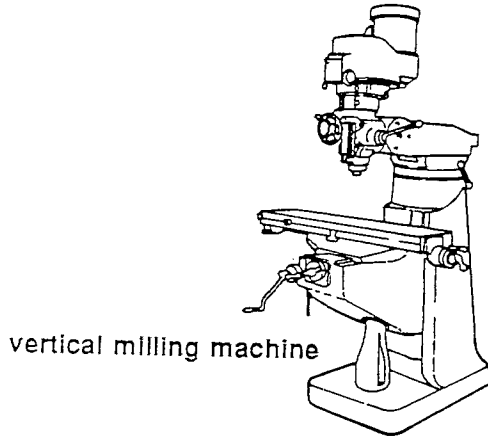


- Remove the chuck key from the chuck before turning the drill press on.
- *Always* set the drill press speed before you begin drilling.
Remember: *The larger the drill bit, the slower the speed should be.*
- *Never* hold the work in your hands. Use a drill press vise to hold the work.
- *Always* be sure you have a secure hold on the drill press table before you loosen the table clamp.
- When drilling round work, always center-punch and use a V-block and clamp.
- If the drill catches on the work, step back from the drill press and shut off the power switch. Wait until the drill bit comes to a full stop before removing the work.
- *Never* try to stop the drill chuck with your hands. Do not try to grab a spinning project with your hands.
- Ease up on the feed pressure as the drill bit breaks through the bottom of the work.
- *Never* clean the drill press while the machine is in motion. Always use a bench brush when cleaning the drill press.
- When drilling thin metal, use a back-up board of wood and clamp both wood and metal firmly to the drill press table.
- *Never* shift belts or make other adjustments while the drill chuck is moving.
- Turn off the switch before removing your work from the table.
- Use a pilot drill before drilling large holes.
- Place long material on the table against the column, and clamp down.
- *Always* use a bench brush to clean away metal chips. Never use a cloth or your bare hands.
- Raise the drill frequently to break long chips and to apply cutting oil.

- Follow start-up procedures provided by your teacher when parting and sawing on the lathe. Do not attempt to remove too much material at a time.
- When polishing spinning work with an abrasive cloth, hold the ends of the abrasive strip in each hand to prevent it from winding around the stock and severely pinching your thumb.



3.5 Milling Machines

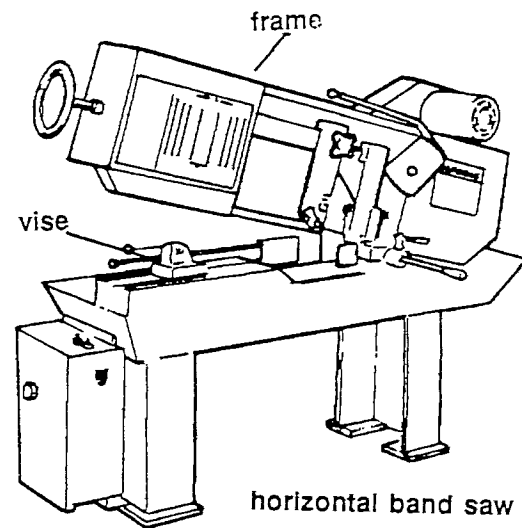
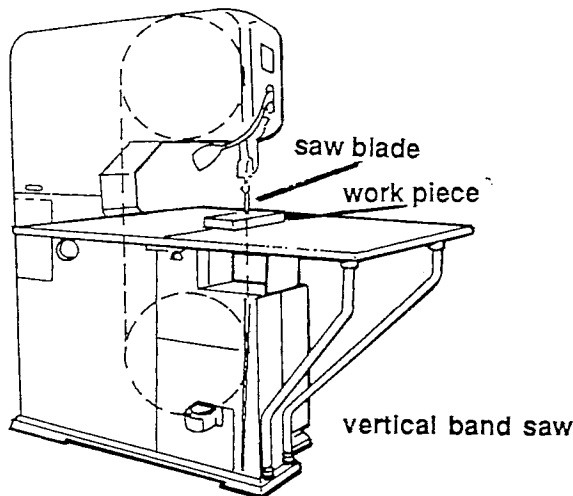


The milling machine is one of the most complex machines in the manufacturing/metals laboratory. The operations that can be performed on this machine vary from plain milling to indexed spiral milling.

- Ask permission from your teacher before using the milling machine.
- Wear the proper safety goggles when using this equipment.
- Set up your work securely in the machine.
- Make sure the work and any holding device will clear the arbor or support during the cut.
- To avoid injuring your hands, handle the razor-sharp milling cutters carefully. Select the proper cutter for the job and use the correct cutter arbor for holding the cutter.
- Ask your teacher to check your setup before you use the milling machine. Disengage all feed controls and the main clutch before starting the motor.
- Only one person may start, stop, and operate this machine. If it is necessary for you to leave the machine, *even for a moment*, turn the power off.
- Keep your hands away from the cutter when the motor is running.

- When you are close to the cutter, be very cautious when using the rapid transverse control.
- When working milling cutters, make sure you have selected the right feed and speed and direction of cutter rotation to prevent overheating and dulling. End mills are extremely hard and brittle and can shatter.
- Turn off the power and wait for the machine to come to a complete stop before cleaning, inspecting, or removing your work.
- When loosening the draw bolt, be sure the cutter holder or arbor does not fall. Use only the correct wrench to loosen the arbor nut. Remove the wrench before turning the power on.
- Turn off the power and release all automatic feeds before leaving the machine.
- *Always* use a bench brush to remove chips from your work or the machine. *Never* use your bare hands to remove metal chips.

3.6 Band Saws

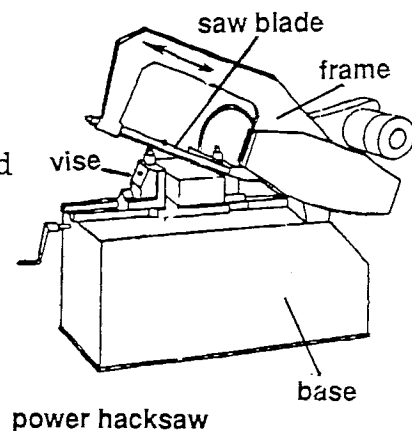


- Ask permission from your teacher before using the band saw. Wear the proper goggles.
- *Never* make adjustments to the machine while the band saw is running.
- Select the proper blade for the material being cut. (See your teacher.)
- Make sure your work is secure and will not wobble when the saw blade pushes down on it. Tightly clamp cylindrical (round) work before cutting it on the band saw so that stock will not rotate.
- Adjust the blade guide to a position of no more than 1/4 inch from the work. All other blade guides should be adjusted by your teacher only.

- Always keep your fingers away from the saw blade.
- Slowly feed the material into the saw.
- When cutting arcs or curves, take care to prevent the blade from binding and breaking. The blade width determines how large or small a curve you can make. Wid blades cannot cut around small curves.
- Before cutting a curve, make some relief cuts. Relief cuts are short, straight cuts that allow unwanted portions to fall as you saw. Turn the saw off if it binds or grabs while you are cutting a curve. Wait until the blade stops before attempting to remove the work.
- If it becomes necessary to back out of a saw cut, stop the machine and carefully remove the work. Never back the saw out of long cuts. This may pull the blade off the wheel or off the guides.
- If the blade breaks or comes off, step back immediately. Shut off the machine.
- When handling work near the blade, use a block, scrap work, push stick, or pushing device.
- *Never* try to stop a coasting band saw blade unless it is equipped with a brake.
- *Do not* stand near person using a band saw.

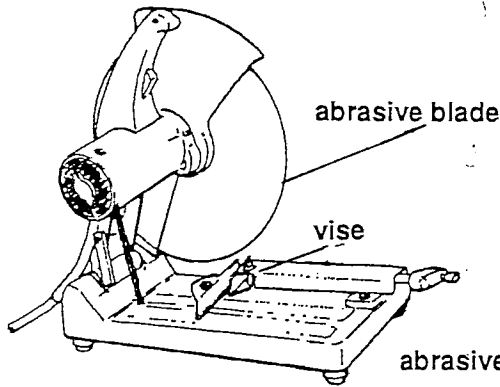
3.7 Power Hacksaw

- Ask permission from your teacher before using the power hacksaw. Wear the proper eye protection.
- Make sure work being cut is held tightly in the machine vise.
- Start the power hacksaw just before the blade is lowered to rest on the work being cut. This will prevent blade breakage and possible damage to the machine.
- Stand to one side while the machine is in operation.
- *Never* attempt to increase pressure on the blade by pushing down on the saw frame.
- If the saw is not equipped with an automatic shut-off switch, stop the machine as soon as the cut is completed. Return the saw frame to its support after a cut is finished.



- *Never* walk away from a saw that is running.
- When the cut has been completed, remove the work and return it to the stockroom. Do not leave any work sticking out from the saw.

3.8 Abrasive Cutoff Saw

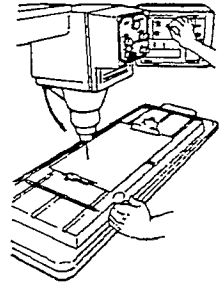


The abrasive cutoff saw is a very powerful machine. Sparks created by cutting work with a blade that turns at high speeds can cause eye injury or serious burns. The saw also produces fumes when cutting.

- Ask permission from your teacher before using the abrasive cutoff saw.
- Wear safety goggles. Roll up long sleeves and keep long hair confined when using this equipment.
- Secure work carefully in the vise.
- *Never* attempt to clean any part of the machine while the power is on. Always use a bench brush to clean the machine.
- If the saw blade locks or sticks in a piece of work, turn off the power. Tell the teacher immediately.
- Material that has just been cut is very hot and should not be handled without using pliers or gloves.

4.0 Computer-Aided Machinery

Conventional machinery (section 3.0) is hand-operated, whereas computer-aided machinery is controlled by a computer. This type of machinery requires extra planning and setup time to ensure efficient production and safe operation.



4.1 Computer Numerical Control Machine

Computer numerical control (CNC) machining is an advanced machining process widely used in both small and large industrial plants. CNC technology, which improves quality, speed, accuracy, and economy, is constantly being improved.

All safety rules that apply to conventional machine tools, such as lathes and mills, also apply to CNC. Some of these rules are:

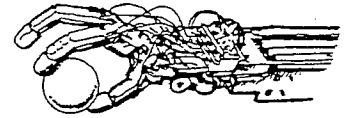
- Do not operate any machine without teacher authorization.
- Remove jewelry and secure long hair and clothing, which can catch in moving machine parts.
- Wear adequate eye protection.
- Keep the work area around the machine clean and clear of obstruction.
- Do not use compressed air to clean the machine. Flying chips can cause serious injury.
- Be sure the spindle has come to a complete stop before making measurements.
- Before starting the machine, securely fasten the work and the work-holding accessory.
- When making adjustments or changing cutting tools, avoid contact with sharp edges and points of tools.
- Cutting tools must be installed securely and correctly.
- Do not operate any machine control until you know how it works.
- Do not attempt to fix any machine without supervision.

- To avoid damage to the CNC machine or injury to yourself, check the tool path by making a dry run. You can do this by:

- Using the manual plotter
- Letting the machine go through the program with no cutting tool
- Using computer simulation on video display.

4.2 Robotics

Robotics is a system which allows machinery to be controlled by humans through the use of electrical signals. These signals are instructions that can be stored in a computer as a program that allows the robot to repeat a task many times in exactly the same way. Robots are sometimes used in areas that would be dangerous to humans.



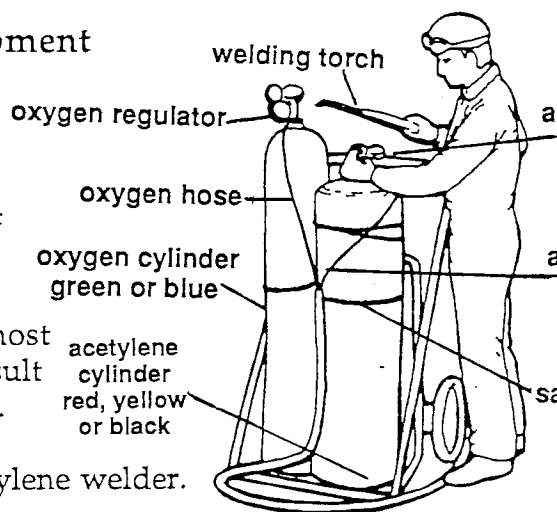
robot arm

- Robots can be programmed to move in many directions. Make sure that the robot has enough room to move in all directions without hitting other objects.
- Robots are controlled by electricity. Make connections in control box centers carefully.
- Place cables and control devices away from water to avoid electrical shock.
- Keep the space around the work area dry.
- Read the manufacturer's manual. Do not force the robot to do more than it was designed to do.
- When operating the robot, stand inside the designated safety zone.
- Be sure your hands are clean and dry. Keep your hair and loose clothing confined when working in the robotic programming area.
- If the robot does not work correctly, turn it off and tell your teacher.
- Keep the work area clean and dry.

5.0 Welding Equipment

5.1 Oxygen-Acetylene Welding

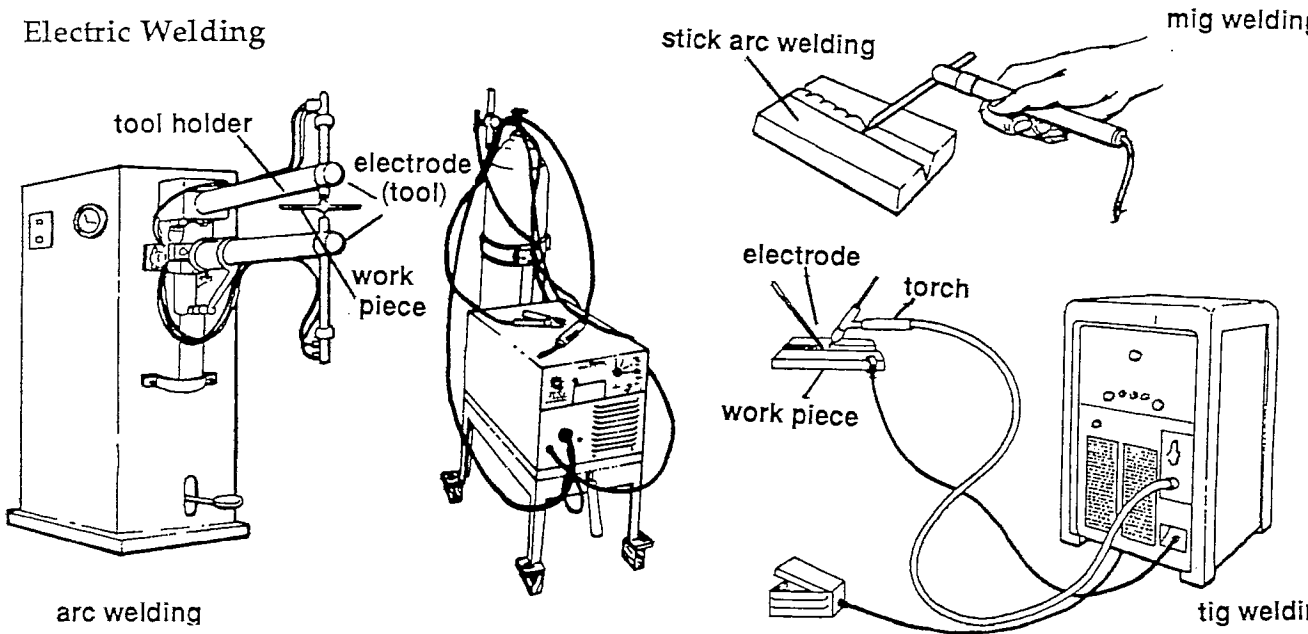
Oxy-acetylene welding is based on the burning of equal amounts of oxygen and acetylene gas to produce a bright, open flame of 6,300 degrees Fahrenheit. This hot flame will melt and fuse most metals. Improper use of this equipment may result in injury to the eyes, severe burns, or explosions.



- Ask your teacher before using the oxygen-acetylene welder.
- *Never look at the open flame unless you are wearing welding goggles.* The welder, and all assistants and observers must wear welding goggles when this equipment is being used.
- Weld only in a well-ventilated area.
- To prevent a fire, keep all surfaces clear of combustible items.
- Use the method demonstrated by your teacher for turning welding equipment on and off. *Never light a torch with another torch.* Always use a friction torch lighter.
- *Never hand a lighted torch to another person. Do not point the torch at another person.*
- Do not tamper with plugs and valves on the welding cylinders.
- Cylinders must be fastened to a cart or table with a chain or other suitable device to prevent them from falling over.
- *Always* close the cylinder valve and cap the cylinder before moving.
- Keep the acetylene cylinder away from sources of ignition.
- *Always* point the lighted torch downward and away from the cylinders and from other students.
- Keep your equipment clean. *Never lubricate or oil any part of the welding equipment.* Explosion can occur when oil comes in contact with the oxygen in the bottle.
- *Never* use a cylinder that is leaking acetylene. Check the connections occasionally for leaks by putting pressure in them and covering with soapy water. Report any leaks in the equipment to your teacher immediately.

- Open the acetylene cylinder valve one-fourth to one-half of a turn, maximum. *Keep the wrench in place* so the valve may be shut off quickly in case of an emergency.
- Keep the acetylene pressure in the hose below 10 pounds.
- Avoid tangles and kinks in the hoses. *Never* allow anything to run over the hoses. Keep all sparks and hot metal away from hoses.
- Keep all flammable materials away from the welding area. Do not weld a tank or receptacle that contains (or has contained) gasoline or other flammable liquids.
- *Always* use extreme caution when moving the welding rig.
- When you have finished welding, cool or quench the metal in water or mark it "HOT" with a piece of chalk. Be careful not to touch pieces of metal that have been welded. Use tongs or pliers to handle hot metal.
- Close cylinder valves when you have finished welding.
- Turn off the torch and remove your goggles before leaving the welding bench.

5.2 Electric Welding



When using electric welding equipment, caution must be taken to prevent burns from ultraviolet rays and hot metal objects.

- Ask permission from your teacher before using electric welding equipment.
- *A helmet with the proper observation window and a pair of treated leather gauntlet gloves must be worn at all times when using this equipment. A leather*

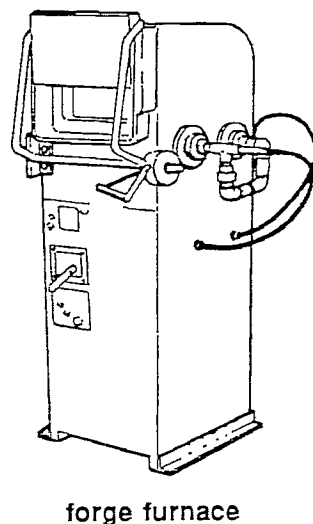
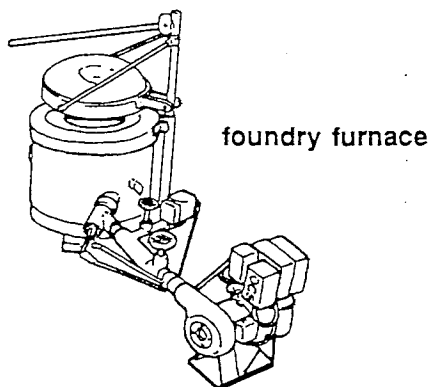
apron may also be worn when needed to protect clothing. Do not wear soft contact lenses when doing arc, tig, or mig welding.

- All observers must wear the proper goggles. Viewing the arc directly can cause arc flash (blistering of the eyeballs). *Do not raise your helmet while welding.*
- Do electric welding only in a booth, welding room, or behind proper screens. Welding may be done elsewhere only with your teacher's approval.
- Check with your teacher before plugging in (or unplugging) a welding machine.
- To prevent rolling, block or secure the welding machine's wheels.
- Only you or your teacher are to alter the work or change the adjustment on the machine.
- Keep flammable materials away from the welding area.
- Keep the floor, cables, yourself, and the work dry at all times.
- Do not handle both the ground and electrode cables at the same time.
- Keep electrode stubs in a can.
- Turn off the welder when work has been completed and place the electrode holder in the proper place. Never lay the electrode holder where it will come in contact with the electrical ground and complete a circuit.
- If the electrical connections become hot, shut off the welder and notify your teacher immediately.
- Be sure to wear safety goggles, eye and face protection, and suitable clothing when chipping the slag from the weld.
- Chip slag only in a protected welding booth.

6.0 Metallurgy and Heat Treatment Technology

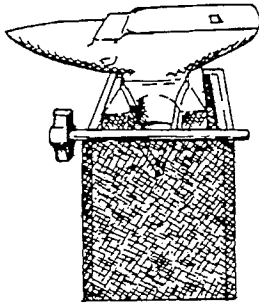
Metallurgy is the technology of creating metals or alloys (combinations of metals) for use in manufacturing. Heat treatment combines heating and cooling of alloys or metals when they are in their solid state. High temperatures are dangerous and must be carefully controlled.

6.1 Forge and Foundry Furnaces

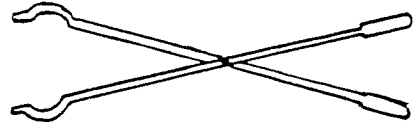


- To light the forging or foundry furnaces:
 - Ask the teacher's permission before lighting the forge or foundry furnace.
 - Open the lid on the furnace.
 - Turn the air on slowly to create a draft.
 - Run the air for one minute in the unlighted furnace.
 - Place a furnace lighter inside the furnace.
 - Stand to one side and turn on the gas. *Never look into the opening of a furnace to see what is happening.*
 - Wait 15 seconds, then check to make sure the furnace is burning properly.
- To turn off the forging or foundry furnace, *always* turn off the gas first, then turn off the air.
- Remember: Furnaces retain heat for a long time. *Treat all furnaces as if they were hot!*

6.2 Forging



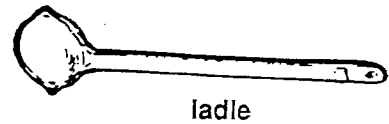
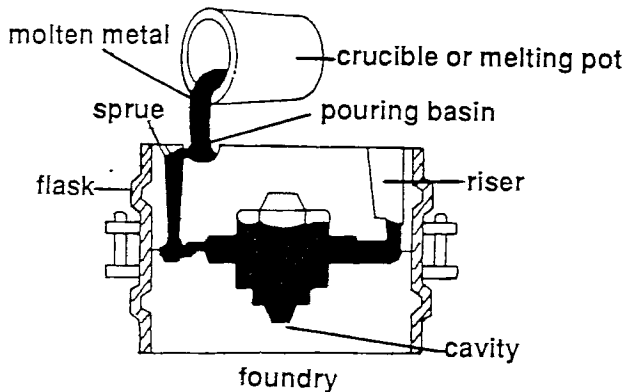
anvil



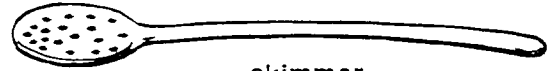
tongs

- Ask permission from your teacher before using forging equipment. Wear a face shield.
- *Always* handle hot metal with tongs or pliers.
- *Always* look before you move when carrying hot metal. Warn other students who may be in the way.
- *Always* pick up tongs by the handles. Cool the tongs in water before setting them down or returning them to the rack.
- Make sure the hammer head is securely fastened to the handle. Check the head as well as the handle for cracks, chips, and other defects.
- *Always* check in front and behind you before swinging a hammer.
- *Never strike the face of a hammer against a hardened steel surface* such as an anvil or another hammer.
- Keep the anvil face clear of scraps of metal and flakes or rust.

6.3 Foundry



ladle



skimmer

Foundry involves the pouring of molten metal into sand molds to create metal castings. There is always a danger of being burned when around hot metal. To avoid severe burns, use the following precautions:

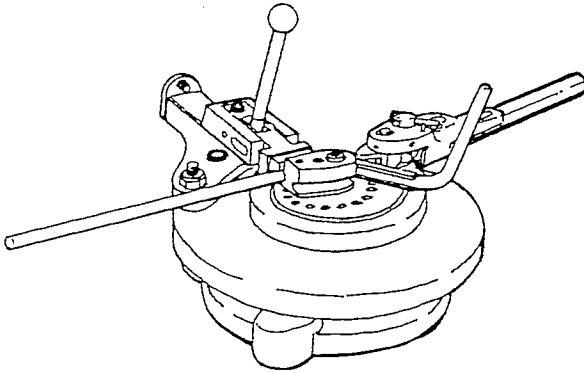
- *Always* ask your teacher's permission before pouring molten metal.
- A face shield, gloves, and an apron must be worn when handling ladles or crucibles containing molten metal.
- Tools, castings, or other metals found in a foundry area may be hot. Check for heat before handling the object. See you teacher if in doubt.
- Water in the foundry area is extremely dangerous. To avoid an explosion, *never* have water near the foundry area.
- Preheat casting metal to remove any water or moisture before placing it in a crucible (melting pot) containing molten metal.
- The skimmer is the tool used for removing impurities on top of the molten metal in the crucible. Preheat the skimmer before using it.
- When carrying molten metal, move *slowly* and *cautiously*. Be sure there is nothing in your way that could trip you. Never carry molten metal over a wet floor or damp sand.
- Always have the mold on the floor when pouring molten metal. Keep the mold covered until ready for pouring.
- Be sure the mold has an exit for steam. All molds must have a riser (large vent hole) or be properly vented with multiple small holes.

- To prevent injury, do not stand directly over the mold when pouring. Pour carefully. Do not let molten metal spill on the floor.
- Make sure observers stand back when the molten metal is being poured into the mold.
- *Always* ask your teacher's permission before breaking a casting out of the mold. Be sure the casting is cool before handling it. Use tongs to handle the mold.
- Tools, castings, or other metals found in a foundry area may be hot. Check for heat before handling the object. See your teacher if in doubt.
- Water in the foundry area is extremely dangerous. To avoid an explosion, *never* have water near the foundry area.
- Preheat casting metal to remove any water or moisture before placing it in a crucible (melting pot) containing molten metal.
- The skimmer is the tool used for removing impurities on top of the molten metal in the crucible. Preheat the skimmer before using it.
- When carrying molten metal, move *slowly* and *cautiously*. Be sure there is nothing in your way that could trip you. Never carry molten metal over a wet floor or damp sand.
- Always have the mold on the floor when pouring molten metal. Keep the mold covered until ready for pouring.
- Be sure the mold has an exit for steam. All molds must have a riser (large vent hole) or be properly vented with multiple small holes.
- To prevent injury, do not stand directly over the mold when pouring. Pour carefully. Do not let molten metal spill on the floor.
- Make sure observers stand back when the molten metal is being poured into the mold.
- *Always* ask your teacher's permission before breaking a casting out of the mold. Be sure the casting is cool before handling it. Use tongs to handle the mold.

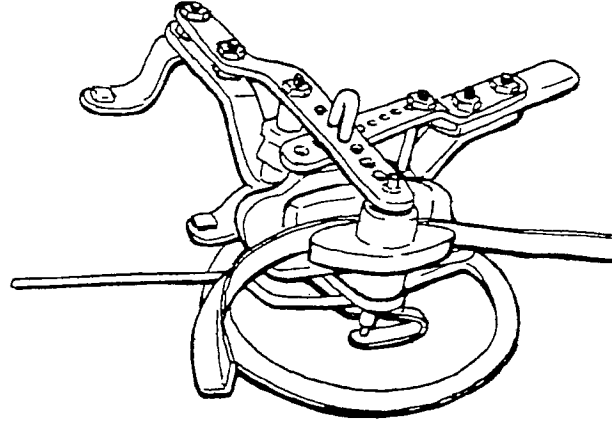
7.0 Heavy Duty Bending Equipment

A number of tools and machines are used to shape material by cold bending. The bending operations change the shape of a piece of material by the use of conventional benders. These machines supply tons of leverage and are dangerous to work with. Brakes, forming rolls, diacro, and multipurpose benders can all be used for this process. Care must be taken with each machine to avoid injury.

7.1 Hossfeld and Diacro Benders



hossfeld bender

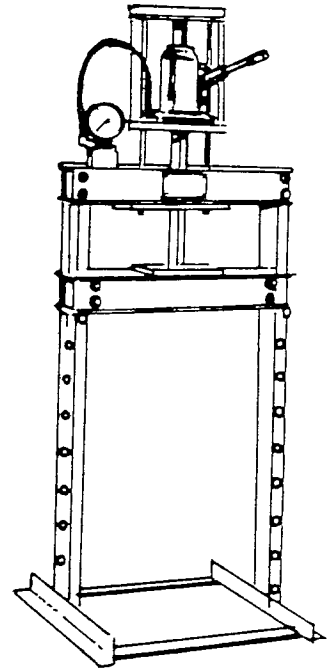


diacro bender

- Ask your teacher before using the bending equipment. Wear the proper eye protection.
- Be sure the floor in your work area is clean and dry.
- Use a handle of proper size. You may damage the machine and possibly injure yourself by using a handle that is too large.
- Do not attempt to bend more than specified by your teacher or the machine's manufacturer.
- Keep your fingers clear of the shoes and the stock being bent.
- Be careful when bending hardened metals to avoid breakage. Do not bend hardened metal without the teacher's permission.

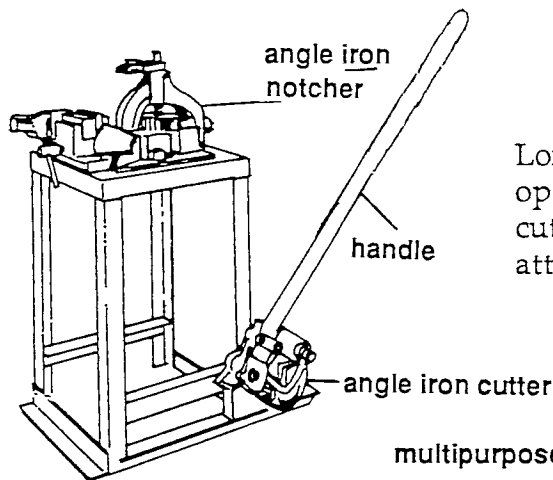
7.2 Hydraulic Press

- Ask your teacher before using the hydraulic press.
- Wear the proper eye protection when working with the press.
- When pressing out bearings or bushings, make sure the work is centered before applying pressure. Apply light pressure; then recheck to see if the work is properly aligned and level. Do not apply pressure if the work is sitting at an angle.
- Have your teacher check the setup before applying the pressure.
- Make sure other students stay outside the working area.



hydraulic press

7.3 Multipurpose Angle Iron Cutter/Bender



Long handles are used to aid the operation of the angle iron notcher, cutter, bender, and rod cutting attachments.

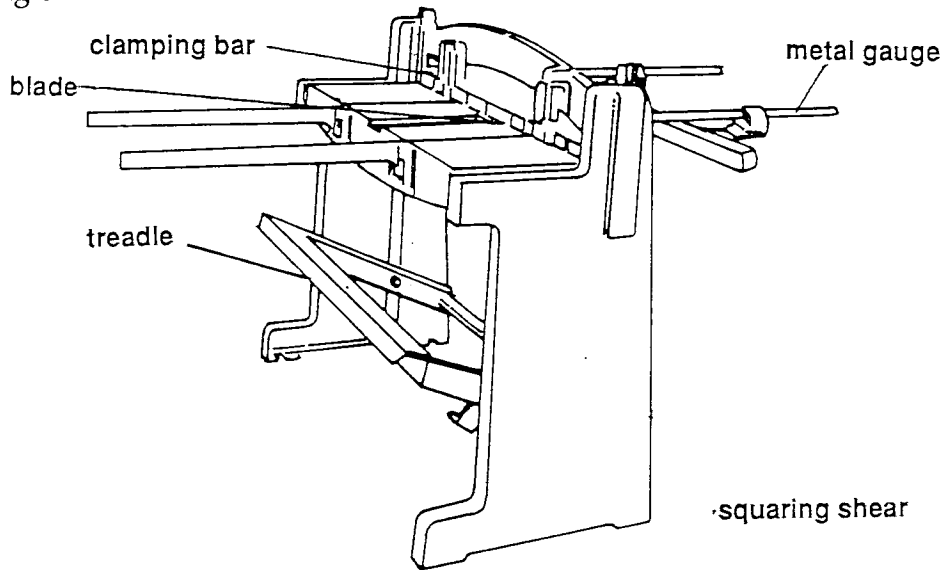
multipurpose angle iron cutter/bender

- Ask your teacher before using these machines.
- Be sure the floor is clean and dry.
- Cut only the size and kind of stock specified by the manufacturer and your teacher.
- Get help as needed when cutting heavy stock.
- Keep your fingers away from all cutting edges and the clamp.

8.0 Sheet Metal Equipment

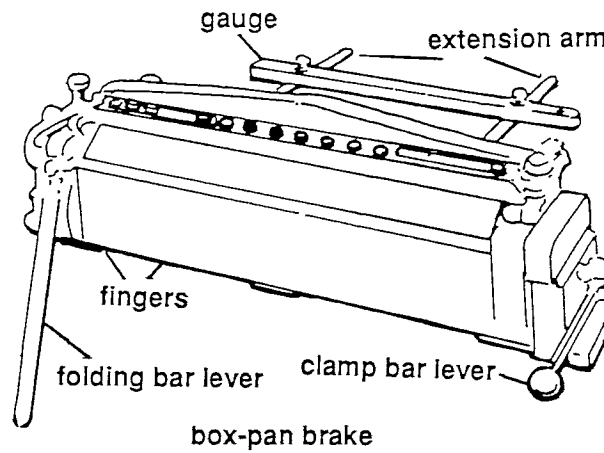
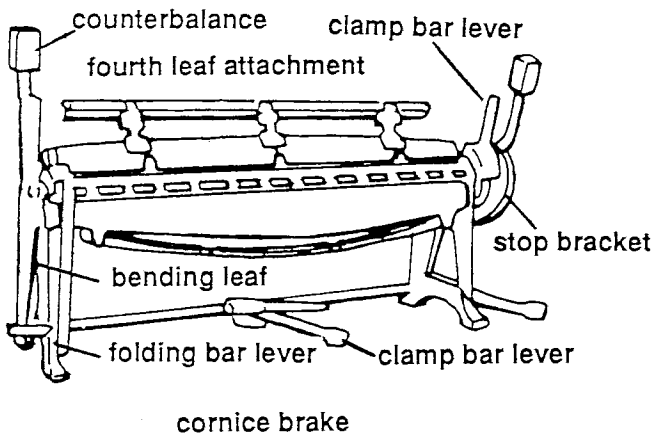
Before using hand- or power-operated machines that cut, form, or bend metal, make sure the material has been deburred. Each metalworking machine is limited in the size, type, thickness, and quantity of material it can safely handle. This information is clearly posted on most machines. If not, ask your teacher for the information.

8.1 Squaring Shear



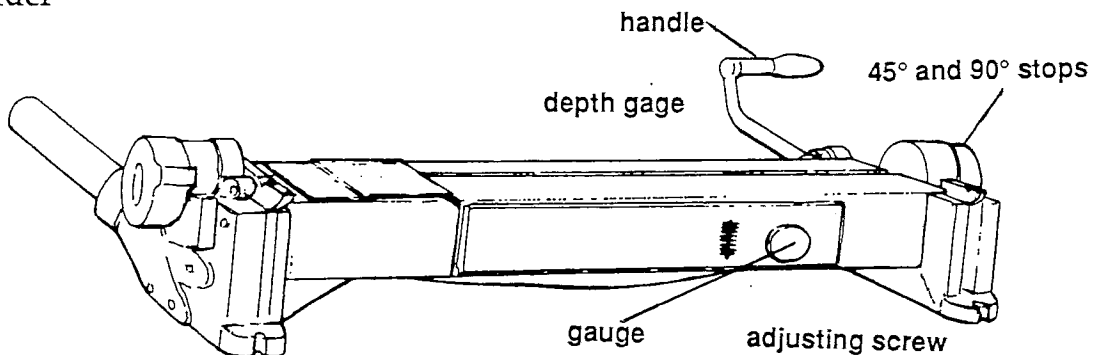
- Ask your teacher's permission before using the squaring shear. Wear the proper eye protection.
- Only one person at a time may operate the squaring shear.
- Operate the machine *only* when guards are in their proper places.
- Keep your hands away from the clamp and the blade.
- Only strips of metal that are wider than three inches can be cut lengthwise on the squaring shear.
- *Never* attempt to catch the piece being cut.
- Do not allow the treadle to spring back after finishing a cut. Keep your foot on the treadle and allow it to come back up slowly.
- Be careful not to push the treadle down on your free foot. Keep this foot clear of the treadle at all times.

8.2 Cornice and Box-Pan Brake



- Ask your teacher's permission before using the equipment. Wear the proper eye protection.
- Only one person at a time may operate the machine.
- Position and tighten all shoes before operating the brake.
- Keep your fingers clear of the clamp bar.
- Before operating the machine, be sure other students are clear of the counterbalances and bending leaf.
- Do not allow the bar to fall back after completing a bend. Keep your hold on the handle and move the bar down slowly.

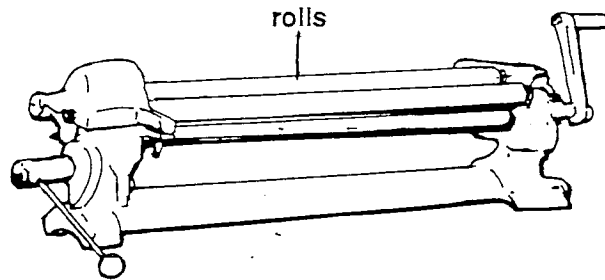
8.3 Bar Folder



- Ask your teacher's permission before using the bar folder. Wear the proper eye protection.
- Only one person at a time may operate the bar folder.

- To avoid pinching your fingers, keep your free hand clear of the moveable bar.
- Do not allow the bar to fall back after completing a bend. Keep your hold on the handle and let the bar down slowly.

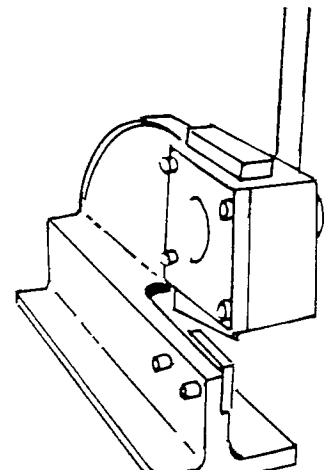
8.4 Forming Rolls



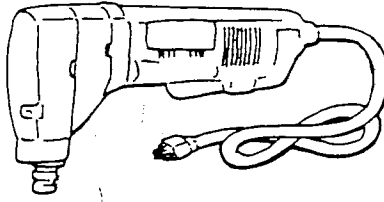
- Ask your teacher's permission before using the forming rolls. Wear the proper eye protection.
- Only one person at a time may operate this machine.
- Keep the hand that is feeding the material clear of the rolls.
- Do not force the handle or push on the material.

8.5 Bench Shear

- Ask your teacher's permission before using the bench shear.
- Only one person at a time may operate the bench shear.
- Keep your hands clear of the cutting blade.
- Stand in a balanced position.
- Do add a piece of pipe or other device to the shear handle to gain more power (leverage in cutting).



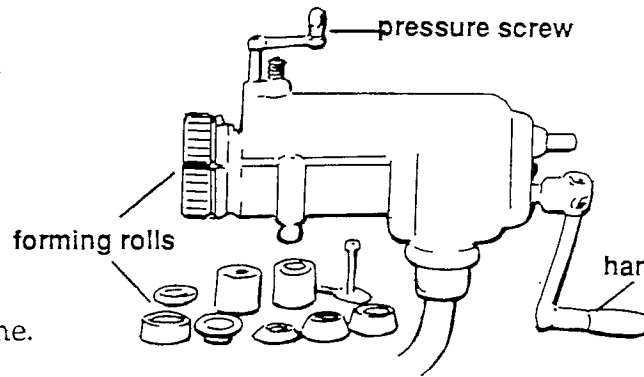
8.6 Portable Electric Shears and Nibblers



- Ask your teacher before using the electric shears and nibblers. Wear the proper eye protection.
- Use the equipment only as instructed.
- Always mount and secure all work.
- Be sure your hands are dry and protected.
- *Watch for flying chips and burrs* on your work during and after cutting. Avoid checking your work with your fingers, as nibblers will leave rough edges on the material.

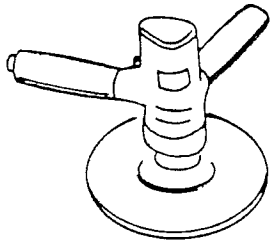
8.7 Rotary Machine

- Ask your teacher before using the rotary machine.
- Wear the proper eye protection when operating this equipment.
- Tighten all nuts and bolts that hold the forming rolls and handle on the machine.
- Stand as instructed in a balanced position in front of the machine.
- Hold your work as instructed. Watch out for rough edges.
- *Always* keep your work against the gauge and well into the machine. Never let the rolls slip off the work.
- Never put excessive pressure on the forming rollers.
- Get help when working on large objects.
- Do not force the machine to work on metal thicker than specified by your teacher or the manufacturer.

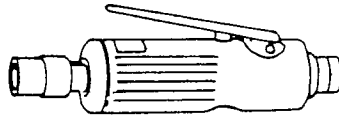


9.0 Pneumatic (Air) Tools

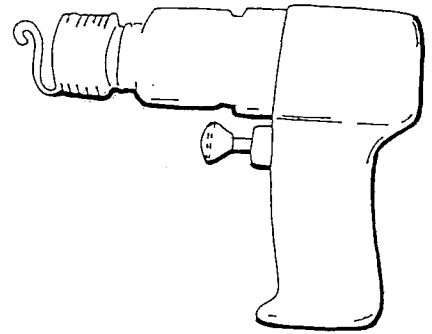
Pneumatic tools are powerful high speed, air-operated hand tools that should be used properly to avoid injury.



air polisher



air die grinder



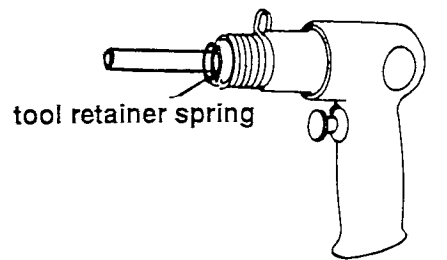
air chisel

9.1 Air Hose

- Ask your teacher for permission before using the air hose. Wear the proper eye protection.
- Air under pressure is extremely dangerous. *Never* play with air nozzles. Use air to blow dust or dirt from your clothing or skin.
- Use both hands to connect or disconnect high-pressure quick-connecting hose couplings.
- Do not allow wheeled carts or jacks to run over high-pressure hoses.
- Use the proper safety devices when cleaning machines and tools with compressed air. Direct the stream of air away from other students.
- Shut off the air and roll up the hose when you are finished.

9.2 Air Hammers

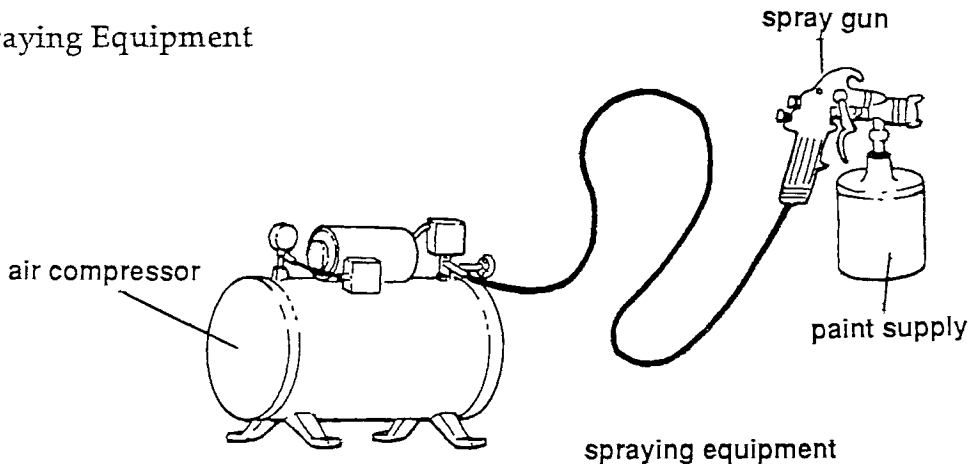
- Ask your teacher's permission before using air hammers. Wear the proper eye protection.
- Do not play with air hammers or other pneumatic tools. Do not squeeze the trigger unless the tool is pressed against the work.
- Use the correct bit for the job. Use the proper procedures for the tool.



air hammer

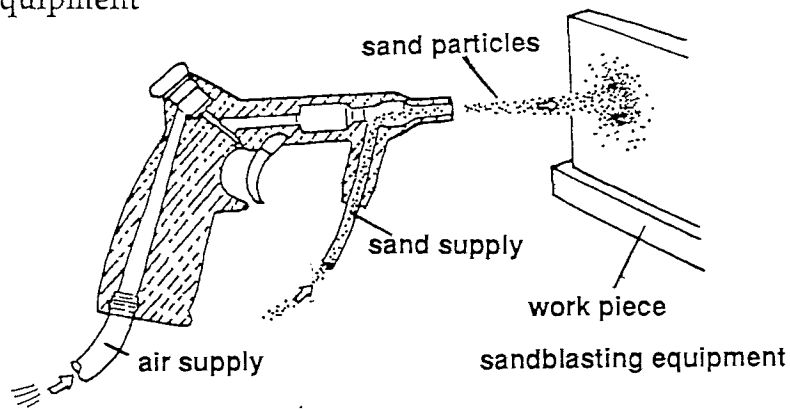
- Air hammers vibrate with great force. Make sure you have a firm grip against the work.
- Do not jam the tool into tight or confined areas. This could injure your hands or cause the bit to fly off or become caught in the work.
- Be sure the tool retainer spring is in place.
- Do not hold a vibrating hammer blade or cutter with your hands.
- Remove all keys and wrenches before you use the tool.

9.3 Spraying Equipment



- Ask permission from your teacher before using spray equipment.
- Wear the proper eye protection. *Special breathing apparatus must be used.*
- Spray only in a well-ventilated area approved by your teacher. *Vapor fumes are highly flammable.* Watch out for sparks, static electricity, and open flames.
- Check the spray gun to determine the correct amount of air pressure to use when spraying. Make sure the relief valve is working.
- Aim your spray gun at your project only.
- If spraying outdoors, work in a sheltered area to prevent the wind from blowing the spray into your eyes or on a car or building.
- Direct the spray away from any observers.
- When you are through spraying, be sure to clean and secure the spray gun and store it in the properly marked area.

9.4 Sandblasting Equipment



- Ask permission from your teacher before using sandblasting equipment.
- Wear the proper eye protection and breathing apparatus. Wear special gloves and a head and face cover. For large jobs, the entire body should be covered.
- When testing the gun, aim it only at your project. Never point the gun in the direction of an observer.
- Work only in a well-ventilated area. Turn off the equipment if you have trouble breathing.
- Use only the air pressure level recommended by your teacher.
- Be sure to clean up all sand from the work area after you have finished.