Machine Safety Program

School of Arts and Communication

Department of Art

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TABLE OF CONTENTS

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INTRODUCTION

The purpose of this guide *is* to provide one source of reference to be used to develop one area of a total safety education program. Supplementary training which includes safety instruction, safety quizzes and other audio and visual aid will be provided by authorized personnel.

This guide alone cannot be used as a complete or all-inclusive method to ensure an effective tool and machine safety program.

Comprehensive Safety Program

While working in the AIMM building shops, safety is the most important priority. The Comprehensive Safety Program includes Occupational Safety training, an instructional lesson, written safety quiz, instructor's demonstration, and student performance evaluation for each laboratory machine.

Step One: Occupational Safety Overview Meeting	The Occupational Safety Specialist will give a presentation outlining general safety concerns and the application of safety rules to each Area Supervisor. The Art department has the responsibility of developing and administering a written safety test to be completed by each student. The test must be approved by the Occupational Safety Specialist before the test is administered. The Art Department is responsible for emailing a PDF copy of the Machine Safety Program to each student. Each student is responsible for returning a signed copy of the Acknowledgement of Receipt form to the Art Department Office, Room 321.
Step Two: Instructional Lesson	The Professional Service Specialist will teach a general safety lesson for students. A written test will follow.
Step Three: Written Safety Quiz	All students must pass the test before they can proceed to use the equipment in the shops. The graded student test will be placed in their respective files for verification, if necessary, at a later date.
Step Four: Instructors Demonstration	The Area Supervisor is responsible to conduct separate lessons for their respective shops. A listing of trained students will be posted in the shops.
Step Five: Students Evaluation	Students will not be allowed to operate shop machines or tools without successfully passing both the written and performance standards of the program as well as returning the signed acknowledgement form. The Area Supervisor is responsible for checking that each student has a sticker on their Student ID Card and are qualified to use the shop equipment.
Step Six: Students Certification	A student is certified to use the shop equipment when he/she has: • returned the signed acknowledgement form indicating that they have received and read the Machine Safety Program manual; • has taken and pass the written test; • has received a sticker on their Student ID card.

AIMM 110 SCULPTURE STUDIO SAFETY RULES

Only Art Students are authorized to be in the shops. Guests and visitors are prohibited from being in the shops.

Authorized personnel mentioned in this manual are persons trained in the operation and safety of the equipment.

SHOP SAFETY

The first step in preventing personal injury in a machine shop is to make sure that you are familiar with and know how to operate the equipment you will be using. If you are not sure about what you are doing, ask the Area Supervisor. Accidents are caused by rushing, inattention, taking shortcuts, horseplay, bad judgment, fatigue, uncooperativeness, improper clothing, defective tools, etc. Accidents can be minimized by strictly following the safety rules given in the following pages and by cooperating with, and following any additional instructions, the Area Supervisor might have. Attending the Safety Lecture, passing the Safety Test, and receiving instruction from an Area Supervisor are necessary prerequisites for using the machine shops. This Safety Lecture must be repeated every year. When you pass the Safety Test a sticker will be placed on your ID card and you will be added to the Authorized Machine Shop Users List.

If you violate any safety rules, you will lose your machine shop privileges as stated below:

1. **First offense – 1 day.**
2. **Second offense – 1 week.**
3. **Third offense – for the entire school year.**

SHOP HOURS

- Regular hours for all shops are posted on the entrance doors of room 110.
- Under no circumstances may work be done in the shop between 10:00pm and 8:00am.
- The shops may be used only when the machine power is ON and a faculty or staff supervisor is present.
- Access to the machine shop may be limited during scheduled classes, vacations, and holidays.

EMERGENCIES

Know the locations of:

-the first aid kits

-the main electric shut-off button

-the yellow phone at the main entrance: dial 911 or hit RED button for local emergency response

-the fire exits

SHOP EMERGENCY PHONE

The emergency shop phone is located in AIMM 110, next to the main entrance. In an emergency situation call 911 from the emergency phone or (609) 771-2345 from a cell phone. By pressing the button on the emergency phone or by dialing 911 on the campus emergency phone, students will reach campus police. *Dialing 911 on a cell phone will delay your connection to Campus Police. If you need to reach Campus Police from a cell phone dial (609) 771-2345. It is a good idea to store this number in your address book.*

SHOP EMERGENCY SHUT DOWN BUTTONS

Emergency stop switches are located throughout the shop on the walls of the shop. Pushing the red stop button (4 located in each room) will turn off all power to machinery.

GENERAL SHOP SAFETY RULES

- Fire Regulations

✓ never block exits.
✓ minimum 3 foot wide entrance to each studio.
✓ studios cannot be completely enclosed or have locked doors.
✓ nothing can be attached to pipes, electrical conduits, sprinklers, or lighting fixtures.
✓ flammable and combustible materials must be stored in flammable storage cabinets.
✓ no open-coil hot plates.

1. Only use wood and plexi glass in the woodshop area (NO METALS!) and work only with metals in the metal area. Plaster and clay may only be used in the plaster room.
2. At this time Welding is not permitted in the Sculpture Studio.
3. Only use approved materials (for example no cutting or sanding of MDF. In the woodshop only use new, plain, untreated wood or plywood. Do NOT use particle board or MDF.
4. Do not bring questionable materials into the building. Do not bring chemicals or fuels into the building. Animals cannot be used in projects. Any food used must be removed promptly.
5. All work must be done in designated areas; i.e.: no metal working in the woodshop etc.
6. Hazardous objects or installations are not allowed and will be dismantled.
7. Actions not in accordance with shop rules will result in immediate termination of shop privileges.
8. Always use the dust collector unit; always clean up after yourselves, including sweeping up (saw) dust.
9. Tag all work and materials.
10. Consult studio staff before engaging in any project in the studio that may require a large amount of space, architectural construction, extraordinary feats of engineering know-how, or anything else that may seem out of the ordinary.

11. You must get approval from your instructor or studio staff to start construction. If fire code violations are discovered they will be corrected without delay.
12. Safety glasses cover goggles, or face shields are required at all times in all shop areas.
13. The minimum footwear must cover the entire foot. Inappropriate footwear such as wearing open toed shoes, high heels, or platform shoes will prohibit entry into any shop area.
14. Do not operate any item of equipment unless you have been trained in its operation. Misuse of tools will result in the immediate suspension of shop privileges.
15. Do not consume reality altering substances before or during work in the shop. **Do not bring food, snacks, or drinks into any shop area**.
16. Avoid use of compressed air to blow dirt or chips from machinery, use a brush instead. Never use compressed air guns to clean clothing, or hair. Never aim a compressed air gun at another person.
17. In case of injury report it to the Area Supervisor. In an emergency situation use the yellow shop phone located near the entrance and call 911 or (609) 771-2345 from a cell phone to reach Campus Police. It is a good idea to program these phone numbers into your cell phone address book. In a non-emergent situation the student must report the Student Health Services located at 107 Eickhoff Hall (609) 771-2483 for first aid. If a *student worker* is injured he/she must go to Capital Health Hospital.
18. Do not attempt to remove foreign objects from the eye or body before seeking medical treatment. If chemicals get in the eye(s), wash eye(s) for 15 minutes in the Eye Wash Station before proceeding for medical treatment. The Eye Wash Stations are located in AIMM 110 next to the sink in the metal area.
19. Machines must be shut off and at rest when cleaning or adjusting.
20. Do not wear ties, lanyards, loose clothing, **jewelry**, gloves, etc. around machinery. Long hair must be tied back or covered to keep it away from moving machinery. Hand protection in the form of high heat gloves, like Kevlar or Neoprene, should be used for handling hot objects, glass or sharp-edged items.
21. Wear appropriate clothing for the job (i.e. do not wear short sleeve shirts, short pants, or sneakers when welding).
22. Do not work in the shop if you are in a hurry or tired.
23. Never indulge in horseplay in the shop areas.
24. All machines must be operated with all provided guards and shields in place. At no time can machines be operated without the guards in place.
25. A brush, hook, or special tool is preferred for removal of chips, shavings, etc. from the work area. Never use your hands. Never use an Air Gun!
26. Keep fingers clear of the point of operation of machines by using special tools or devices, such as, push sticks, hooks, pliers, etc. Never use a rag near moving machinery.
27. A hard hammer should not be used to strike a hardened tool or any machine part. Use a soft faced hammer.

28. Do not block open any machine shop door.
29. Keep the floor around machines clean, dry and free from trip hazards. Do not allow debris to accumulate.
30. Think through the entire job before starting.
31. Before starting a machine, always check it for correct setup and always check to see if the machine is clear by operating it manually, if possible.
32. No work may be performed in any shop using power tools unless at least two people are in the shop area and **can see each other**.
33. Don't rush or take shortcuts. Obey all safety rules.
34. If you have not worked with a particular material before, check the Material Safety Data Sheets (MSDS) book in AIMM 110 for any specific precautions to be taken while working with the material. Also, ask the Area Supervisor before cutting any unusual material.
35. Painting and heavy sanding should only be done outside (patio area) or in the designated area which is the spray booth.
36. Follow all MHDS Sheets, which are posted on wall near entrance, regarding precautions when working with solvents, paints, adhesives or other chemicals. Use appropriate protective equipment such as gloves, goggles, and masks.
37. Before using always check the power cords and plugs on portable tools for wear before using them. Do not use if portable tools are damaged. Notify the shop supervisor about the damaged portable tools.
38. Always store oily rags in an approved metal container.
39. Note the location of the nearest fire extinguisher by observing their location on the shop wall as well as at each welding station.

DRILL PRESS SAFETY RULES

1. Run drill at correct RPM for diameter of drill bit and material. Ask the Area Supervisor for the correct RPM.
2. Always hold work in a vise or clamp the work to the drill table.
3. Use a correctly ground drill bit for the material being drilled. The Area Supervisor can help select the correct bit.
4. Use the proper cutting fluid for the material being drilled. Ask the Area Supervisor about the appropriate fluid for the material you are machining.
5. Remove chips with a brush, never by hand.
6. Ease up on drilling pressure as the drill starts to break through the work.
7. Always inspect the drill before using and do not use a dull or cracked drill or drill bit.
8. Always try to support the work on parallels or a backing board when drilling thru material.
9. Never place taper shank tools such as large diameter drills or tapered shank reamers in a drill chuck. Only straight shank tools such as standard drills can be clamped in chucks.
10. Always clean drill shank and/or drill sleeve, and, spindle hole before mounting.
11. Remove taper shank tools from spindle or sleeve with a drill drift and hammer.
12. Never try to loosen the drill chuck while the power is on.

13. Lower the drill spindle close to the table when releasing the drill chuck or taper shank drill to reduce the chance of damage in the event they fall onto the table.
14. Never clean the machine while it is in motion!!
15. If the drill binds in a hole, stop the machine and turn the spindle backwards by hand to release the bit.
16. When drilling a deep hole withdraw the drill bit frequently to clear chips.
17. Always remove the drill chuck key or the drill drift from the spindle immediately after using.
18. Let the spindle stop of its own accord after turning the power off. Never try to stop the spindle with your hand.
19. Plexiglas and other brittle plastics can be difficult to drill. Ask the Area Supervisor for advice on drill and coolant selection when drilling these materials.

GRINDING SAFETY RULES

1. Abrasive wheel machinery shall not be operated without guards in place. Be aware of pinch points.
2. Tool rests on bench or pedestal grinders shall be set no more than 1/8 inch from the wheel.
3. Never use a wheel that has been dropped or received a heavy blow, even though there may be no apparent damage. Such wheels may be weakened or unbalanced enough to fly apart on startup.
4. Stand to one side when starting machine.
5. Do not grind on side of wheel unless wheel is specifically designed for such use.
6. Do not use excessive pressure while grinding.
7. Report to the Area Supervisor immediately any cracked, broken or otherwise defective wheels.
8. Have the Area Supervisor mount and balance new wheels.
9. Keep the grinding wheel dressed. Dressing a small amount frequently is better than having to dress a lot later and will allow the wheel to cut faster, cooler and with a better surface finish.
1. Dressing is cleaning and smoothing the surface of the grinding wheel.
10. Hold work securely while grinding, use the tool rest to support the work when offhand grinding on bench or pedestal grinders.
11. Do not grind aluminum.
12. Wear goggles over safety glasses when grinding on bench or pedestal grinders.

VERTICAL BAND SAW SAFETY RULES

1. Always wear safety goggles, hearing protection, and use the dust collection system. Secure all loose clothing, hair and hanging jewelry.
2. Clean the table and the area around the band saw before beginning work and when you are finished.
3. Saw only stock which is free of dirt, paint, nails, splits, warps and loose knots.

4. Make all adjustments to the machine before turning it on. Never open the wheel enclosure doors while the machine is in operation. Adjust the upper guide post so that it is no more than 1/4 inch above the work.
5. If the blade is not tracking properly or needs adjustment stop the machine and see the instructor. Do not use a dull blade.
6. Be extremely cautious of the exposed blade. Keep fingers clear. Never allow your hands or fingers to be IN LINE with the blade. Make sure your fingers are out of the way as you near the end of a cut.
7. Avoid backing out of saw cuts. You could pull the blade off the wheel.
8. If a blade breaks, step back quickly, turn off the saw, and report to the instructor.
9. Clean up.
10. The upper guide and guard should be set as close to the work as possible, at least within ¼ inch.
11. If the band breaks, immediately shut off the power and stand clear until the machine has stopped. The installation of new bands will only be performed by authorized personnel.
12. Examine blade before installing to see if it is cracked, do not install a cracked blade.
13. Use the proper pitch blade for the thickness of the material to be cut. There should be at least 2 teeth in the material when cutting aluminum and three teeth when cutting steel.
14. Do not run the band saw at a higher speed than recommended for the material being cut.
15. If the saw stalls in a cut, turn the power off

HORIZONTAL BAND SAW SAFETY RULES

1. Clamp the work-piece firmly in the vise, but don't over tighten!
2. The vise jaws must be parallel. Use a spacer block when cutting short or odd shaped pieces to keep the jaws parallel.
3. Support the descent of the saw as it starts the cut, or for the entire cut when cutting thin stock or if the saw drops rapidly.
4. Use only the correct blade for the material being cut. (Fine blade for steel, coarser one for aluminum, plastic or wood.)
5. Adjust the blade guides and rollers properly, and adjust the speed. The leading saw guide should clear the jaws when it descends, but be as close to the jaws as possible.
6. Check the work-piece to be sure it is free of defects (i.e. broken off tool bits).
7. A minimum of three teeth must be engaged in the work-piece at all times or the teeth will be torn off of the blade.
8. Hold round stock securely with a "V block" in a vise.
9. The Horizontal Band saw is a flood coolant machine; the fluid that flows over the blade is re-circulated. If the fluid is not flowing inform the Area Supervisor immediately and it will be refilled.

TABLE SAW SAFETY RULES

1. It is the responsibility of those using the table saw to first determine if this machine is the safest way to accomplish the desired task.
2. Always wear safety goggles, hearing protection, and use the dust collection system. Also, do not wear loose or dangling clothing and jewelry.
3. Clean the table of the machine and the floor around the saw before beginning work, and then again when you are finished.
4. Position the saw guard, splitter and anti-kickback device before turning the saw on. (See "Operational Guide to Saw Guards", Sculpture Studio files.) Always lock out power before changing the saw guard or servicing the machine in any way.
5. Use only new stock that is free of dirt, paint, nails, loose knots, splits and warps. Also, attempting to rip short, narrow or thin Sculpture invites trouble.
6. Stock should be surfaced on one side and at least one edge jointed before being cut on the saw.
7. Make sure that any necessary aids such as a push stick, push blocks, or rollers to catch outgoing Sculpture are ready before beginning an operation. If a person is going to help you cut a large piece of stock, be sure they only support the stock and do not attempt to push or pull it. YOU, the operator, must control the feed and direction of the cut.
8. Be certain the blade to be used is sharp and the proper type for the operation.
9. Adjust the height of the blade to no more than one-eighth inch above the stock to be cut.
10. Stand to one side of the blade, and never reach across, behind or beyond the blade while cutting. Again, your hands should never be IN LINE with the cutting blade. Maintain a four-inch margin of safety: do not let your hands come closer than four inches from the blade. USE the push stick.
11. Be sure no one is standing in a direct line behind the saw.
12. Always use either the rip fence or the miter gauge when cutting. NEVER CUT STOCK FREEHAND. When setting the rip fence, make sure that the fence locks parallel to the blade. Otherwise the Sculpture can bind and kick back. Never use the miter gauge in combination with the rip fence unless a clearance block is used. Never try to support both pieces on opposing sides of the saw blade when using the miter gauge; support the portion positioned against the gauge side only. When ripping, always support the portion of your piece that is in between the rip fence and the blade.
13. If you tilt the blade or change the miter gauge, return them to their original position after using the saw. When changing blades always be sure that the washer and lock-nut are tight to the blade.
14. When making a cut, make sure you pass the stock completely past the blade as you finish your cut. NEVER BACK UP STOCK ONCE YOU HAVE PROCEEDED WITH A CUT. If need be, stop, and shut the machine down. Always turn the saw off before attempting to remove scrap.
15. Never talk to anyone or let them distract you while the saw is running. Keep your attention focused on your work.
16. Never cut free between the fence and the blade
17. Stand to one side, never directly in line with, work being fed through the saw.

18. Use the proper blade for the material and type of cut. Do not use a rip blade for cross cutting or a crosscut blade for rip sawing. Do not use a plywood blade for anything but plywood.
19. Inspect the blade before using it, to make sure it is the proper blade and is sharp and free from cracks.
20. Never allow your fingers to get near the blade when sawing. Use a pusher stick to rip narrow pieces of stock. Don't use pusher stick to remove scrap. For scrap removal, shut off machine and wait until blade stops, then remove scraps.
21. Attached guards must be in place at all times. Never remove the guard. Ask the Area
22. Supervisor for help if you think the guard is in the way.
23. If the piece of material you are cutting is large, get someone to assist in tailing-off for you.
24. Never try to do it alone. Tailing off refers to supporting a large work piece by supporting it underneath with your hands.
25. 23. If you are tailing-off for someone else let them guide the work through the saw. You should just support the work without influencing the cut. The operator will advise the assistant of the procedure.
26. 24. Never reach over the saw to obtain something from the other side.
27. 25. When shutting off the power, never attempt to stop the saw quickly by shoving anything against the blade. Make sure the saw has stopped before leaving it.
28. 26. Never make any adjustments to the saw while it is running. Turn off the power and make sure the saw is completely stopped before attempting to adjust it.
29. 27. Do not allow material to collect on or around the saw table. Sweep up sawdust and material scraps regularly while working to minimize chances of slipping or stumbling.
30. 28. Make sure that you clean up thoroughly around the saw before leaving the area. If you don't you could be the cause of someone else having an accident.
31. 29. The circular blade of the table saw should be set to 1/4 inch above the work. Dust collection system must always be operating when saw is in use.

RADIAL ARM SAW SAFETY RULES

1. Always wear personal protective equipment (i.e.: safety goggles) before operating equipment.
2. Blade should only be changed by authorized personnel.
3. Select the proper blade for the cut to be made. Check the blade to be free of cracks or nicks, and that it is sharp.
4. Limit the blade extension to 1/4 inch beyond the piece being cut.
5. Use the ripping fence or the cutoff gauge when cutting material, but don’t use both of them at the same time!
6. Cut the work piece at a moderate rate, but not so fast to slow down the motor.
7. You may not cut any work-piece on the radial arm saw that is less than 12 inches in length.
8. The radial arm saws are for cutting wood or plastic materials only!

SQUARING SHEAR SAFETY RULES

1. Always wear personal protective equipment (i.e.: safety goggles) before operating equipment.
2. Keep fingers and measuring scales out of the way of the blade.
3. Do not cut round stock or anything except sheet metal in the shear!
4. Place the sheet against the guide and then clamp it in position with the clamp on the machine.
5. Don't jump up and down on the treadle. Operate with one foot, or stand on it and use the other foot to stomp the treadle down.
6. Return the treadle to the up position slowly with foot pressure. Do not let it make a rapid return.
7. Pick up the scrap pieces when you have completed cutting.

POWER BREAK SAFETY RULES

1. Bend only sheet stock in the brake. No round stock!
2. Adjust the clamping bar correctly to suit gauge of metal being formed, and stand clear of the moving part of the brake.
3. Keep fingers clear of the jaws of the brake.

CIRCULAR SAW SAFETY RULES

1. Before using any power tool, inspect it to make sure the cord is not damaged in any way, that the ground pin is intact, and that the blade is sharp and undamaged. Check the guard does not stick.
2. Do not use the saw in a wet area.
3. Do not run the extension cord across walkways where people might trip over it or where the cord may be run over and damaged.
4. Keep your head out of the path of particles thrown out by the blade.
5. Disconnect the power cord before cleaning, changing blades, or making any adjustments to the saw.
6. When it is necessary to raise the guard for certain types of cuts, always use the guard lever.
7. **Never** wedge, wire, or otherwise jam the guard to prevent it from working. **This is a particularly dangerous practice and will cause your permission to work in the machine shop to be revoked immediately!!!**
8. Wait until the saw stops before lifting it from a cut.
9. Before setting the saw down, make sure the guard is closed, as the blade may still be turning.
10. Don't carry the saw with your fingers on the switch trigger.
11. Don't pull the saw backwards in a cut if you can avoid it.
12. Use the proper blade for the type of cut.
13. Do not use the cord to move or drag the saw as it can damage the wiring.
14. Do not use the power hand saw for cuts if you cannot keep a firm and secure grip on the saw and the material being cut. A hand saw is still the best for some kinds of work and often faster.

15. Before cutting small work pieces consult the Area Supervisor for appropriate training.

DISC AND BELT SANDER SAFETY RULES

1. Do not operate sanders without the guards in place.
2. On the disc sander always use the downward motion side of the disc to sand. Never the upward motion side as this can throw your part upwards with tremendous force.
3. Always attempt to place your work against the rest on the disc and belt sanders.
4. On the horizontal belt sander, always sand, so that the belt motion is away from you.
5. Do not operate machines with torn or ripped belts or disks.
6. Do not sand any material that will give off a dangerous dust. Such materials as beryllium or copper beryllium alloys must not be sanded or filed. Asbestos must not be sanded. Asbestos is an ingredient of brake shoes and pads.

SCROLL SAW SAFETY RULES

1. Do not operate the scroll saw without the guards in place.
2. Make all adjustments with the power off, and then rotate the motor by hand as a final check.
3. Be sure hold down (clamp) is pressing lightly on the work piece.
4. The blade should be held firmly in the chucks, be square with the table, and be properly supported by the guide assembly.
5. Guide the material slowly through the machine with both hands, keeping fingers away from the cut line.
6. Consult the authorized shop personnel for the correct blade and correct speed for the material to be cut, and for the smallest radius required.

MULTI-MEDIA

1. The combination of various materials has become common place in the field of sculpture. All materials which are brought into the studio must be examined and approved before they can be used by the TCNJ sculpture faculty.
2. The combination of various materials and methods used to secure them may pose hazardous conditions for both the user and studio environment. Extreme caution must be used when using various glues, adhesives or unorthodox methods of combining materials. Approval from TCNJ sculpture faculty is mandatory.

SAFETY RULES FOR HEAVY SANDING OF WOOD AND FOAM

1. Always sand outside (patio area) or in the designated area (spray booth).
2. Use a vacuum or a dust collector to collect dust **while** sanding to prevent the dispersal over a large area.
3. A dust mask should be worn.

WELDING SAFETY RULES

AT THIS TIME WELDING IS NOT PERMITTED IN THE SCULPTURE STUDIO.

Area Supervisor approval is required before using any welding equipment.

1. Welders, assistants, and anyone else in the welding area shall wear glasses or shields of recommended shades during welding operations.
2. A screen shall be erected around the welding area to protect other personnel in the shop from injury.
3. Inspect all welding equipment to be used, prior to each use, for possible damage.
4. Never handle oxygen bottles with greasy hands, gloves or rags. Fatal explosions have resulted from this practice.
5. Always strap tanks to a welding cart or a fixed object. Never allow a gas cylinder to be free standing. Replace the safety cap on all cylinders when not in use.
6. When arc welding, make sure work and/or work table is properly grounded.
7. Do not arc weld in a wet area.
8. Be alert to possible fire hazards. Move the object to be welded to a safe location, and, remove all flammable materials from the work area.
9. Never weld in the same area where degreasing or other cleaning operations are performed.
10. Keep fire extinguishing equipment nearby and know how to operate it.
11. Shut off the cylinder valves when the job is completed, release pressure from the regulators by opening the torch valves momentarily and back out regulator adjusting valves. Never leave the torch unattended with pressure in the hoses.
12. Utilize all protective equipment and clothing. Do not arc weld with any part of the body uncovered, the arc light is actinic light (excessive ultraviolet) and will cause burns similar to severe sunburn.
13. Never weld inside drums or enclosed spaces without adequate ventilation, or, the use of airline respirators or self-contained breathing apparatus.
14. Check the ventilation system before starting to weld and periodically thereafter to insure adequate performance. Welding fumes should not be allowed to get into the rest of the shop working areas.
15. Never cut or weld any container that has held explosive or flammable materials. Use prescribed methods for cleaning or flooding.
16. Never use wrenches or tools except those provided or approved by the gas cylinder manufacturer to open valves. Never use a hammer to open or close valves.
17. Abide by any other safety measures required for each particular type of welding.
18. Allow for proper ventilation when brazing or soldering. The fluxes are acidic and toxic.
19. Do not weld on painted, galvanized or greasy, oily metals. Not only can the fumes be toxic, but the welds will not be satisfactory and will fail in use.
20. The welding studio includes both gas and electric welding equipment. Only students enrolled in a TCNJ sculpture classes with sculpture faculty approval may use welding equipment. Metals maintenance, organization and cleaning are mandatory and must be done after any welding activity. Metal scraps and residue must be removed after studio use.

21. All gas welding tanks must be properly secured to carts or chained to walls in designated areas. All empty and full tanks must be labeled and properly stored.
22. Students must wear proper fire resistant clothing including approved aprons, gloves, eye protection and welding mask.
23. Welding and cutting metal and general metal work must be done in designated areas only. Proper pressure for gas gauges should be clearly stated in the welding area along with proper procedures for turning on and off gas welding tanks.
24. All related metal working machinery or hand tools requires the use of eye, ear and personal protective equipment protection.
25. Electric welding must be done in designated areas free of any flammable materials or water which may cause electric shock.
26. Arc welding (electric) is electrical, watch for wet hands or wet work which can cause shock. Light produced by arc will seriously damage the retina of the eye. Over exposure can cause skin cancer and skin burn. Face and eye protection (i.e.: glasses and welding mask) and ventilation over work must always be in place before applying electricity. Always work behind welding screens and watch out for others around you.
27. Any metal used in the welding area must be approved by sculpture faculty.

SAFETY RULES FOR WORKING WITH SOLVENTS AND RESINS

1. Avoid skin contact. Wear nitrale gloves or check MDHS for proper glove.
2. Avoid using solvents around hot metal surfaces and flames.
3. Do not smoke or light flames in areas where solvents are used and stored.
4. Report to Student Tech and Facilities any spill. If advise, use spill kits to clean up any spills immediately.
5. Do not work with solvents in confined, unventilated areas.
6. Do not drink alcoholic beverages or take medications containing alcohol before or during working with solvents. Alcohol in the bloodstream sometimes causes synergistic reactions with various solvents that can lead to loss of consciousness, and even possibly, death.
7. Report any ill effects and/or skin disorders to the Area Supervisor. If necessary, students will need to report to Student Health Services. College employees, such as Student Workers, need to report to Capital Health Hospital.
8. Develop and maintain good personal hygiene habits. Remove protective equipment and wash thoroughly after contact with solvents.
9. Fumes from paints, solvents, adhesives can drift into the shop. Work with the Area Supervisor to minimize these problems.
10. Mix resins in small batches.

CLAY AND PLASTER AREA

1. The clay and plaster studio includes materials which may contain silica and proper ventilation must be used. Silica in clay dust (silica dioxide) is present in dry clay and in many glaze materials either as a component or contaminant. Inhalation may result in silicosis, permanent scarring of the lungs, which may incubate for 15-20 years. Personal protective equipment use is mandatory.
2. Only students enrolled in sculpture classes may use the clay/plaster studio with permission from sculpture faculty.
3. All clay material must be properly stored in the storage room and in the appropriately marked container/bag.
4. Studio maintenance and daily cleaning is mandatory because of the nature of clay and related silica concerns.
5. Plaster and clay must be mixed and used in designated areas with proper ventilation.
6. Proper clothing must be worn when modeling clay and casting plaster and should not be brought out of the studio environment.
7. Personal protective equipment use and eye protection (i.e.: goggles and masks) are required when using clay and plaster.
8. Plaster must be kept packaged and away from any source of moisture.
9. Always wear dust mask when sensitive to plaster dust.
10. Always rinse off plaster in water buckets. Never pour plaster in the sinks.

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GENERAL LABORATORY SAFETY RULES

- ✓ Safety glasses, with side shields, or goggles must be worn at all times when materials are being processed in a laboratory. Additional eye and/or face protection may be required when working on or around specified machinery.
- ✓ No tool or machine is to be used until the student has received instruction in its proper use, and has passed both the written and performance tests.
- ✓ No smoking is permitted in any laboratory.
- ✓ No food or beverage will be permitted in any laboratory.
- ✓ Long hair should be tied back.
- ✓ Rings or jewelry should be removed before working in any laboratory.
- ✓ Loose clothing should not be worn when operating machinery.
- ✓ Long or loose sleeves should be rolled up above the elbow.
- ✓ Power tools must not be used without the permission of the instructor.
- ✓ Only closed-toe shoes will be permitted in any laboratory.
- ✓ All sharp-pointed objects should be carried with point down.
- ✓ Help should be sought when handling heavy or awkward materials.
- ✓ Liquids spilled on the floor or tables should be cleaned up immediately.
- ✓ Oily rags should be placed in approved containers.
- ✓ Machines will not be operated when the instructor is not present in the laboratory.
- ✓ Broken tools, machines or unsafe conditions will be reported to an instructor immediately.
- ✓ The operator of a machine must not be disturbed.
- ✓ All injuries, regardless of severity, are to be reported to an instructor.
- ✓ Keep floor, benches and machine surfaces clear of scraps, litter and hardware.

GENERAL LABORATORY SAFETY RULES CONTINUED

- ✓ Machines placed out of order will not be operated.
- ✓ Drawers and doors are to be closed when not being used.
- ✓ Horseplay or disturbances will not be tolerated in any laboratory.
- ✓ Seek instructor's assistance when uncertain of a procedure or method.
- ✓ Use tools only for their intended purpose.
- ✓ Never operate machines without all guards in place.
- ✓ Never leave a machine running unattended.

METAL PROCESSING SAFETY RULES

ALL RULES LISTED UNDER GENERAL LABORATORY SAFETY RULES WILL BE OBSERVED.

- ✓ Check all tools to be used for condition and proper functioning.
- ✓ Never carry tools in pockets.
- ✓ Keep all tools clean and sharp.
- ✓ Grind off mushroomed heads of chisels, punches and similar hand tools.
- ✓ Wear protective clothing when working with hot metals.
- ✓ Use a brush to remove metal chips.
- ✓ Stop the machine before making adjustments.
- ✓ Use a jig or fixture to hold work while processing.
- ✓ Never use electrical equipment around flammable materials.
- ✓ Always use machine guards.
- ✓ Never touch the work while the machining operation is being performed.

COMPRESSED GASSES

- ✓ Handle gas cylinders with care.
- ✓ Gas cylinders are to be kept in the upright position at all times.
- ✓ Read all labels on the cylinder. Color codes are not standard throughout the industry.
- ✓ Know the properties of the gases being used.
- ✓ All cylinders must be secured at all times with chains or straps.
- ✓ When moving cylinders use the hand cart and make sure caps are in place.
- ✓ All cylinders are to be stored in a well ventilated area.

- ✓ Check the entire welding outfit before beginning to use.
- ✓ Always work in a well ventilated area.
- ✓ Never use oil around the equipment.
- ✓ Shut all valves and regulators when not in use.
- ✓ Have the instructor check the equipment before opening any valve.

FOUNDRY

- ✓ Protective clothing- safety glasses face shield, apron, leggings and gloves are to worn at all times when handling hot metals.
- ✓ Flammable materials are to be kept away from the foundry area.
- ✓ Treat all foundry equipment as if it is hot- NEVER assume anything is cold.
- ✓ Always have the instructor check the mold before casting. A mold which is too damp can explode, causing bodily harm and equipment damage.
- ✓ The instructor's permission must be given before lighting the furnace. The correct operating procedure must be followed.
- ✓ When the proper temperature has been reached, shut off the gas, then the air. Remove the crucible using the crucible lifter.
- ✓ Use the two-person pouring tool, carrying the molten metal as close to the floor as possible.
- ✓ Keep the pouring area free from water or wet materials. These items may cause an explosion.
- ✓ The pouring area should be covered with sand to prevent "floor explosions" in the event of a spill.

WOOD PROCESSING SAFETY RULES

ALL RULES LISTED UNDER GENERAL LABORATORY SAFETY RULES ARE TO BE OBSERVED.

- ✓ Recommended safety rules for each power tool and machine are to be observed.
- ✓ Nails and foreign objects are to be removed before processing any material.
- ✓ Small pieces of wood should not be processed without the aid of a push-stick or holding fixture.
- ✓ All guards must be in place.
- ✓ Disconnect the electricity to the machine before attempting any adjustment.
- ✓ Work should be planned before beginning any machine operation.
- ✓ Hearing protection should be worn when excessive noise is produced.
- ✓ Machines or power equipment should not be used when the operator is in a hurry or tried.

FINISHING AREA

- ✓ Check the ventilation system for proper operation before beginning to work.
- ✓ A respirator should be worn if needed.
- ✓ All flammable liquids are to be stored in an approved storage locker.
- ✓ All oily rags to be discarded are to be put in an approved metal container.
- ✓ Working surfaces must be cleaned immediately after use.
- ✓ All containers must be tightly closed after first wiping the lip of the container.
- ✓ The finishing area is to be used for no other operation.
- ✓ Spray booths and equipment are to be cleaned up immediately after use.

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GENERAL EQUIPMENT SAFETY RULES

- ✓ Never wear loose clothing or jewelry in the laboratory.
- ✓ Tie up long hair
- ✓ Make certain all guards are in place and in good condition.
- ✓ Always allow the machine to reach full operating speed before beginning to process material.
- ✓ Never operate power equipment when ill or overly tired
- ✓ Make all adjustments with power disconnected.
- ✓ All operations should be planned out before processing work.
- ✓ Help should be obtained when processing large or bulky materials.
- ✓ Machines should be used for the designed purpose of the machine.
- ✓ Never leave a machine running unattended.
- ✓ Never distract the operator of a machine.
- ✓ Avoid the "safe zone" when equipment is being operated.
- ✓ Machines not running properly should be reported to the instructor immediately.
- ✓ Use only approved push-sticks and feather-boards.
- ✓ Hands should be kept at least 4" from the cutting tool.
- ✓ Keep machine surfaces free from all unnecessary materials.
- ✓ Feed the material carefully; never force the material into the machine.

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GENERAL HAND TOOL SAFETY RULES

- ✓ Tools are to be stored in the proper storage area.
- ✓ Tools are to be kept clean, sharp and rubbed with a fine oil to prevent rust.
- ✓ Mushroomed heads are to ground to a proper head.
- ✓ Check to see that handles are tightly secured.
- ✓ Tools are never to be carried in pockets.
- ✓ Tools are to be used for the purpose for which they are intended.
- ✓ Any damaged tool should be reported to the instructor.
- ✓ Small work should be held by a fixture, vise or clamp.

CHISELS

- ✓ Never use a chisel which is dull or has a mushroomed head.
- ✓ Replace a damaged handle immediately.
- ✓ Discard chisels which show signs of cracks, chips or excessive wear.
- ✓ A proper mallet or hammer should be used when using chisels.

CLAMPS

- ✓ Store clamps in the proper location.
- ✓ Never use extra leverage on a clamp to tighten.
- ✓ Use deep-throat clamps only when necessary.
- ✓ Discard clamps when they appear to be damaged or bent.

HAMMERS

- ✓ A hammer should never be redressed.

- ✓ Discard any hammer which shows signs of cracks, dents, wear, or chips.
- ✓ Never strike two hammers together.
- ✓ Always strike a hammer blow squarely
- ✓ Use a hammer of correct size and weight for the job. The face of the hammer should be 1/2 larger than the tool being struck.

PLIERS

- ✓ Cutting pliers should only be use on mild steel wire.
- ✓ Cutting pliers should only be used at right angles to the wire being cut.
- ✓ Do not use pliers for jobs which are too large or not suited for their use.
- ✓ Do not use pliers to hold work when welding or brazing.
- ✓ Never extend the length of the handles to gain extra leverage.
- ✓ Pliers should not be used on nuts or bolts.

SAWS

- ✓ Saws should be stored to protect the teeth.
- ✓ To prevent rust, saws should be oiled periodically.
- ✓ Saws should be kept clean and sharp.
- ✓ Whenever possible, both sides of the work should be supported when sawing.

SCREWDRIVERS

- ✓ Do not use a screwdriver near direct heat, such as when welding.
- ✓ Do not use other tools in conjunction with the screwdriver to increase its leverage.
- ✓ Discard screwdrivers with broken handles or show signs of damage.
- ✓ Use the correct *size* screwdriver for the job, the tip must fit the slot of the screw.

- ✓ Use screwdrivers only for their intended purpose, not for prying, chiseling, scraping or punching.
- ✓ Keep screwdrivers clean and handles free form oil.
- ✓ Redress screwdrivers when they become worn, restore the tip with a file to a straight edge.

SNIPS

- ✓ Use only hand pressure when using snips.
- ✓ Snips are only designed for cutting soft sheet metal.
- ✓ Metal over 0.060" should never be cut using snips.
- ✓ The pivot bolt should be kept tightened and oiled.
- ✓ When cutting sheet metal, gloves and safety glasses should be worn.
- ✓ Use snips for their intended purpose.
- ✓ Use the correct size and type snip for the job.
- ✓ Never sharpen the inside ground edge of the snips
- ✓ Snips are to be stored in their proper location.

VISES

- ✓ Vises should be mounted securely, using all the holes provided.
- ✓ Never use an extension on the vise handle.
- ✓ Never strike the handle of a vise with a hammer.
- ✓ Discard any vise which shows sign of fatigue--NEVER attempt to weld a vise.
- ✓ The jaws of the vise should never used as an anvil.
- ✓ Vises should never be used to secure work when welding.

- ✓ Work clamped at just the corner of the vise, should never be clamped with heavy pressure.

- ✓ When clamping work to be cut in the vise~ the cutting line should be as close to the vise as possible to prevent vibration.

WRENCHES

- ✓ Never use an extension to increase the leverage of a wrench.

- ✓ Use the correct size wrench for the nut or bolt.

- ✓ Always allow for the possibility of the wrench slipping off.

- ✓ Never strike a regular wrench to loosen a frozen nut or bolt.

- ✓ Make certain the nut or bolt is fully seated in the jaws of the wrench.

- ✓ Wrenches should never be exposed to excessive heat, such as in welding.

- ✓ Avoid over-torquing a wrench.

- ✓ Wrenches should never be ground.

- ✓ Adjustable wrenches should be adjusted to fit the nut or bolt tightly. Always use the adjustable wrench in the proper direction.

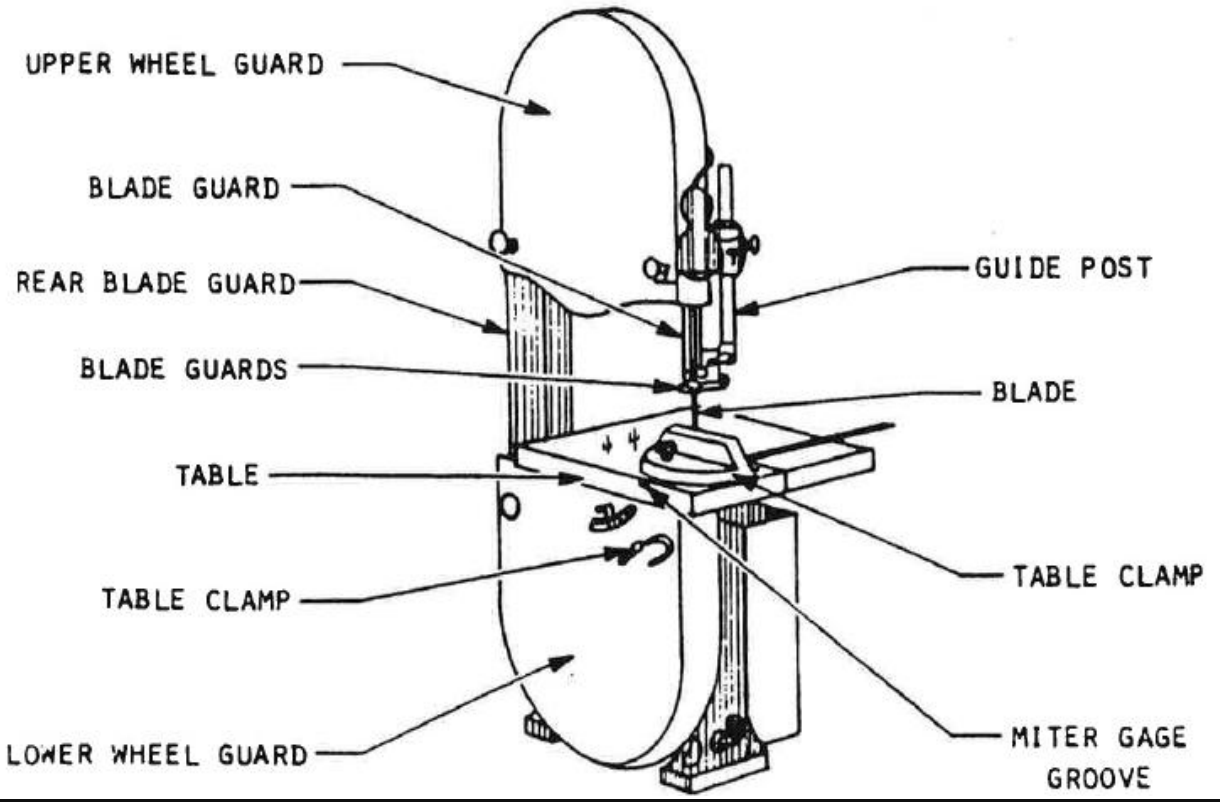
VERTICAL BAND SAW

VERTICAL BAND SAW SAFETY RULES

1. Always wear safety goggles, hearing protection, and use the dust collection system. Secure all loose clothing, hair and hanging jewelry
2. Clean the table and the area around the band saw before beginning work and when you are finished.
3. Saw only stock which is free of dirt, paint, nails, splits, warps and loose knots.
4. Make all adjustments to the machine before turning it on. Never open the wheel enclosure doors while the machine is in operation. Adjust the upper guide post so that it is no more than 1/4 inch above the work.
5. If the blade is not tracking properly or needs adjustment stop the machine and see the instructor. Do not use a dull blade.
6. Be extremely cautious of the exposed blade. Keep fingers clear. Never allow your hands or fingers to be IN LINE with the blade. Make sure your fingers are out of the way as you near the end of a cut.
7. Avoid backing out of saw cuts. You could pull the blade off the wheel.
8. If a blade breaks, step back quickly, turn off the saw, and report to the instructor.
9. Clean up.
10. The upper guide and guard should be set as close to the work as possible, at least within **¼ inch.**
11. If the band breaks, immediately shut off the power and stand clear until the machine has stopped. The installation of new bands will only be performed by authorized personnel.
12. Examine blade before installing to see if it is cracked, do not install a cracked blade.
13. Use the proper pitch blade for the thickness of the material to be cut. There should be at least 2 teeth in the material when cutting aluminum and three teeth when cutting steel.
14. **Do not run** the band saw at a higher speed than recommended for the material being cut.
15. If the saw stalls in a cut, turn the power off.

VERTICAL BAND SAW

The band saw is used primarily for cutting curved forms. The size of the band saw is determined by the diameter of the wheels, varying in size from 10" to 7'.



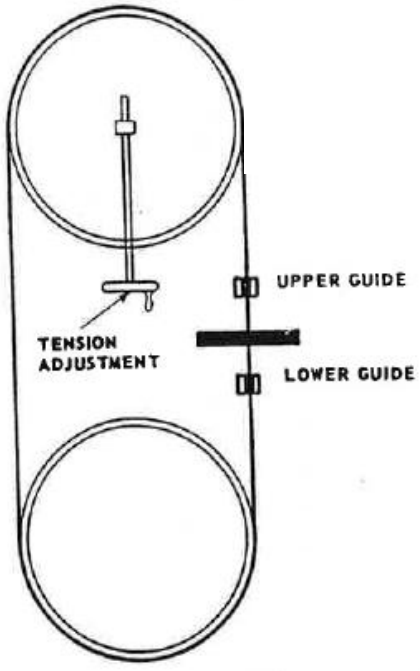
PARTS AND CONTROLS

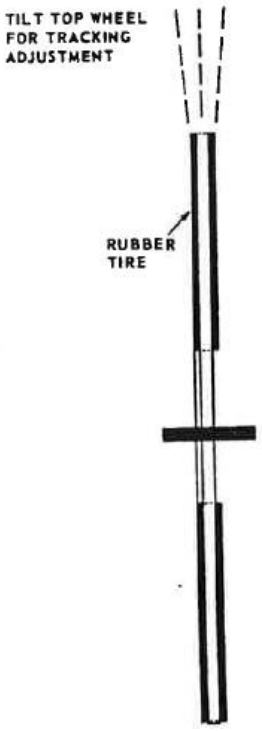
The band saw consists of two wheels mounted in a frame. The upper wheel is the adjustment wheel, it can be raised or lowered, for tension control and tilted for tracking control. The lower wheel is the driving wheel; this is connected to a motor by a pulley and belt. A sliding bar or post moves up and down out of the upper part of the housing. Attached to this are guide blocks and guide wheels. The blade and wheels are covered with safety guards.

OPERATION OF THE BAND SAW

Replacing the blade should be done in the following manner:

1. Disconnect the power and remove the guards.
2. Turn the tension control to release the blade tension.
3. Release the upper and lower blade support wheels and guide blocks.
4. Remove the throat plate.
5. Remove the blade.
6. Select a blade suited for the job and pass it through the throat opening, making sure the teeth are pointed toward the table. Put the blade over the upper and lower wheels.
7. Turn the tension control knob until a firm pressure is felt.
8. Replace the throat plate.
9. Turn the machine over by hand, making sure the blade stays on the wheels. If adjustment *is* needed tilt the upper wheel with the tilt control knob.
10. Adjust the blade tension until a firm, but slight give in the blade is obtained.
11. Adjust the upper and lower support wheels until they just about touch the blade, and only run when pressure is applied to the blade. Adjust the guide blocks or wheels until the teeth of the blade clear the front. Tighten the guides to give a clearance of about .005".





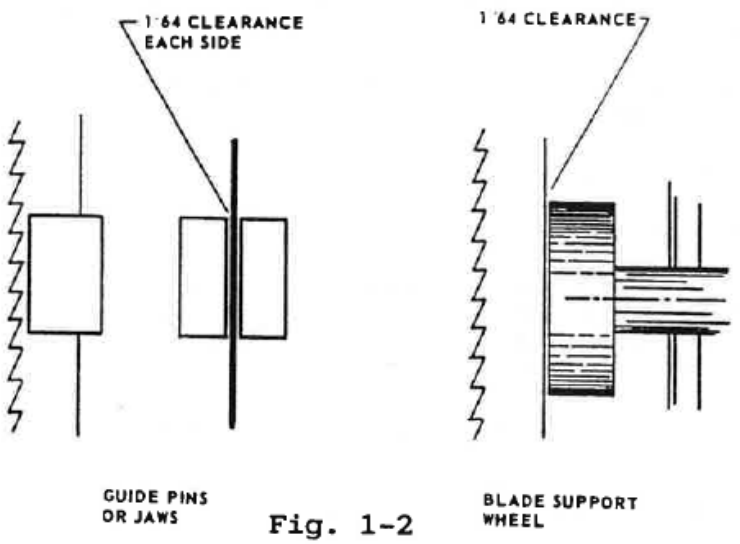


Fig. 1-2

When straight cutting, stand to the left of the blade. Guide the work piece with the right hand, holding it with the left. Keep both hands out of the cut line. Cutting curves should be planned in advance to avoid the need to back out of the cut. Each size blade has a minimum radius it is capable of cutting safely. It is often necessary to break up the curve by cutting relief cuts. Drill holes in the corners of the work when a right turn is to be cut. Fig. 1-3. Fig. 1-4 shows other methods of cutting complicated shapes.

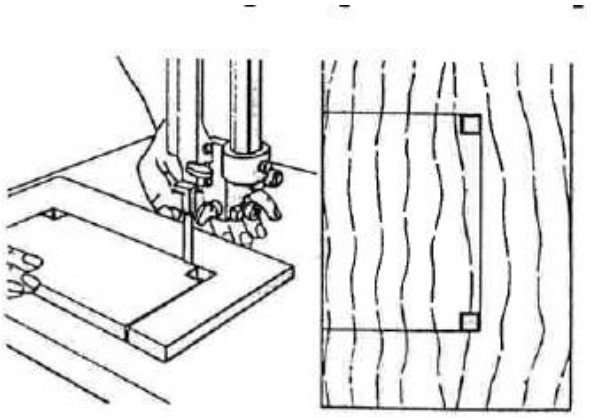


Fig. 1-3

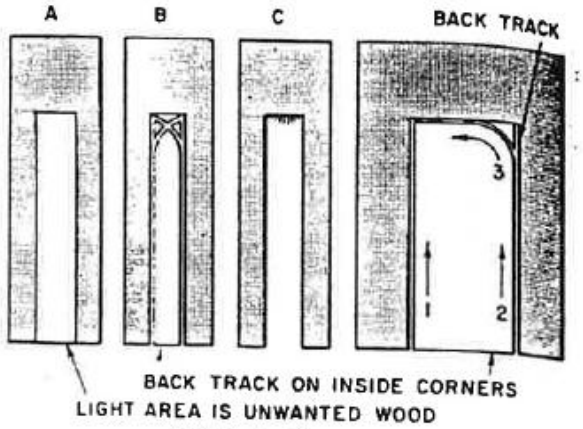


Fig 1-4

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES, WOOD PROCESSING RULES and METAL PROCESSING SAFETY RULES.

- ✓ Check the work for foreign objects before processing.
- ✓ Check the blade for proper tension.
- ✓ Lower the blade guide to within 1/4" of the work.
- ✓ Feed the work slowly, do not force it, and let the machine do the work.
- ✓ Avoid backing out of a long cut.
- ✓ Use relief cuts when cutting a small radius.
- ✓ Cylindrical stock must be secured in a V-block.
- ✓ Position fingers on either side of the cut line.

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CIRCULAR TABLE SAW

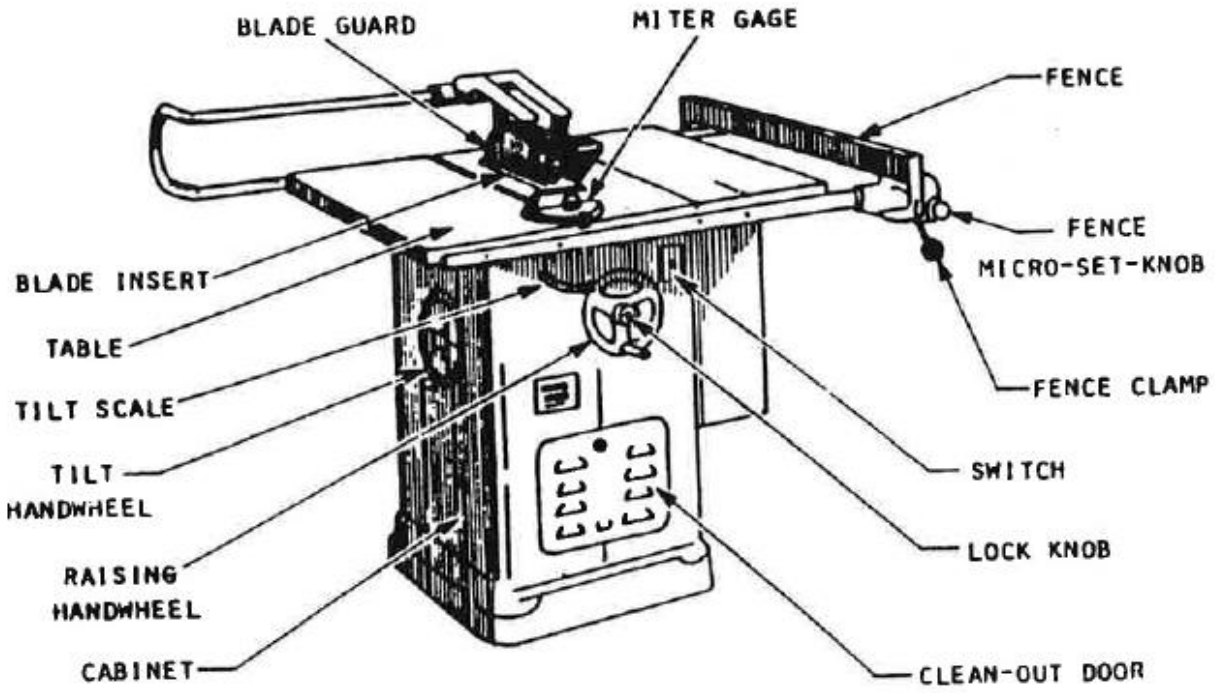
TABLE SAW SAFETY RULES

1. It is the responsibility of those using the table saw to first determine if this machine is the safest way to accomplish the desired task.
2. Always wear safety goggles, hearing protection, and use the dust collection system. Also, do not wear loose or dangling clothing and jewelry.
3. Clean the table of the machine and the floor around the saw before beginning work, and then again when you are finished.
4. Position the saw guard, splitter and anti-kickback device before turning the saw on. (See "Operational Guide to Saw Guards", Sculpture Studio files.) Always lock out power before changing the saw guard or servicing the machine in any way.
5. Use only new stock that is free of dirt, paint, nails, loose knots, splits and warps. Also, attempting to rip short, narrow or thin Sculpture invites trouble.
6. Stock should be surfaced on one side and at least one edge jointed before being cut on the saw.
7. Make sure that any necessary aids such as a push stick, push blocks, or rollers to catch outgoing Sculpture are ready before beginning an operation. If a person is going to help you cut a large piece of stock, be sure they only support the stock and do not attempt to push or pull it. YOU, the operator, must control the feed and direction of the cut.
8. Be certain the blade to be used is sharp and the proper type for the operation.
9. Adjust the height of the blade to no more than one-eighth inch above the stock to be cut.
10. Stand to one side of the blade, and never reach across, behind or beyond the blade while cutting. Again, your hands should never be IN LINE with the cutting blade. Maintain a four-inch margin of safety: do not let your hands come closer than four inches from the blade. USE the push stick.
11. Be sure no one is standing in a direct line behind the saw.
12. Always use either the rip fence or the miter gauge when cutting. NEVER CUT STOCK FREEHAND. When setting the rip fence, make sure that the fence locks parallel to the blade. Otherwise the Sculpture can bind and kick back. Never use the miter gauge in combination with the rip fence unless a clearance block is used. Never try to support both pieces on opposing sides of the saw blade when using the miter gauge; support the portion positioned against the gauge side only. When ripping, always support the portion of your piece that is in between the rip fence and the blade.
13. If you tilt the blade or change the miter gauge, return them to their original position after using the saw. When changing blades always be sure that the washer and lock-nut are tight to the blade.
14. When making a cut, make sure you pass the stock completely past the blade as you finish your cut. NEVER BACK UP STOCK ONCE YOU HAVE PROCEEDED WITH A CUT. If need be, stop, and shut the machine down. Always turn the saw off before attempting to remove scrap.

15. Never talk to anyone or let them distract you while the saw is running. Keep your attention focused on your work.
16. Never cut free between the fence and the blade
17. Stand to one side, never directly in line with, work being fed through the saw.
18. Use the proper blade for the material and type of cut. Do not use a rip blade for cross cutting or a crosscut blade for rip sawing. Do not use a plywood blade for anything but plywood.
19. Inspect the blade before using it, to make sure it is the proper blade and is sharp and free from cracks.
20. **Never** allow your fingers to get near the blade when sawing. Use a pusher stick to rip narrow pieces of stock. Don't use pusher stick to remove scrap. For scrap removal, shut off machine and wait until blade stops, then remove scraps.
21. **Attached guards must be in place at all times.** Never remove the guard. Ask the Area
22. Supervisor for help if you think the guard is in the way.
23. If the piece of material you are cutting is large, get someone to assist in tailing-off for you.
24. Never try to do it alone. Tailing off refers to supporting a large work piece by supporting it underneath with your hands.
25. If you are tailing-off for someone else let them guide the work through the saw. You should just support the work without influencing the cut. The operator will advise the assistant of the procedure.
26. Never reach over the saw to obtain something from the other side.
27. When shutting off the power, never attempt to stop the saw quickly by shoving anything against the blade. Make sure the saw has stopped before leaving it.
28. Never make any adjustments to the saw while it is running. Turn off the power and make sure the saw is completely stopped before attempting to adjust it.
29. Do not allow material to collect on or around the saw table**. Sweep up sawdust and material scraps regularly** while working to minimize chances of slipping or stumbling.
30. Make sure that you clean up thoroughly around the saw before leaving the area. If you don't you could be the cause of someone else having an accident.
31. The circular blade of the table saw should be set **to 1/4 inch above the work**. Dust collection system must always be operating when saw is in use.

CIRCULAR TABLE SAW

The table saw can be used for a variety of cutting and joinery operations. Saws are available in a wide range of sizes, which is determined by the blade diameter. There are two main types of table saws, either the table tilts or the blade arbor tilts. Work can be fed into the saw by hand or under power.



The table saw consists of a base or frame, which provides the support for the motor, the blade arbor and the table. The blade protrudes through a slot in the table and is adjustable up and down, and can be tilted to 45 degrees. A fence is attached to the table for ripping stock. The miter, which rides in a groove machined into the surface of the table permits stock to be crosscut at 0-90 degrees. Saws should also be equipped with guards and anti-kickback devices. To raise or lower the blade, locate the elevating hand wheel and loosen the lock knob. Turn the wheel in either direction to adjust the height, and retighten the lock knob. To tilt the blade, locate the tilt hand wheel and loosen the lock knob. Turn the wheel to the correct angle, using the tilt scale at the hand wheel. To adjust the fence, loosen the locking device and slide the fence along the table. A fine adjustment knob is sometimes provided to aid *in* fine adjustments. The fence is generally positioned to the right of the blade. To adjust the miter, loosen the locking knob and swing the miter head to the desired angle. The mi.ter can be used on either side of the blade.

BLADES

Saw blades are available to perform a variety of cutting operations. The most common types of blades are; (1) the ripping blade, which is used for cutting stock *in* the direction of the grain, (2) the crosscut blade, used for cutting across the *grain,* (3) the combination blade, used for either ripping or crosscutting, (The combination blade is sometimes hollow ground, to provide the clearance necessary to prevent heating up of the blade) and (4) carbide-tipped blades provide the durability needed in production. These blade types are commonly used on all the circular-type saws.

BLADE REPLACEMENT

1. Disconnect the electrical power.
2. Remove the insert plate from the table top.
3. Jam a piece of soft wood into the front of the blade if the arbor has a right-hand thread. Should the arbor have a left-hand tread, place the wood in the back side of the blade.
4. Use the correct arbor wrenches and loosen the arbor nut, the collar and the old blade.
5. Slide the new blade onto the arbor, making certain the teeth are pointed toward the front of the saw.
6. Replace the collar and the nut. Jam the piece of wood in the back of the blade and tighten the arbor nut.
7. Replace the plate and turn the machine over by hand to check the operation.

OPERATION

Crosscutting should be performed using either a crosscut or combination blade. To crosscut, use the miter set at 90 degrees, hold the work firmly against the miter head and carefully feed the work into the blade. Miters cuts (cuts at other than 90 degrees) are performed in the same manner as the crosscut. Adjust the miter for the desired angle. When feeding a miter cut, it will have a tendency to creep along the miter head, as the cut proceeds, the work therefore must be firmly secured to the miter.

To cut a bevel in a work piece, adjust the angle as described in ADJUSTMENTS. To ensure accuracy, use a protractor or sliding T bevel to adjust for the desired angle. When performing these cuts use the fence or miter. To rip a piece of stock, use either a ripping or combination blade. Adjust the fence, using the scale, a rule or a sample work piece. Make a test cut using a scrap piece. Check the cut and make additional adjustments if necessary. Adjust the blade to a height 1/8" above the work. Be sure the guards are in the correct position. Stand to either side of the work, in case of kickback. Turn the power on, and feed the work, holding it firmly against the fence by hand or with the use of a feather board. Never reach across the blade to feed work or to catch stock. Long pieces should be supported by a helper or a dead-man.

When ripping narrow pieces, never use your hand to feed the material, always use a push stick to feed the material. An alternative method would be to rip half the piece, then turn it around and rip the remainder. An auxiliary plywood table should be placed on the table top,

and the blade raised just enough to allow for 1/8" above the work piece. This additional table will prevent the piece from falling down between the blade and the insert plate.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Keep hands out of the cut line, and never reach over the saw blade.
- ✓ Disconnect the saw when making adjustments or replacing the blade.
- ✓ Never force the work, allow the blade to do the work.
- ✓ Choose the correct blade for the operation. Keep the blade clean and sharp.
- ✓ Adjust the blade to a height 1/8" above the work.
- ✓ Stand to either side of the work, in case of kickback.
- ✓ Never saw work freehand.
- ✓ Never clear pieces close to the blade with your hands always use a stick.
- ✓ Use the guard whenever possible.
- ✓ Do not cut cylindrical stock on the machine.
- ✓ Never use the fence and the miter to cut duplicate pieces, unless a clearance block is fastened to the fence.
- ✓ Hold stock firmly.
- ✓ Use a push stick when needed.
- ✓ Lower the blade before leaving the machine.
- ✓ Get help when cutting large or bulky pieces.

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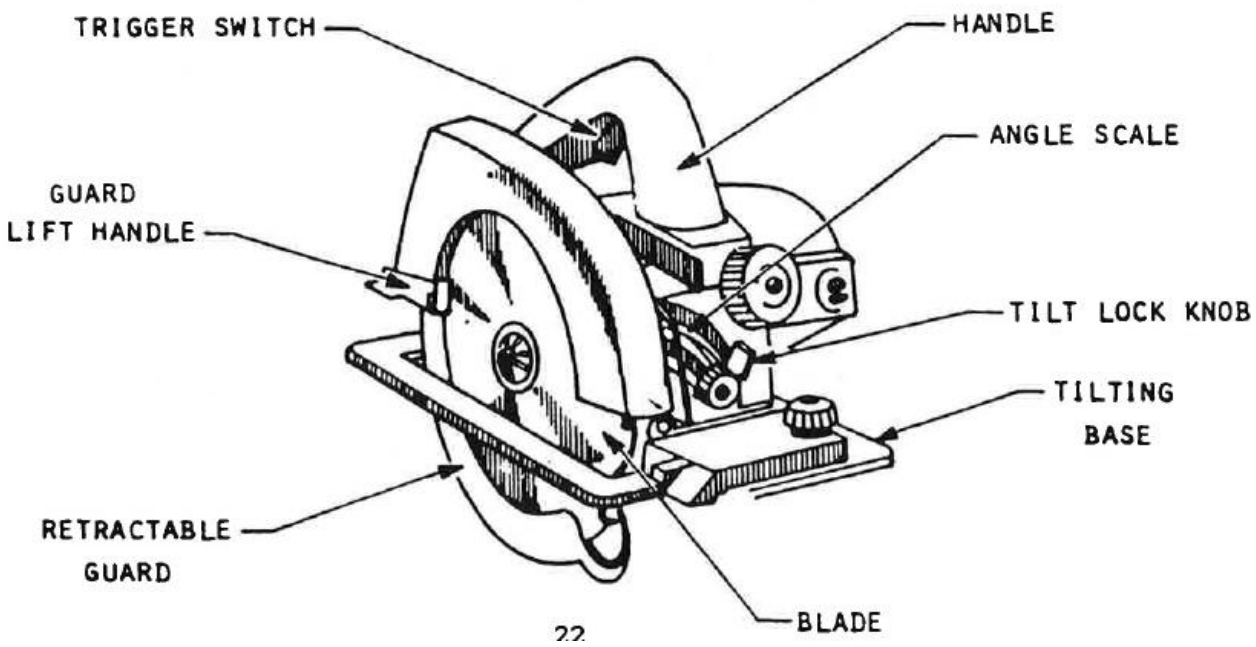
PORTABLE CIRCULAR SAW

CIRCULAR SAW SAFETY RULES

1. Before using any power tool, inspect it to make sure the cord is not damaged in any way, that the ground pin is intact, and that the blade is sharp and undamaged. Check the guard does not stick.
2. Do not use the saw in a wet area.
3. Do not run the extension cord across walkways where people might trip over it or where the cord may be run over and damaged.
4. Keep your head out of the path of particles thrown out by the blade.
5. Disconnect the power cord before cleaning, changing blades, or making any adjustments to the saw.
6. When it is necessary to raise the guard for certain types of cuts, always use the guard lever.
7. **Never** wedge, wire, or otherwise jam the guard to prevent it from working. **This is a particularly dangerous practice and will cause your permission to work in the machine shop to be revoked immediately!!!**
8. Wait until the saw stops before lifting it from a cut.
9. Before setting the saw down, make sure the guard is closed, as the blade may still be turning.
10. Don't carry the saw with your fingers on the switch trigger.
11. Don't pull the saw backwards in a cut if you can avoid it.
12. Use the proper blade for the type of cut.
13. Do not use the cord to move or drag the saw as it can damage the wiring.
14. Do not use the power hand saw for cuts if you cannot keep a firm and secure grip on the saw and the material being cut. A hand saw is still the best for some kinds of work and often faster.
15. Before cutting small work pieces consult the Area Supervisor for appropriate training.

PORTABLE CIRCULAR SAW

The portable circular saw is used for on-site work, generally construction or carpentry. The saw can be used for pre-cutting work or for trimming work after installation. The saws are available in a variety of sizes, ranging from 4" to 12". The 8" size is the most popular because of its 2 3/4" maximum cut.



PARTS AND ADJUSTMENTS

The saw consists of a motor, a handle, a base plate, and a blade. The base plate is usually hinged on the motor to adjust the depth of the cut. The base is also able to tilt, to permit the cutting of bevels. Blades are chosen according to the type of cut and the material. Blades are described in the section on the table saw.

OPERATION

To crosscut, adjust the saw so the blade protrudes 1/8" below the work. Mark the cut. Place the work on saw horses, being certain the cut line is not through the horses. Rest the front edge of the base plate on the work and align the cut. Turn on the power and out along the marked line.

To rip, first mark the work. Place the work on saw horses, with the cut line avoiding the horses, and able to complete the cut in one operation. If possible, use the rip guide adjusted for the proper width. Rest the base on the work and turn on the power. Start the cut and slowly walk along the cut. Never over-extend yourself when ripping a large piece.

To bevel cut, adjust the saw to the desired angle. The depth of the cut should be rechecked, as this adjustment is often affected by changing the bevel angle. Rest the base on the work and turn on the power. Start the cut and carefully move the saw across the work.

To miter cut, mark the work with the desired angle. Make the cut freehand or with the aid of a miter guide.

To make a cut in the middle of the work, (pocket cut) adjust the depth to the maximum setting. Swing the guard up out of the way. Place the front edge of the base on the work, and align the saw. Turn on the power, and slowly lower the back edge of the saw into the work. Once the saw is through the work, make the cut in the usual manner. When the cut is complete, allow the saw to come to a complete stop, before removing the saw from the cut.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ All work should be well supported, and at a comfortable working height.
- ✓ Adjust the depth to 1/8" below the work.
- ✓ Keep the power cord clear of the cut.
- ✓ Always rest the front edge of the base on the work before turning on the power.
- ✓ Move the saw slowly across the work.
- ✓ Allow the saw to come to a complete stop, before putting it down.
- ✓ Disconnect the power before making adjustments or changing the blade.
- ✓ Make certain if an extension cord is used it is of sufficient gauge to cover the distance.

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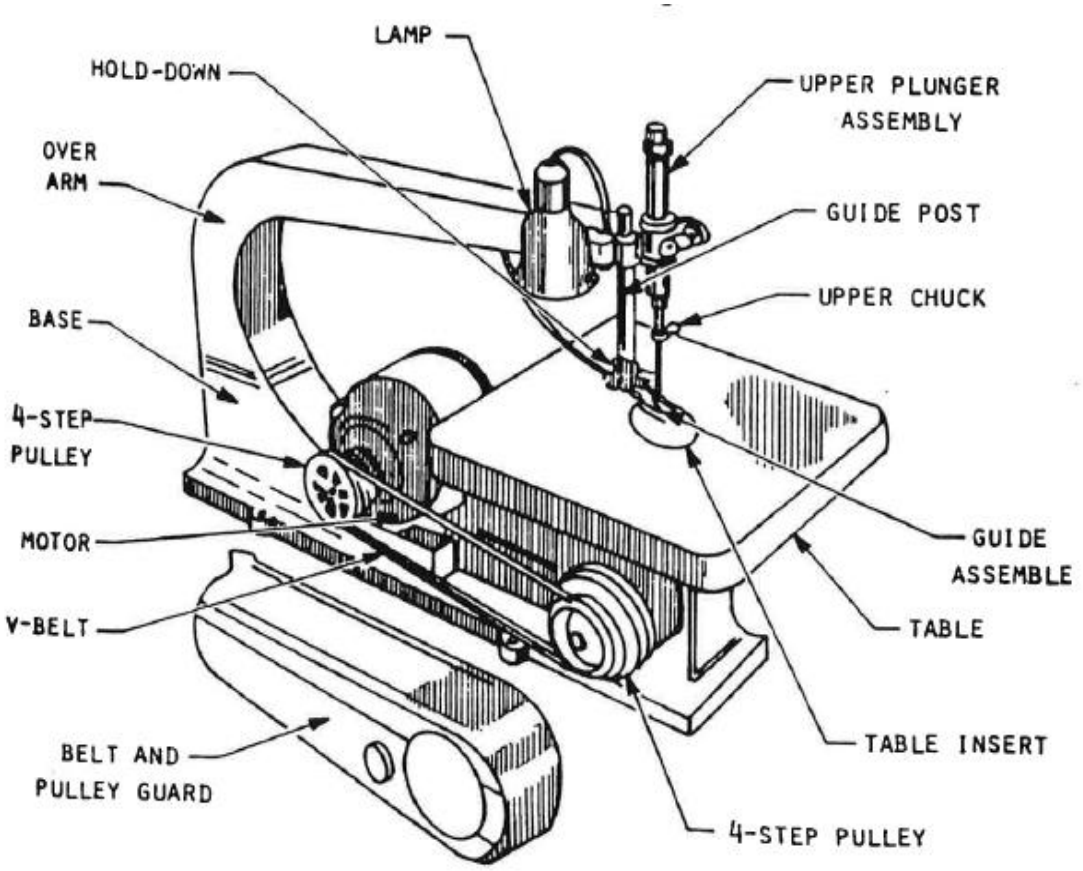
JIG OR SCROLL SAW

SCROLL SAW SAFETY RULES

1. Do not operate the scroll saw without the guards in place.
2. Make all adjustments with the power off, and then rotate the motor by hand as a final check.
3. Be sure hold down (clamp) is pressing lightly on the work piece.
4. The blade should be held firmly in the chucks, be square with the table, and be properly supported by the guide assembly.
5. Guide the material slowly through the machine with both hands, keeping fingers away from the cut line.
6. Consult the authorized shop personnel for the correct blade and correct speed for the material to be cut, and for the smallest radius required.

JIG OR SCROLL SAW

The jig or scroll can be used to cut curves. The size of the machine is determined by the distance between the blade and the throat. There are generally two speeds, which are adjustable for hard or soft materials. The higher speed is chosen for wood and producing smooth, clean curved cuts. The slower speed is used when cutting metals.



BLADES

The set rule for blade choice is to choose a blade which keeps three teeth in contact with the material at all times. The thickness and width of the blade depends on the size of the curve being cut. A tight curve requires a narrow blade.

To mount the blade, remove the plate in the table. Insert the blade into the lower chuck as far down and back as possible, making sure the teeth of the blade point towards the table.

Use a square to position the blade in the vertical position and tighten the jaws. Turn the machine over by hand to position the blade at the top of the stroke. Loosen the blade tension knob and lower the mechanism. Insert the blade 3/8" in the upper chuck and tighten. Adjust the tension by raising the upper shaft housing. The correct tension is achieved when the blade remains straight during cutting. Too much tension will cause the blade to break. Replace the plate in the table. Turn the machine over by hand to check for proper operation.

Adjust the blade guides to the thickness of the blade and position them just behind the teeth of the blade. The hold down should be adjusted to the thickness of the work.

OPERATION

Feed the material straight into the blade without forcing or twisting. Allow the machine to do the cutting. Cut through the waste when the cut cannot be continued. Never back out of a cut, if at all possible.

When using the jig saw to cut an internal curve, drill a hole in the waste area larger than the width of the blade. Remove the blade from the upper chuck and pass it through the hole which has been drilled. Re-insert the blade into the upper chuck and check the tension.

Both chucks can be positioned at 90 degrees to accommodate long stock.

SAFETY RULES

- ✓ Make all adjustments with the power disconnected
- ✓ Turn the machine over by hand to check operation.
- ✓ Adjust the hold down to apply pressure on the work.
- ✓ The teeth of the blade should point downward.
- ✓ Choose the correct blade and speed for the curve and material.
- ✓ Guide the material slowly and straight, avoid side pressure.
- ✓ Use the chip blower.
- ✓ Keep hands clear of the cut line.

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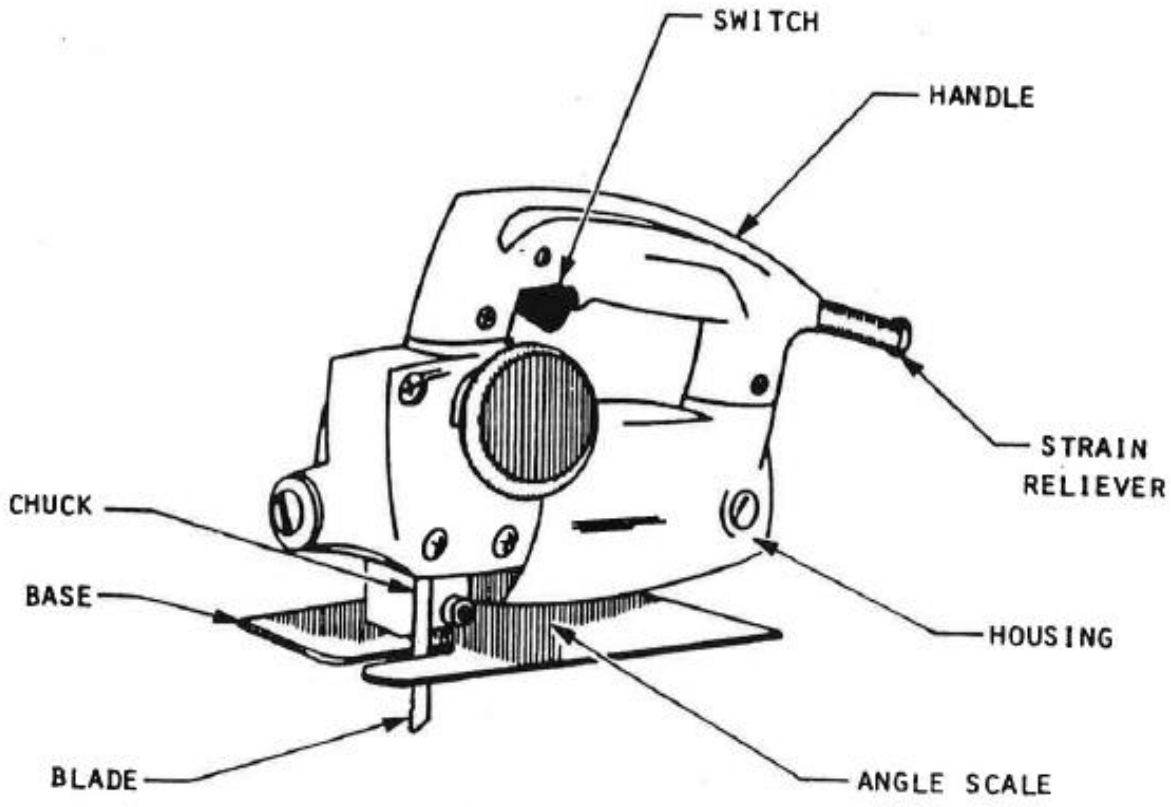
HAND JIG, SABER, OR BAYONET SAW

The hand jig saw is similar to the floor model jigsaw. It is used for on-sight jobs requiring straight or curved cuts, both internal and external. The tool consists of a motor, a handle and a base. The base, on some models is adjustable for tilt.

Many kinds of blades are available, depending on the job and material. The blade is held in position by two set screws at right angles to one another, in a locking clamp.



OPERATION

Install the blade with the teeth pointed forward and upward. The cutting is accomplished on the up-stroke. When cutting, the saw must be held down with firm pressure to avoid vibration.

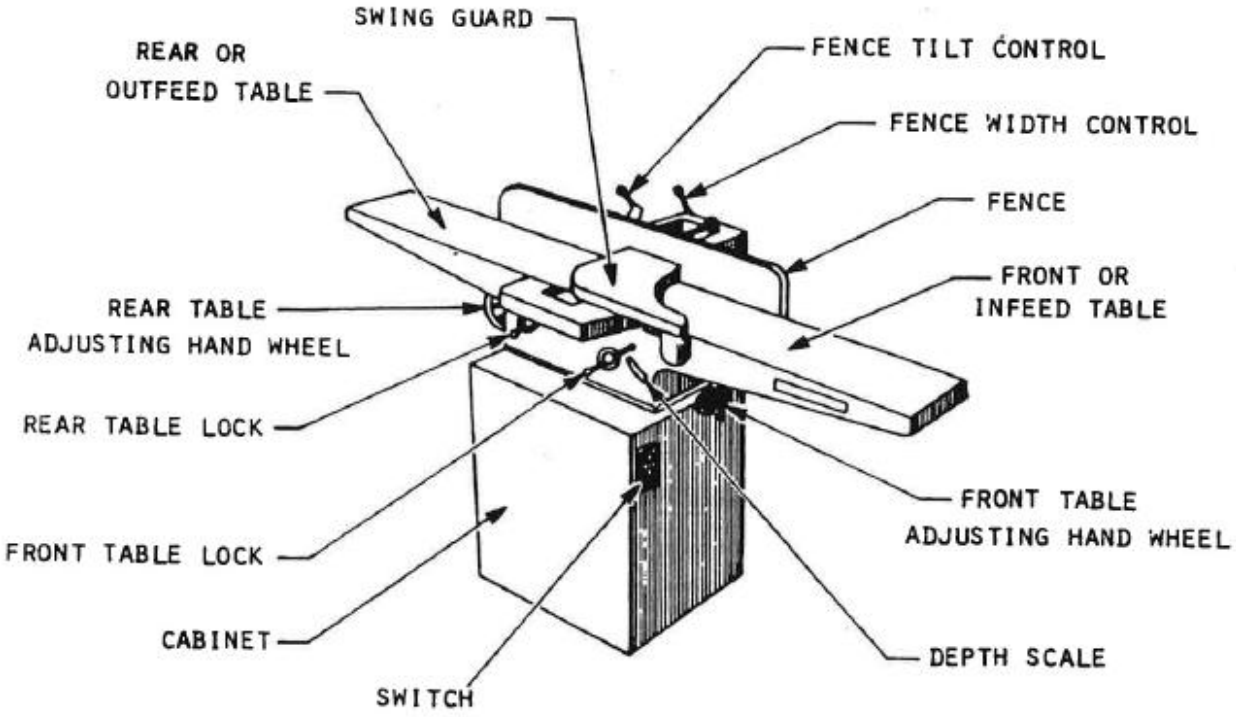
Crosscutting or straight cutting can be done freehand or with the aid of the rip fence. Cutting curves are easily done by freehand or the aid of a circle cutter. To bevel cut, the table must be adjusted to the desired angle. Internal cuts are done by first drilling a hole, larger than the blade, and then inserting the blade in the hole to begin the cut.

SAFETY RULES

- ✓ Select the correct blade for the material and curve.
- ✓ Disconnect the saw when making adjustments or replacing the blade.
- ✓ Clamp the work.
- ✓ Avoid side pressure when cutting, do not force the machine.
- ✓ The saw must come to a complete stop before putting it down.

JOINTER

The jointer does the work of a hand plane. It can be used to plane a surface, an edge or an end, and to square stock for further processing. The jointer consists of a rotating cutter drum or head with three, four or more cutters or knives. The drum revolves into the stock removing material as the stock is passed over. The quality of the cut depends on the speed of the drum, the number of knives and the rate at which the stock is fed. The size of the jointer is determined by the length of the knives.



PARTS AND ADJUSTMENTS

The jointer is constructed on a heavy metal frame. The machine consists of two tables, cutter head, guard, and fence. The rear or out feed table is only adjusted for the height of the blades and is done so infrequently. The front or in feed table is adjustable and controls the depth of the cut. The fence is adjustable crosswise over the table and can be tilted in either direction to approximately 45 degrees. The guard covers the cutters and is spring loaded. It swings out of the way as the stock is fed into the machine and returns to cover the cutters after the cut is completed.

The rear table is a machine adjustment. The height is adjusted to be exactly the same height as the cutters. This adjustment is only made after sharpening, or replacing the cutters. On some models of jointers the out feed table is fixed and the cutter drum is adjustable.

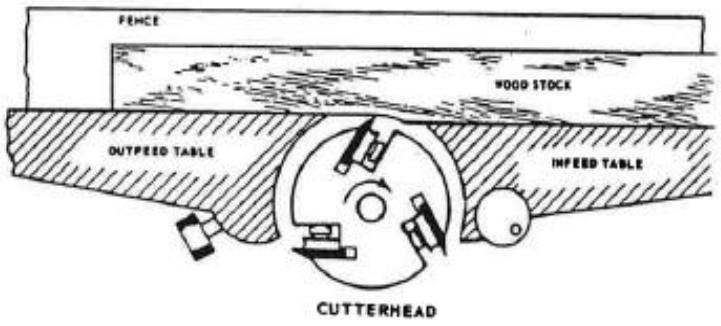


Fig. 4-1

The front or in feed table is adjusted for the depth of the cut. To adjust, loosen the lock knob and turn the adjusting wheel to the desired depth. When lowering the table, bring it down beyond the desired depth, and then raise it up to the correct. This method will eliminate the "play" in the table adjustment. Lock the table at this position with the locking knob. Some models are equipped with a depth scale. The accuracy of this should be checked before using the jointer.

Loosen the fence tilt control and check with a try square, set it perpendicular to the table or to a desired angle. The fence is also adjustable over the cutters.

OPERATION

For face or surface planing, adjust the machine for the correct depth. Check the condition of the stock to be planed. Stock that is warped should be fed with the concave side down. Start the pass by placing the board on the in feed table with both hands on the top of the work. Feed the stock over the machine. NEVER pass your hands over the cutters except when using a push block or paddle. As soon as a portion of the stock large enough for a hand hold is on the out feed table, place your left hand on it. When the right approaches the cutters, hold the stock firmly with the left hand and move the right hand on top of the stock over the out feed table. When planing thin or narrow pieces use a push block or paddle. Check the minimum length listed that can be safely planed on the jointer.

To plane an edge, check the fence for square. Place the stock firmly against the in feed table and the fence with both hands. Feed the stock as described in surface planing. The fence should be adjusted crosswise to different positions, to distribute wear evenly across the length of the knives.

To plane an end, adjust the depth for a light cut. NEVER plane ends less than 10". Take a small cut on one end, about 1/2". Turn the stock around and feed from the opposite direction.

To bevel plane, adjust the fence to the correct angle. Place the stock firmly against the fence and the table. Feed the stock as described in the surface planing paragraph.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Make all adjustments with power disconnected.
- ✓ The maximum depth for jointing an edge is 1/8" and for surfacing is 1/16".
- ✓ The minimum length of stock that can be safely planed is twice the length of the knives.
- ✓ Feed the stock so the knives cut with the grain, check for knots, splits and checks.
- ✓ Do not plane an end less than 10" wide.
- ✓ Make several cuts instead of one large cut.
- ✓ Hands should never come within 4" of the cutters.
- ✓ Adjust only the in feed table
- ✓ Feed the stock at a slow rate.
- ✓ The blades need sharpening when; planed stock looks fuzzy or the stock chatters when cutting.

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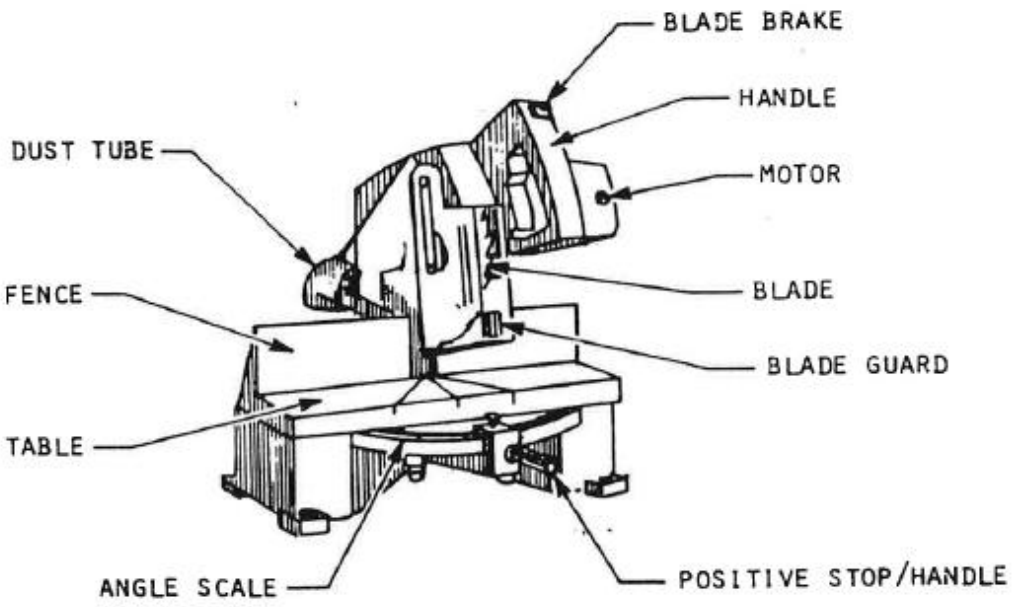
POWER MITER SAW

The motorized miter box is used to cut miters on trim and molding. The saw is actually a portable circular saw mounted on a spring loaded arm. A crosscut blade is the most common choice for the motorized miter box. The blade is designed to give a smoother cut at higher rpm's than other circular saws. The size of the saw is determined by the maximum diameter blade the saw can accommodate.



PARTS AND ADJUSTMENTS

As previously mentioned, the motorized miter box is a circular saw mounted to a spring loaded arm. The arm contains the handle and the switch. The arm is spring loaded and returns to the open or up position after completing the cut. The angle of the miter cut is adjusted with the miter latch or index and the miter clamp. The table and the fence are stationary at all times.

Changing the blade is done in the same manner as the portable circular saw; the only difference may be that the guard will have to be removed.

OPERATION

Adjusting the angle requires the loosening of the miter clamp knob and the releasing of the miter latch or index lever. The entire arm assembly pivots to the desired angle. The index has positive stops at 0, 22 1/2 and 45 degrees, but, by using just the miter clamp any angle is possible. To cut, place and hold the work firmly against the fence. A align the mark on the work with the blade. Grasp the handle, turn on the switch and allow the saw to come to full operating speed. Slowly lower the saw into the work, allowing the saw to cut the stock. After the cut is made, raise the blade up to the stop and release the trigger.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Be certain the guard is working properly.
- ✓ Use the correct blade-size and rpm rating.
- ✓ Adjustments are made with the power disconnected.
- ✓ Never attempt to hold with your hands any piece shorter than 12".
- ✓ Hold the work firmly against the fence and the table.
- ✓ Secure the motorized miter box to a solid mount.
- ✓ Use table extensions when cutting long pieces.
- ✓ Remove scrap stock when making multiple cuts.

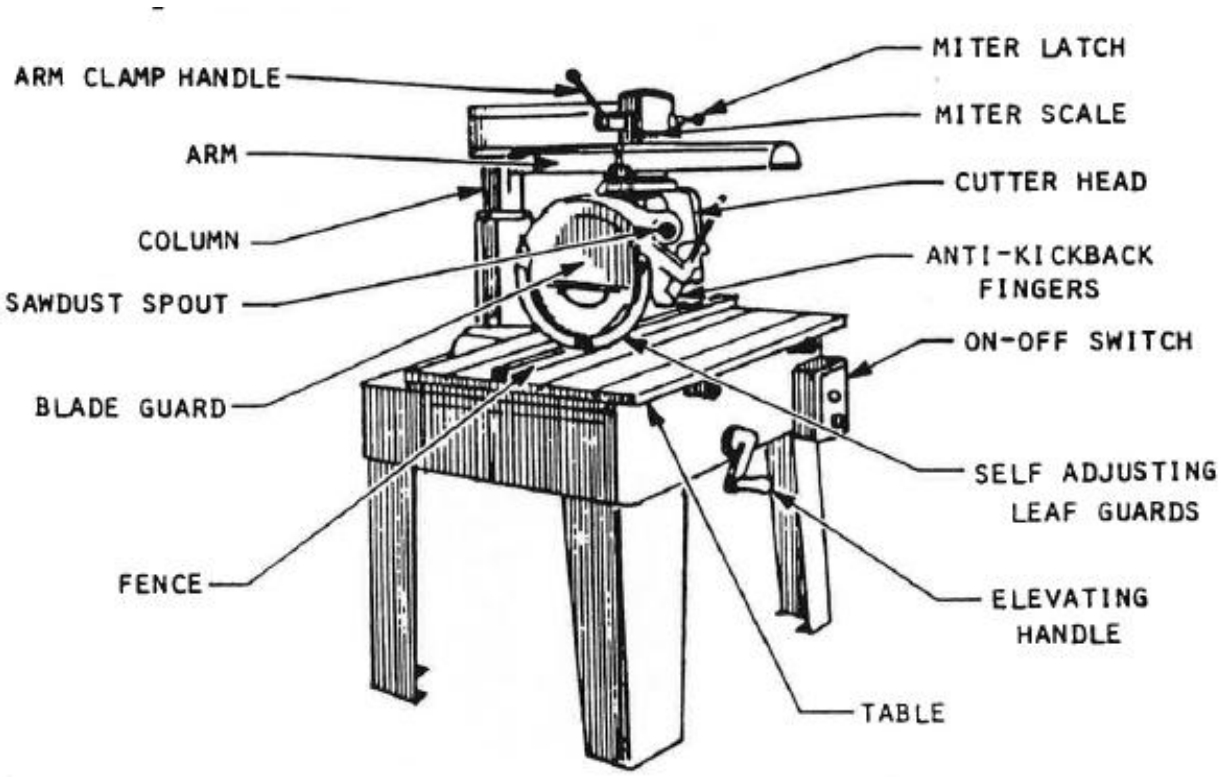
RADIAL ARM SAW

RADIAL ARM SAW SAFETY RULES

1. Always wear personal protective equipment (i.e.: safety goggles) before operating equipment.
2. Blade should only be changed by authorized personnel.
3. Select the proper blade for the cut to be made. Check the blade to be free of cracks or nicks, and that it is sharp.
4. Limit the blade extension to 1/4 inch beyond the piece being cut.
5. Use the ripping fence or the cutoff gauge when cutting material, but don't use both of them at the same time!
6. Cut the work piece at a moderate rate, but not so fast to slow down the motor.
7. You may not cut any work-piece on the radial arm saw that is less than 12 inches in length.
8. The radial arm saws are for cutting wood or plastic materials only!

RADIAL ARM SAW

The radial arm saw is an extremely versatile machine. They are able to perform a variety of cutting operations. This saw is particularly well suited for crosscutting. The saw is moved through the work when crosscutting. The ripping operation is performed by moving the work through the saw. The radial arm saw is favored by builders and carpenters, because of its flexibility. The size of the saw is determined by the diameter of the blade.



PARTS AND ADJUSTMENTS

The radial arm saw consists of a base, a table, a motor, a vertical column and an overhead arm. The motor and blade is carried by the arm which is attached to the vertical column. The depth of the cut is adjusted by raising or lowering the arm with the elevating lever. The arm can be pivoted on the vertical column to crosscut miters at desired angles.

The motor is suspended in a yoke which can be tilted to cut bevels. The motor can also be rotated in a horizontal plane, and locked into position for ripping.

OPERATION

To crosscut, mount the proper blade (described in circular saws), pointing the teeth toward the operator. Adjust the arm to zero for a 90 degree crosscut. Adjust the motor yoke so the blade is at right angle to the fence. Lock *all* adjustments. Lower the saw blade so that the blade is 1/16" below the table surface. Adjust the anti-kickback device to 1/8" above the work. Place the work back firmly against the fence with the layout mark aligned with the blade. Turn on the power, firmly grasp the handle and pull it slowly towards you. After the cut is complete, return the saw all the way back to its rest position. Turn the saw off.

To cut duplicate pieces, first square off one end of the work. Use a block and a clamp as a stop gauge. Fasten this to the fence to the desired length. Place the squared off edge against the stop and make the cut.

To make miter cuts, adjust the arm to the desired angle and make the cut as previously described. To make bevel cuts, tilt the motor yoke to the desired angle, and make the cut as previously described.

To rip, rotate the motor yoke 90 degrees and lock into place. Adjust for the width of the cut by pulling the saw in or out along the arm, and locking it in position. Set the anti-kickback device. Carefully feed the material into the saw, keeping your hands out of the cut line.

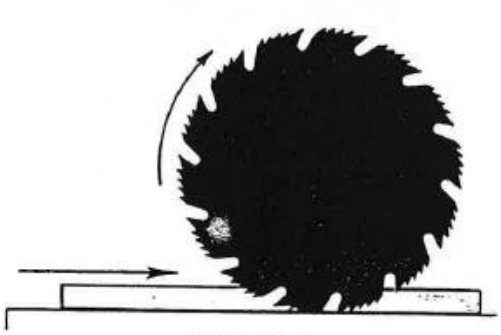


Fig. 6-1

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Push the saw back against the stop after finishing the cut
- ✓ Place the stock firmly against the fence.
- ✓ Always rip into the blade, never in the same direction as the rotation.
- ✓ Avoid reaching around the saw.
- ✓ Use guards and anti-kickback devices.
- ✓ Never force the saw.
- ✓ Extension tables should be used for large work. Make sure all adjustments are tight.
- ✓ Keep the blade clean and sharp.

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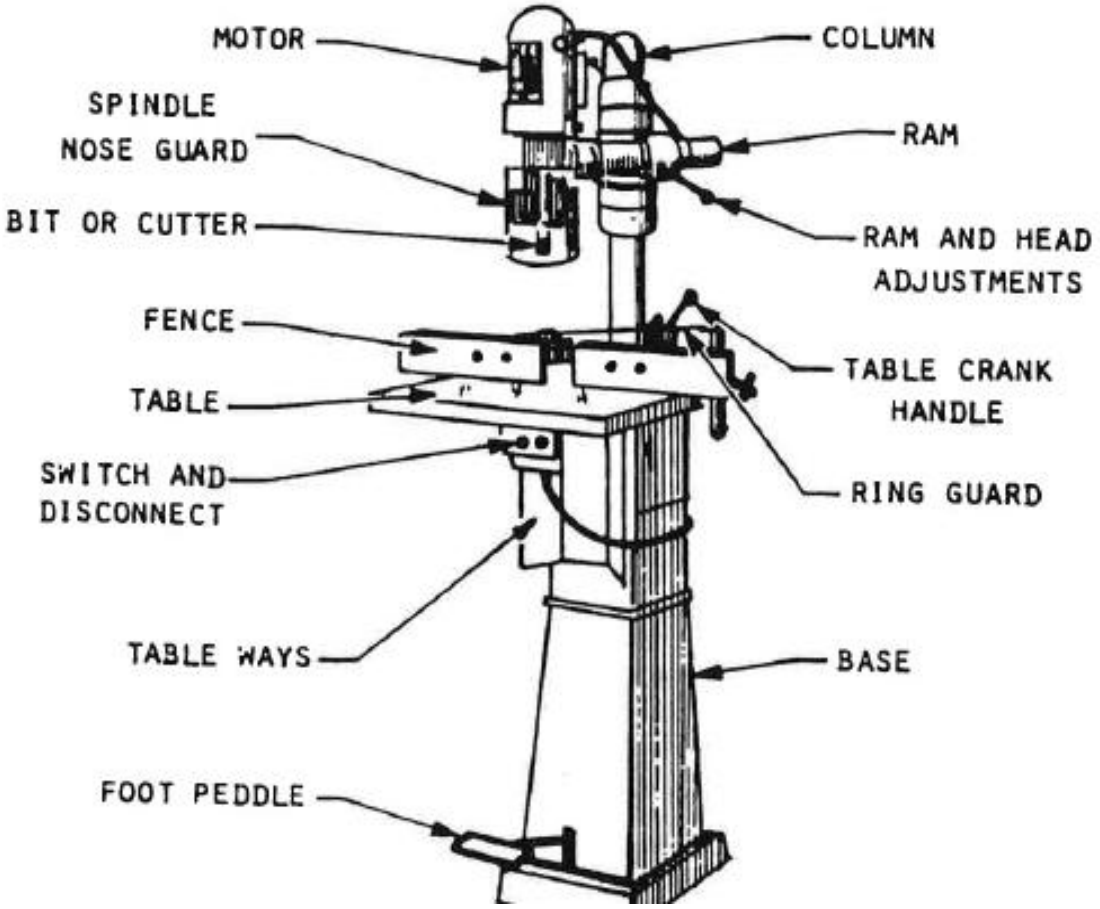
ROUTER: PORTABLE AND OVERHEAD

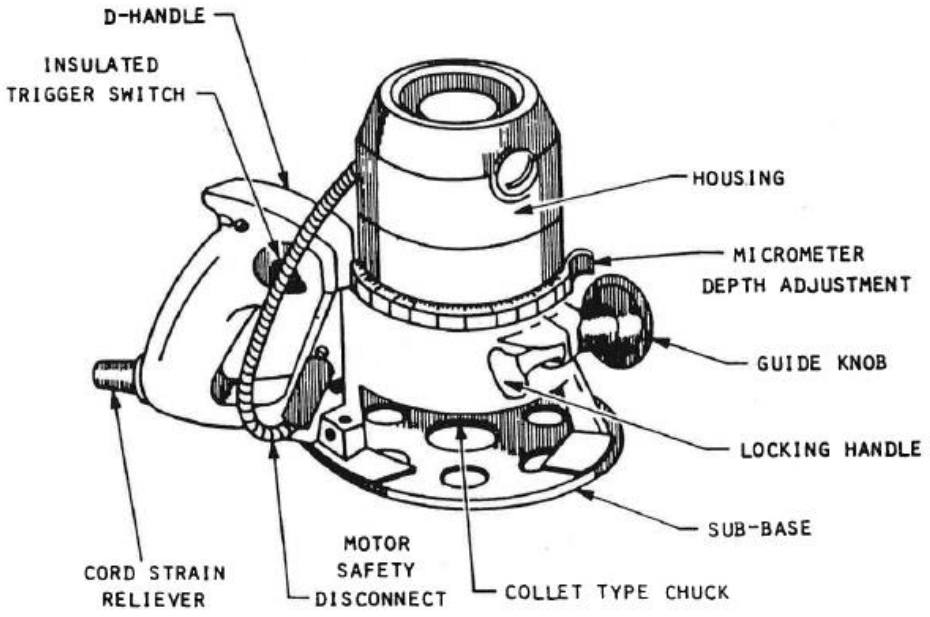
Routers are used for a variety of cutting, trimming, shaping and routing jobs. The work to be done depends on the cutters used in the router. Cutters can be used singularly or in combination with other cutters in multiple operations. Fixtures and attachments may be used depending on the type of work to be performed.



PARTS AND ADJUSTMENTS

The portable router consists of a motor and a base. The collet is connected to the end of the motor shaft. The collet is a split chuck designed to clamp the cutter securely. The base of the router allows the motor to be raised up or lowered down, to adjust the depth of the cutter.

The overhead router is generally used in the furniture industry or manufacturing. This machine consists of a heavy base, to which is mounted a table and a vertical column. The motor is mounted to a horizontal arm that is mounted to the vertical column. The table is adjustable in the up and down positions. It is also controllable with a foot pedal. This operation can be restricted with adjustment of the stops. Adjustments forward and backward are made with the horizontal arm. Additional up and down adjustments can be made with the vertical column.



OPERATION

Select the desired cutter for the work to be done. If a shape is desired requiring the use of more than one cutter, careful consideration should be given to the order of the cuttings. The cutter should be inserted fully into the collet then pulled out 1/8" and tightened securely.

The depth of the cut should be determined and adjusted for on the router by moving the router motor or the table up or down. The type of adjustment will depend on the model of the router. After the proper height is obtained, lock the motor or table in place. Check the adjustments by cutting a scrap piece of stock.

When routing, hold the machine firmly against the surface of the work. Cut in a left to right direction at a slow rate of speed to produce a fine cut. When cutting circular or irregular shapes, use a counter-clockwise movement.

Proper speed of moving the router will take experience and feel. Moving the router too slowly, will cause the cutter to burn the work. Moving the router too fast will cause excessive wear on the cutter and produce a cut of poor quality. Never force the cutter through the material. Deep cuts should be made by using a series of cuts, each one progressively deeper until the desired depth is achieved.

Guiding the router can be done in a number of methods: (1) A guide block or T-square can be temporarily clamped to the work to guide the router along the edge. (2) Use a straight or circular guide attached to the router. (3) Use a cutter with a pilot end. These cutters have a bearing or solid end just below the cutting edge which comes in contact with the work when the desired depth is achieved and prevents further cutting. These cutters are used for edge cutting. (4) Use a template cut to the desired shape. (5) Freehand routing is done with no guides. A great amount of experience is needed to perform quality cuts using this method.

A variety of operations can be performed using special templates and guides. Cutting a groove or dado is accomplished with the aid of the T-square guide. Spline joints can be made by

using a straight cutter and routing the edge of the work. Dovetail joints can be done using a special template. A special template is also used when cutting mortises for butt hinges.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Be sure power is disconnected before changing cutters or making adjustments.
- ✓ Be certain collet is tightened before each use.
- ✓ Use the router with both hands.
- ✓ Feed the router or stock at a safe rate, never force the router or material.
- ✓ Always try new adjustments on a scrap piece of material.
- ✓ When making deep cuts, use a series of cuts to achieve the desired depth.
- ✓ Allow the cutter to come to a complete stop before placing the router on the bench.
- ✓ On the overhead router, check adjustments, cutter clearance of the table and the fence, before starting the machine.
- ✓ Be sure the guard is in place on the overhead router.
- ✓ Feed material against the rotation of the cutter.

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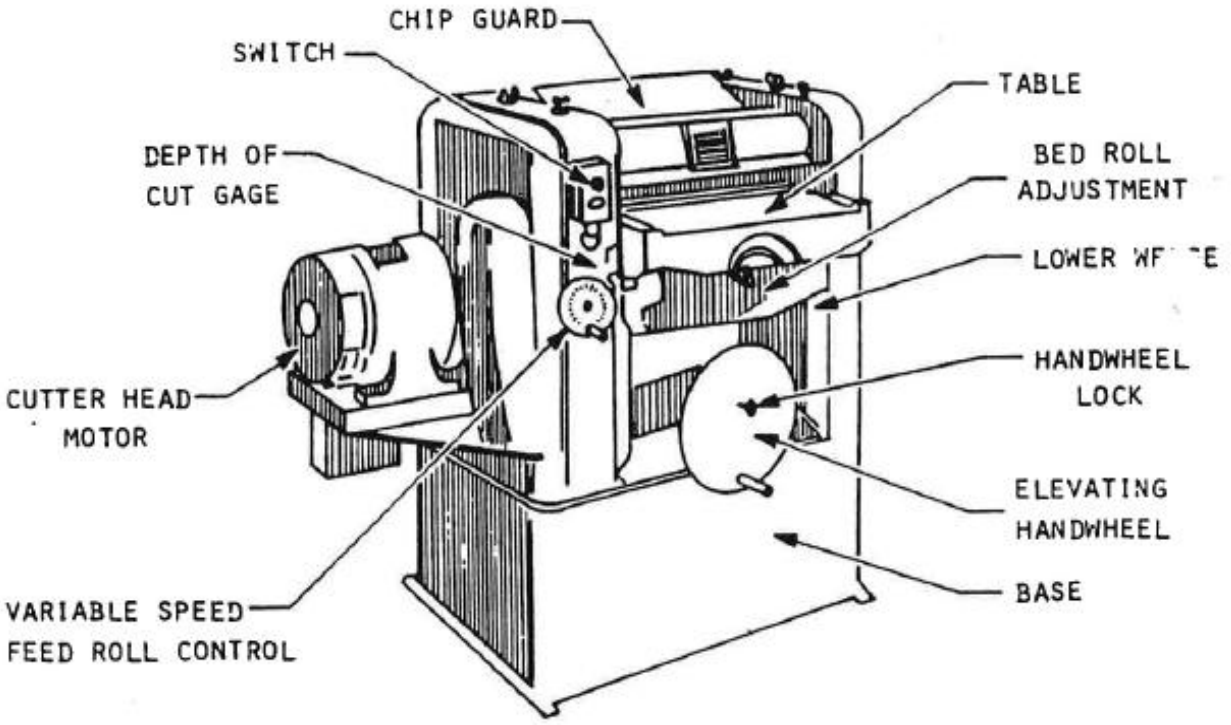
PLANER OR SURFACER

The planer or surfacer is used primarily to bring stock to thickness after any warp is removed on the jointer. Surfacers are available in sizes from 12" to 52". The size *is* determined by the maximum width stock is can accommodate. There are two types of surfacers; the single and the double. The single surfacer is the most common.



PARTS AND ADJUSTMENTS

The surfacer consists of a heavy frame that houses an adjustable table, a planer head, feed drive mechanism and a system for making the necessary adjustments.

The planing mechanism consists of one or two lower in feed rollers and one or two upper in feed rollers. The upper rollers are corrugated to grip and feed the material into the cutters. A chip breaker is placed between the in feed rollers and the cutters. This *is* a heavy piece of casting which applies pressure to the stock and prevents splintering. Next *in* line *is* the cutter head. This head *is* similar to that of the jointer. The head contains three, four, or more knives. To the rear of the cutting head *is* the pressure bar. This provides the pressure required to keep the finished stock firmly against the table. Behind the pressure bar *is* the out feed rollers. One upper and one lower

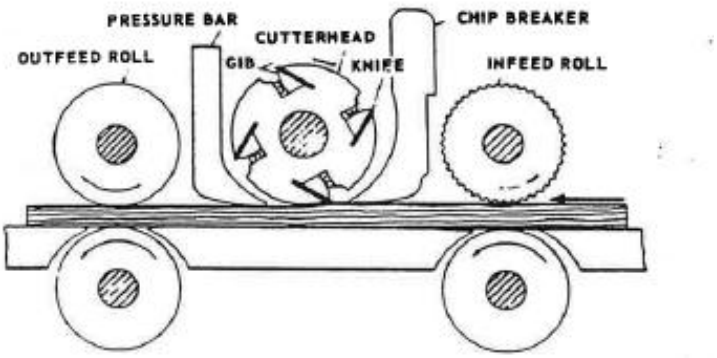


Fig. 8-1

The cutting *is* done on the upper side of the stock. The lower table and feed mechanism *is* adjustable for the desired thickness. Some models of surfacers are equipped with a thickness scale, the accuracy of which should be checked periodically. The thickness *is* adjusted with the elevating hand wheel. Surfacers have a variable feed speed control which *is* adjusted according to the depth of the cut.

OPERATION

Before planing a board, remove any warp on the jointer. Adjust the surfacer to a thickness of 1/16" less than the starting thickness of the board. Adjust the feed rate. Determine the grain direction of all pieces to be surfaced. Place the stock *in* a convenient location with the grain in the proper direction, so to facilitate easy handling. Start the motor. When feeding stock into the machine, always stand to one side of it, to prevent injury in the event of kickback. Use a dead man or a helper when surfacing long pieces. Never feed stock which *is* shorter than the distance between the in feed and out feed rollers. Feed stock into the surfacer with the jointed side against the table. In the event stock gets stuck *in* the surfacer, lower the table and turn off the power. When surfacing glued stock, remove all excess glue. Never plane stock which has been finished.

When surfacing more than one piece to thickness, measure the pieces and determine the thickest piece. Set the surfacer to 1/16" less than this piece. Run all the pieces through the surfacer with the working face towards the table. Feed the pieces so they cut with the grain. Apply pressure to the stock until the surfacer grips the stock and removes it from your hands. Feed each piece in a different location to avoid uneven wear of the knives. After all the stock has been run through the surfacer, check the thickness and make the necessary adjustments if another round is required. Alternate the sides of the material with each successive round. The final cut should be left slightly thicker to allow for finish sanding.

When surfacing stock thinner than 3/8" the use of a backer board is suggested. A backer board is constructed from a flat piece of stock, 3/4" thick and wider and longer than the piece to be surfaced. To one end of the backer board a stop should be fixed to prevent the piece from kicking out of the surfacer. The stop should be thinner than the desired thickness of the piece being surfaced.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Check all material for loose knots, nails, and other foreign objects.
- ✓ True all material on the jointer before surfacing.
- ✓ Stand to one side of the material being surfaced.
- ✓ Do not surface stock shorter than the distance between the in feed and the out feed rollers.
- ✓ Never look into the surfacer when the machine is running.
- ✓ Thin stock should be surfaced using a backer board.
- ✓ Avoid deep cuts and fast feed rates.
- ✓ Do not force stock through the surfacer that the surfacer will not "grab".
- ✓ Feed stock to cut with the grain.
- ✓ Never surface stock that has been painted or varnished
- ✓ If the material gets stuck, lower the bed and turn off the power.
- ✓ Get help if the material is too long or awkward.
- ✓ As soon as the rollers grip the material, release your grip.
- ✓ Make sure the stock to be surfaced has one good surface.

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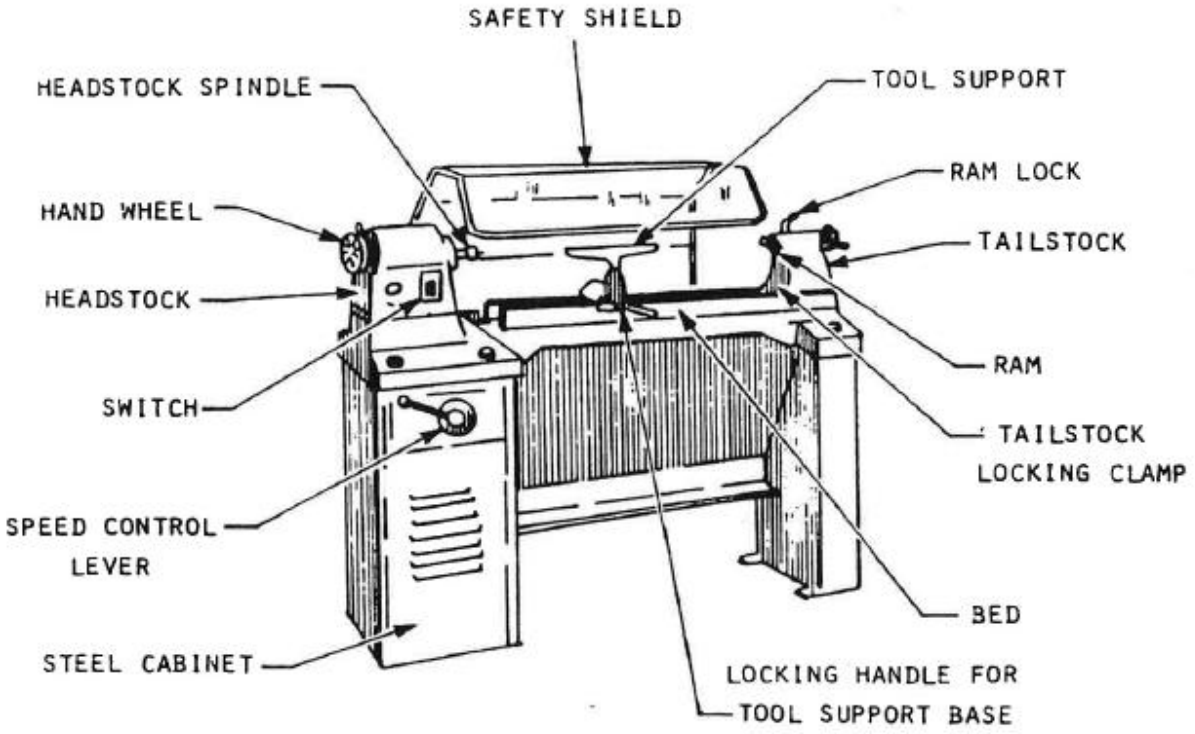
WOOD LATHE

The wood lathe is used to turn round items, such as bowls, furniture legs, and various other objects. Most turned parts found on furniture are manufactured on an automatic lathe. Lathe sizes are determined by the largest diameter it can turn and the length of the lathe bed. The most common size is the 10" diameter lathe with a 36" bed. Lathes are either belt-driven or direct drive, and have adjustable speeds from 600 to 3,400 rpm's.



PARTS AND ADJUSTMENT

The headstock is located at the left side of the lathe and is stationary. It has a hollow spindle which is threaded at both ends. A spur center can be inserted in the spindle for turning between centers. The faceplate can be threaded on either end of the spindle for faceplate turning.

The tail stock, located at the right end of the lathe, can be slid along the lathe bed to accommodate different size work. The tail stock also has a hollow spindle to accept the cup center.

The tool rest is mounted on a base which is secured to the lathe bed. Tool rests are available in various sizes. The tool rest is slid along the lathe bed and positioned at the work area.

There are five basic types of turning tools. The gouge is used for cutting rough stock to round or dimension. The gouge has a 30 degree bevel ground in the convex side of the tool. The

skew is used for finish cuts and smoothing. It is also used for cutting shoulders, trimming ends, V's and beads. A parting tool is used for cutting recesses or grooves with straight sides and flat or square bottoms. The round nose is used for roughing out stock or for making concave cuts. The diamond point tool is used to square corners or finishing recesses. Fig. 9-1 In addition to the turning tools, marking tools are needed; a rule, pencil, dividers, inside and outside calipers.

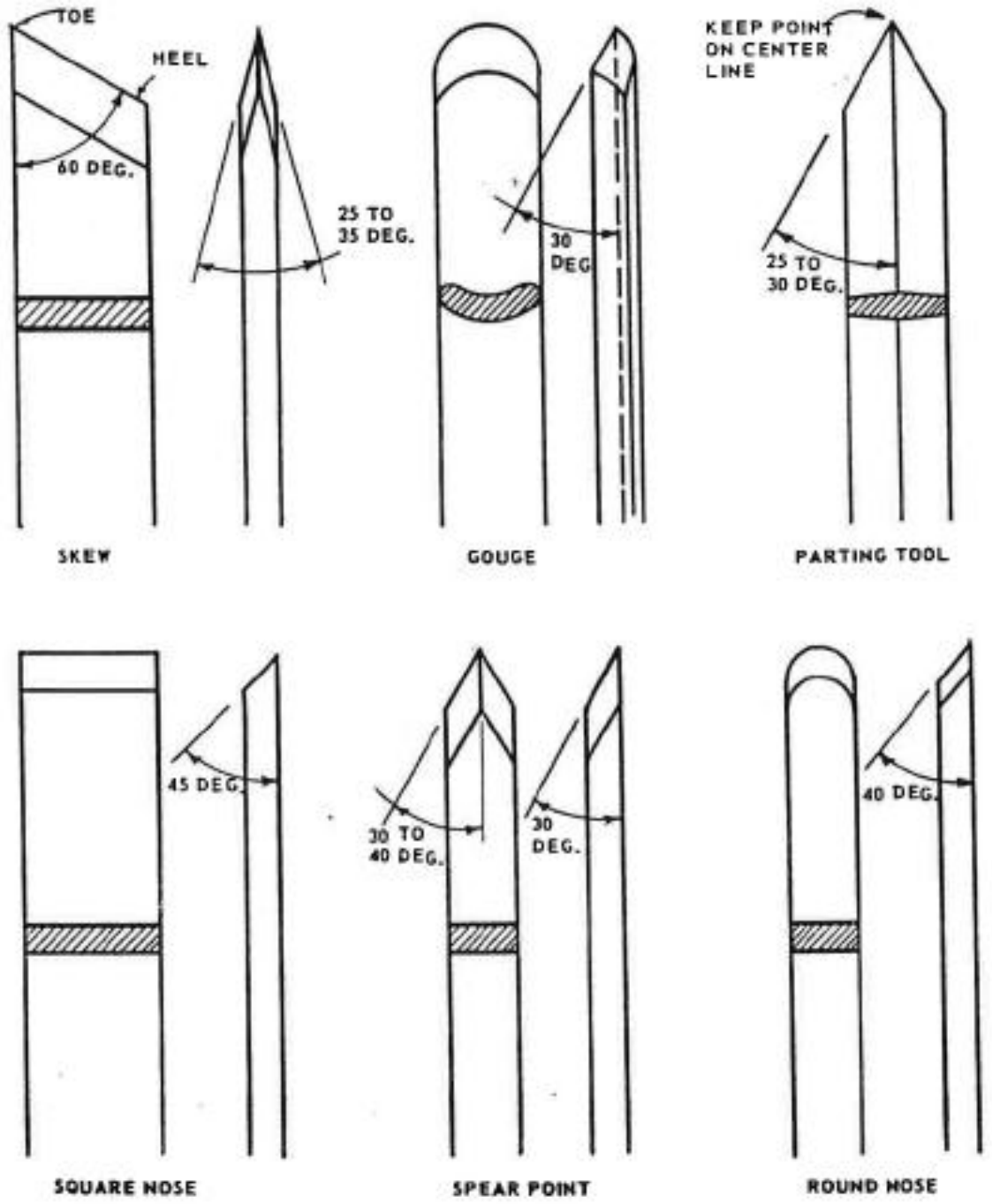


Fig. 9-1

OPERATION

Spindle turning is done between the live center in the headstock and the dead center in the tail stock. The procedure is started by selecting a piece of stock slightly larger than the desired finished diameter and 1" longer than the finished length. Stock that is square and larger than 3", should be cut to an octagon on the band saw. Draw diagonally across the ends to locate the centers. Mark the centers with a punch. If the stock is hardwood, use a drill to locate the center and cut shallow kerfs along the marked lines. At one end, place the spur center in position and drive it into the stock with a mallet. Fig. 9-2

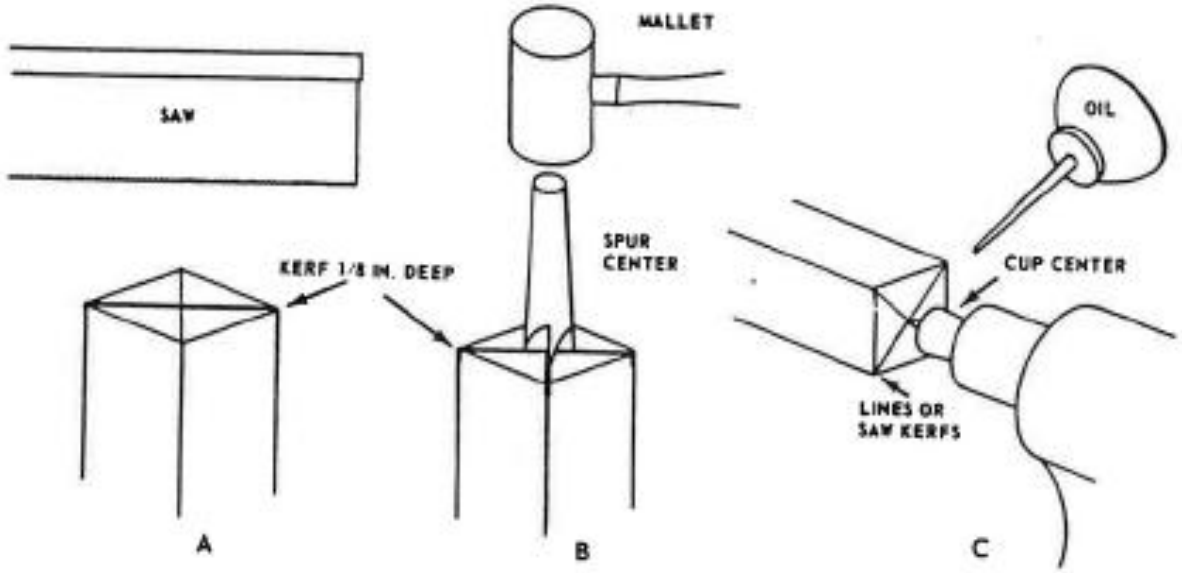


Fig. 9-2

Place the stock with the center into the head stock. Bring the tail stock within 1/4" of the stock and tighten it down. Turn the hand wheel until the cup center is seated in the stock. Turn the wheel out and apply a lubricant to the cup center. Retighten the hand wheel to provide a firm tension and lock it with the clamp. Position the tool rest to the area of the cut. The rest should be adjusted within 1/8" of the work with the top of the rest 1/8" above the center of the work. Adjust the speed of the machine to the diameter of the work being turned; 1-2" use the fastest speed, 2-3" use the medium speed, 3" and over use the slowest speed. Before turning on the lathe, turn it over by hand to check for proper operation. Begin by using a gouge to round out square stock. The tool is held by placing the right hand on the handle and the left hand on the blade. To cut with a gouge, place the tool against the work and slightly twist it to the right, forcing it into the work until cutting begins. The beveled side of the tool should be tangent to the work. Move the tool toward the tail stock. With each successive cut, begin the cuts closer to the head stock. When the cylinder is formed within 2" of the headstock twist the tool to the left and move it toward the headstock. Continue the process until a

cylinder is achieved of the proper diameter. The tool rest may need to be moved at times to follow the work.

Finish turning is done after the desired diameter is reached. The skew is used for this operation. Start at a point several inches in from the end of the work to prevent the tool from catching and splitting the work. The tools should always be placed on the tool rest before forcing it into the work. The parting tool is also used for finishing work, for cutting shoulders or cutting the work to length. The round nose tool is a finish tool used to cut concave areas. The diamond point is used for finishing the insides of areas or squaring off cuts.

Faceplate turning is used for turning bowls or "disclike" objects. Place the faceplate on the headstock. Mount the work on the faceplate with four wood screws. The tool rest may be adjusted parallel to the faceplate or at a right angle. The same techniques and tools are used for faceplate turning as for spindle turning.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Select the correct spindle speed according to the diameter of the work.
- ✓ Hold tool firmly on the tool rest before forcing into the work.
- ✓ Be certain the tail stock is secured to the base of the lathe.
- ✓ Always remove the tool rest when sanding on the lathe.
- ✓ Stop the lathe before attempting any adjustments.
- ✓ Stop the machine if excessive vibration if noted and check the problem.
- ✓ Carefully check work for check, knots or defects before turning.
- ✓ Adjust the tool rest to the proper position.
- ✓ Use the proper tool.
- ✓ Be careful when turning at the end of the work, tool may catch and cause splitting.
- ✓ Be sure safety shield is in place.

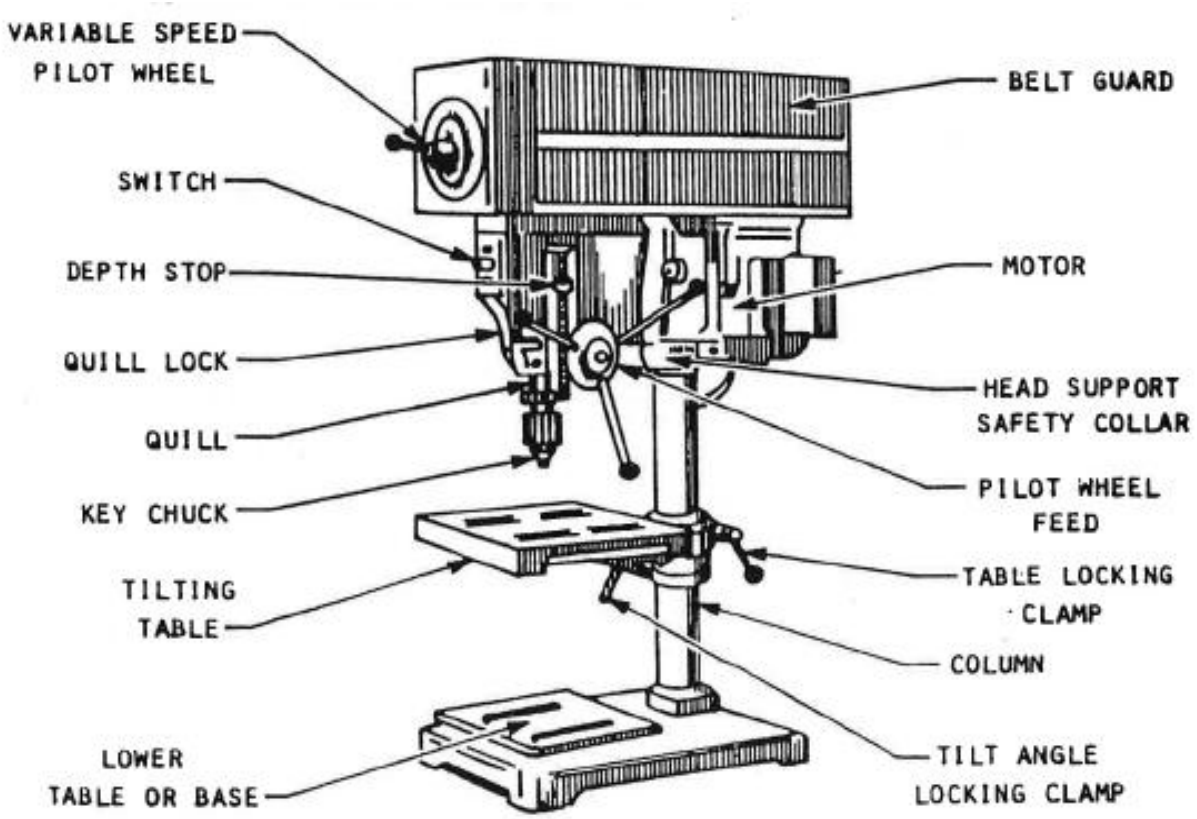
DRILL PRESS

DRILL PRESS SAFETY RULES

1. Run drill at correct RPM for diameter of drill bit and material. Ask the Area Supervisor for the correct RPM.
2. Always hold work in a vise or clamp the work to the drill table.
3. Use a correctly ground drill bit for the material being drilled. The Area Supervisor can help select the correct bit.
4. Use the proper cutting fluid for the material being drilled. Ask the Area Supervisor about the appropriate fluid for the material you are machining.
5. Remove chips with a brush, never by hand.
6. Ease up on drilling pressure as the drill starts to break through the work.
7. Always inspect the drill before using and do not use a dull or cracked drill or drill bit.
8. Always try to support the work on parallels or a backing board when drilling thru material.
9. Never place taper shank tools such as large diameter drills or tapered shank reamers in a drill chuck. Only straight shank tools such as standard drills can be clamped in chucks.
10. Always clean drill shank and/or drill sleeve, and, spindle hole before mounting.
11. Remove taper shank tools from spindle or sleeve with a drill drift and hammer.
12. Never try to loosen the drill chuck while the power is on.
13. Lower the drill spindle close to the table when releasing the drill chuck or taper shank drill to reduce the chance of damage in the event they fall onto the table.
14. Never clean the machine while it is in motion!!
15. If the drill binds in a hole, stop the machine and turn the spindle backwards by hand to release the bit.
16. When drilling a deep hole withdraw the drill bit frequently to clear chips.
17. Always remove the drill chuck key or the drill drift from the spindle immediately after using.
18. Let the spindle stop of its own accord after turning the power off. Never try to stop the spindle with your hand.
19. Plexiglas and other brittle plastics can be difficult to drill. Ask the Area Supervisor for advice on drill and coolant selection when drilling these materials.

DRILL PRESS

The drill press is a very valuable tool. It is used for boring and other operations with attachments. The drill press speed is adjustable, either by step pulleys or variable-speed pulleys. Drill press size is determined by the largest size work piece in which a hole can be b bored in the center. An 15" drill press has a distance of 7 1/2" between the chuck center and the column.



PARTS AND ADJUSTMENTS

The base of the drill press supports the column. The table of the press slides up and down on the column. The table is locked into position by a clamp and can be tilted to a position parallel to the drill chuck.

At the top of the column is the drill head, which supports the motor and the drilling mechanism. A motor drives the spindle by a belt. The spindle extends down through a quill; a chuck is attached to the end of the spindle. The chuck is usually a three jaw clamping device. The quill is lowered by the feed levers and forces the drill into the work. The quill is spring

loaded and returns to the up position when released. The quill can be locked into position by using the quill lock. There is also a quill stop used to bore a hole to a pre-determined depth.

OPERATION

The speed of the drill will vary with the kind of material, type of drill and the size. Bits over 1/2" should be used at the slowest speed 400 to 800rpm. Large bits driven at high speeds will heat up and may be damaged. Adjust the table to provide about 1/2" clearance between the drill and the work.

When boring only a few holes, lay-out and center punch each hole location. If the hole is to drilled all the way through, support it on a flat piece of scrap stock. This will prevent splintering of the underside of the work.

Hold the stock firmly with the left hand, turn on the machine and slowly lower the drill to the surface of the work. Align the point of the drill with the punched hole and feed the drill into the work with smooth, even pressure. When the hole is through, raise the drill and reposition work for the next hole.

To bore a hole to a specified depth, use the depth stop. To set the stop, lower the drill along the edge of the work piece until the desired depth is achieved. Lock the quill at this position and set the stop. Unlock the quill and bore the hole. Fig. 10-1

Stock that is round or irregular should be clamped to the table or held by special supports. A V-block can be used to bore round stock. The V-block is first centered with the drill and clamped into position to insure a hole through the center of the round stock. Metal vises are available which rest on the drill table and hold irregular stock.

When drilling holes in the end or the edges of stock, it is often best to turn the table to the vertical position. The work is then clamped to the table.

When drilling deep holes, raise the drill out of the work frequently to clear the cuttings and allow the bit to cool.

Drilling metal has a few additional considerations. Begin by selecting a drill of the correct size. Drilling holes larger than 1/2” require the drilling first of a pilot or lead hole. The small hole should be as large as the dead center of the final size drill. This pilot hole relieves the pressure at the dead center, and allows the pressure to be directed to the cutting edges.

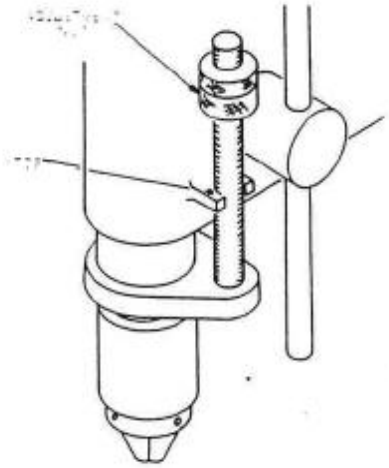


Fig. 10-1

The use of a cutting fluid is necessary when drilling metals. This is applied liberally at the start and frequently thereafter by raising the drill, to clear chips and applying more fluid. The most critical time of drilling metal is when the drill begins to break through the underside. When this occurs, ease up on the feed pressure to prevent the drill from digging in. Remove the drill from the work and turn off the power. Clear the chips with a brush.

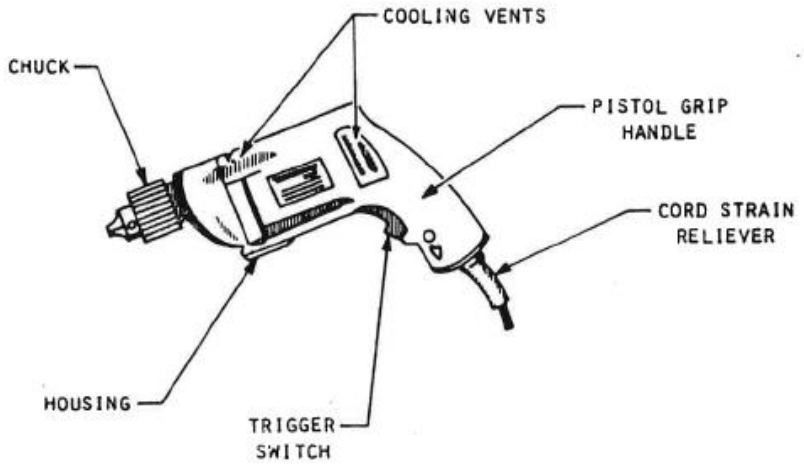
SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES, WOOD PROCESSING RULES and METAL PROCESSING SAFETY RULES.

- ✓ Clamp all work to the table.
- ✓ Be sure the chuck key is removed before turning the drill press on.
- ✓ Use a V-block for drilling round stock.
- ✓ Use the correct speed- size drill, type of drill and type of material.
- ✓ Adjust the table to avoid drilling through the table.
- ✓ If drill catches in material, turn off drill.
- ✓ When drilling deep holes, remove the drill from the hole occasionally to remove the chips.

PORTABLE HAND DRILL

The portable drill is used for a variety of on-site jobs, including drilling holes in metal, wood, and masonry or driving screws. The size is determined by the horsepower rating and more commonly by the chuck size.



PARTS AND ADJUSTMENTS

The portable drill is basically a motor, a handle and a chuck for holding the drill. Press the trigger for on, release it for off. Most drills have the Jacobs chuck, the geared type and requires a special key to use. Some drills are equipped with two speeds for metal and wood. Another type of portable which is popular is the cordless drill.

OPERATION

Mark out the work and center punch the holes. Open the chuck and insert the drill to the bottom. Tighten the chuck and remove the key. Back thin work with a piece of scrap wood. Firmly hold the drill using the left hand to guide the drill. Place the drill on the punched hole with the power off. Straighten the drill and turn on the drill. When the hole is nearly through, ease up on the pressure and complete the hole.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES, WOOD PROCESSING RULES and METAL PROCESSING SAFETY RULES.

- ✓ Select the correct drill and mount it securely to the full depth of the chuck.
- ✓ Clamp all work.
- ✓ Drill with a straight pressure, avoid applying a side pressure.
- ✓ When drilling deep holes, pull the drill out of the hole occasionally to clear chips.

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SANDING MACHINES

SAFETY RULES FOR HEAVY SANDING OF WOOD AND FOAM

1. Always sand outside (patio area) or in the designated area (spray booth).
2. Use a vacuum or a dust collector to collect dust **while** sanding to prevent the dispersal over a large area.
3. A dust mask should always be worn.

Sanding machines vary in sizes and types, ranging from small portable machines to large stationary machines. Power sanders cut wood rapidly and create a great amount of dust. These sanders should not be used without an adequate dust collection system.

GENERAL SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Sanders should not be used to form or shape work which could be more safely done by another operation.
- ✓ Sand only new wood. Painted or glued pieces will load up the abrasive.
- ✓ Move the stock or the machine evenly and steadily over the entire surface.
- ✓ Never leave the machine until it has come to a complete stop.
- ✓ Apply only sufficient pressure to do the job.
- ✓ Make certain guards, adjustments and table are secure.
- ✓ Check the disc or belt for wear or damage.

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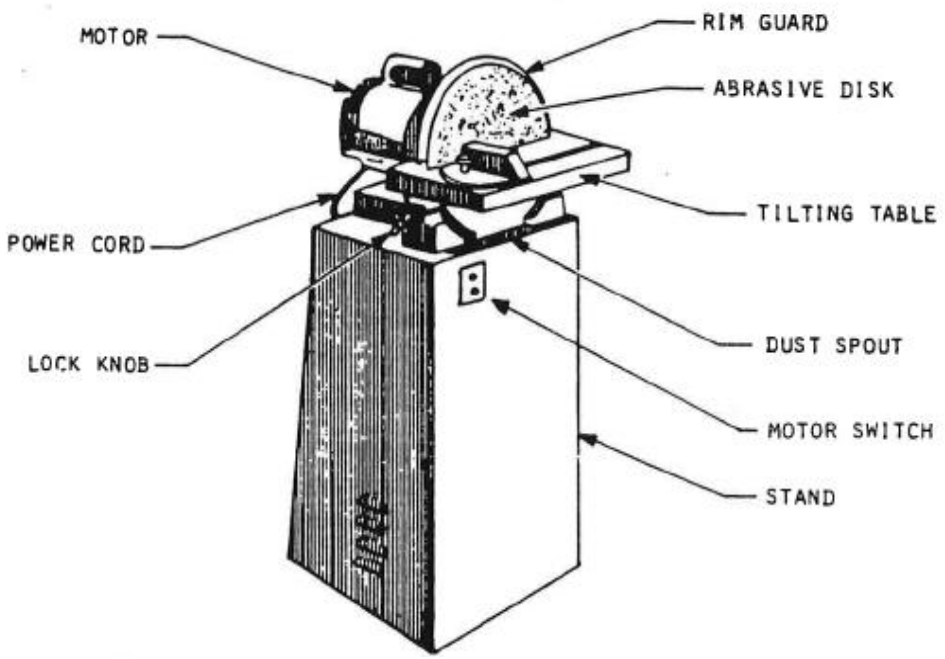
DISK SANDER

1. **DISC AND BELT SANDER SAFETY RULES**
2. Do not operate sanders without the guards in place.
3. On the disc sander always use the downward motion side of the disc to sand. Never the upward motion side as this can throw your part upwards with tremendous force.
4. Always attempt to place your work against the rest on the disc and belt sanders.
5. On the horizontal belt sander, always sand, so that the belt motion is away from you.
6. Do not operate machines with torn or ripped belts or disks.
7. Do not sand any material that will give off a dangerous dust. Such materials as beryllium or copper beryllium alloys must not be sanded or filed. Asbestos must not be sanded. Asbestos is an ingredient of brake shoes and pads.

These stationary machines consist of a metal disk that carries the abrasive and a table to support the work. The table can be tilted at various angles to accommodate such in the work piece. The table usually has a slot, for the addition of a miter. The major use of this machine is the shaping and forming of pieces prior to finishing.



OPERATION

The paper is held on the disc with a special non-drying adhesive. The old disc is peeled off; if the surface is clean it may be reused. With the machine on, run a stick along the disc starting at the center and moving to the outside, to smooth the adhesive. Apply adhesive to the abrasive disc in an even, uniform coat. Carefully mount the abrasive to the disc and press firmly in place. Be certain the abrasive is centered on the disc.

The chief use of the disc sander is for edge sanding. Hold the work firmly on the table and move the work into the disc with light pressure. The half of the disc which revolves down is the only surface to be used when sanding. Move the work along the entire half of the disc. This prevents excessive heat, and the abrasive from loading up with gum and pitch.

Pieces of irregular shapes are sanded freehand. For sanding straight edges, the use of a miter is recommended. Other guides and fixtures can be developed for special needs.

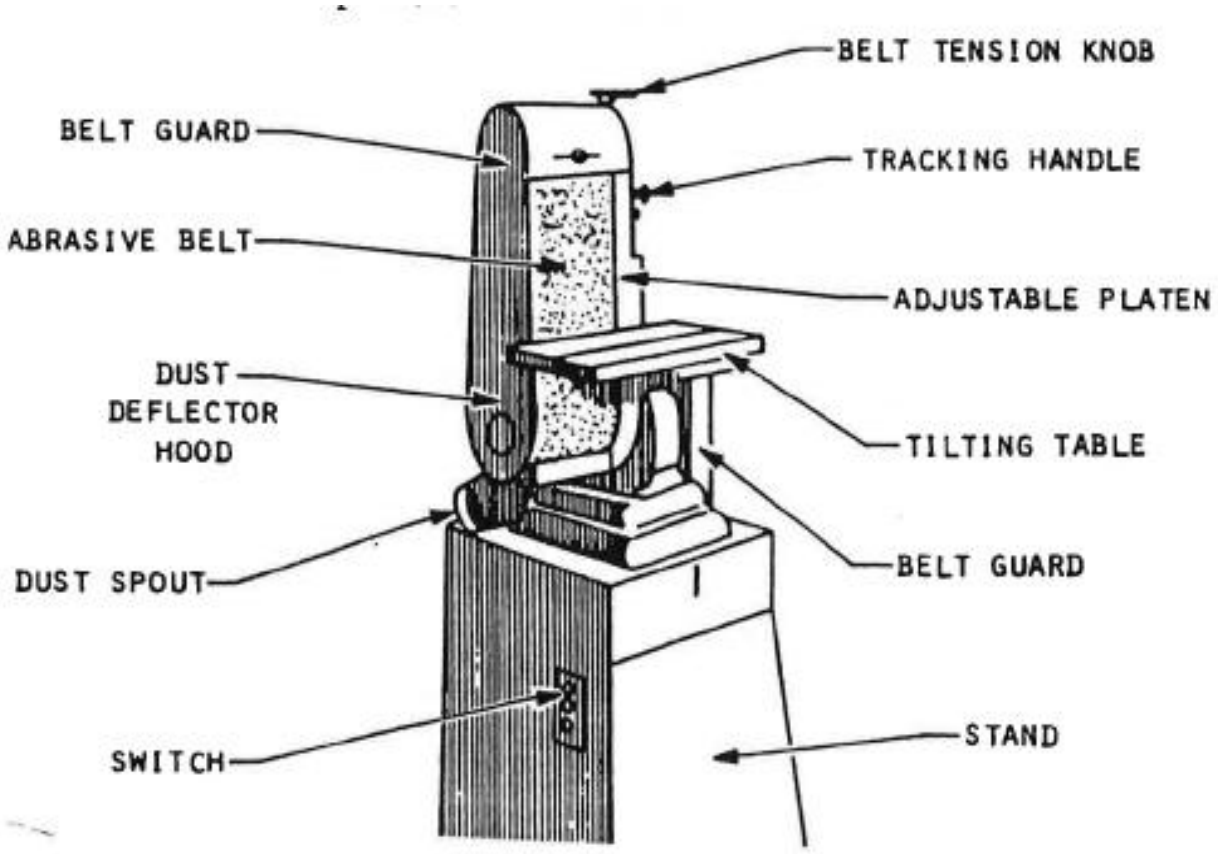
SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Be certain the abrasive disc is securely mounted to the platen.
- ✓ Check the abrasive disc for tears or damage.
- ✓ Only the side of the disc rotating down should be used.
- ✓ The table should be adjusted within a 1/16" of the disc.

BELT SANDER

The belt on a belt sander runs around two drums and rides over a platen. One drum *is* powered and the other is an idler, which can be adjusted so the belt will track in the center of the platen.



OPERATION

To replace a belt, remove the guards, release the tension, and remove the belt. Select the proper belt for the operation and put the belt on noting the direction arrow inside the belt. Adjust the belt tension and turn the machine over by hand to check the tracking. Replace the guards, turn the machine on and readjust the tracking if necessary. The tracking should be observed for the first few minutes when beginning sanding a work piece.

Flat pieces can be held by hand on the platen surface of the sander. Thin or small pieces should be held with a wood pad. To sand work pieces square, a table and miter gauge can be used. Curved surfaces can be sanded by removing the end guard and using the idle or drive drum.

SAFETY RULES

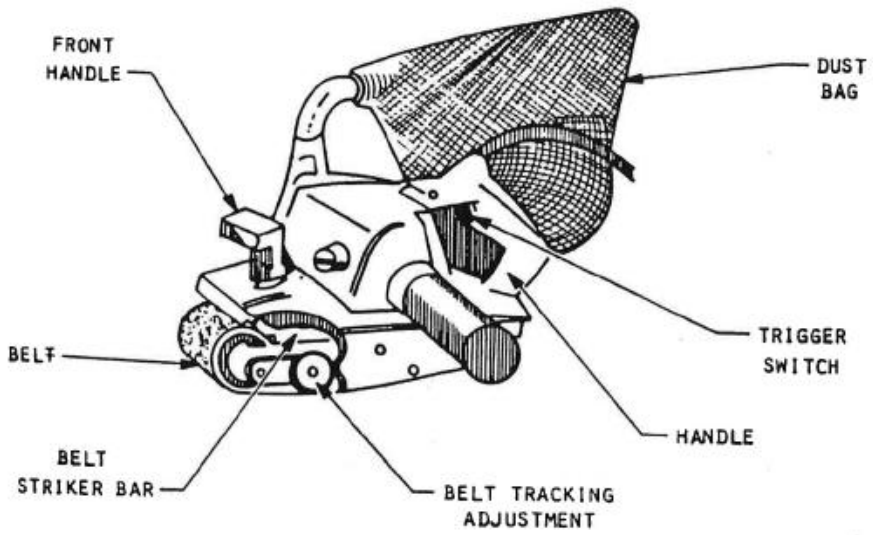
Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Check the belt for correct tension.
- ✓ All adjustments should be made with the power off, except the final belt adjustment.
- ✓ When replacing the belt, be certain the new belt runs in the correct direction.
- ✓ Check the tracking of the belt.

PORTABLE BELT SANDER

The portable belt sander is a smaller version of the large stationary model. The size of the sander is determined by the width and length of the belt.

The installation of the belt is similar to the large belt sander. Release the idle drum (usually a lever) and remove the belt. Replace the belt with the proper belt and reapply the tension. Turn on the machine and check the tracking of the belt, making the necessary adjustments.



OPERATION

The work should be secured to a bench by a clamp or held by a stop block mounted to the bench. Turn the sander on before placing it on the work. Lower the sander carefully and evenly onto the work. Move the sander forward and backward over the work piece. At the end of each stroke slide the sander over, about one half the belt width, until the entire surface is sanded evenly. There is no need to apply additional pressure, as the weight of the sander usually provides sufficient pressure. When the operation is finished, raise the sander from the surface and turn off the machine.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Start the sander above the work.
- ✓ Be certain the belt runs in the correct direction, when replacing it with a new one.

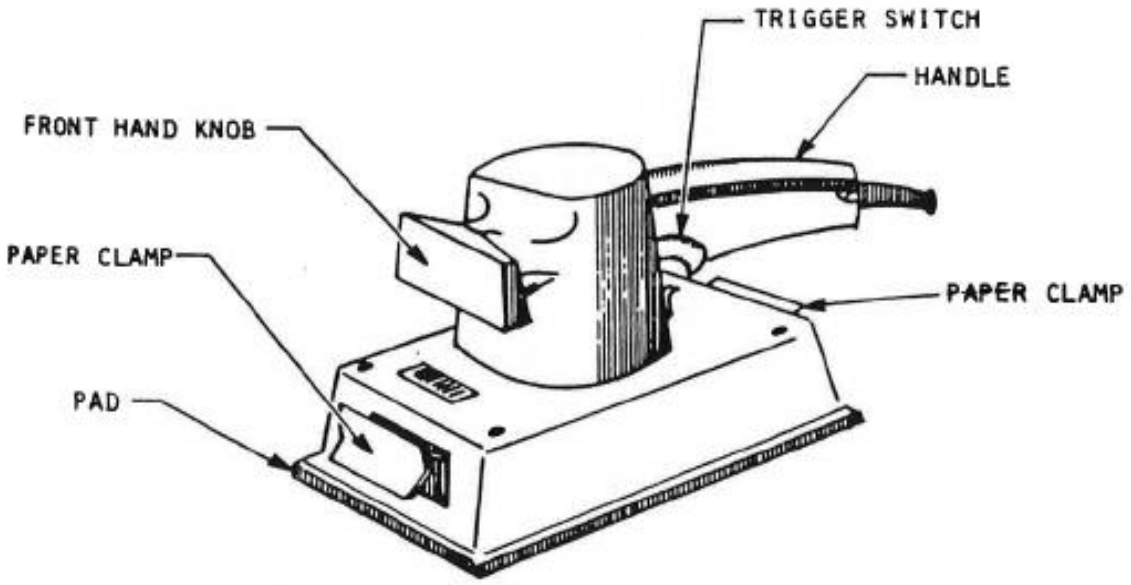
- ✓ Keep the electrical cord free from the operation.
- ✓ Check the tracking of the belt
- ✓ All work should be secured to a working surface.

PORTABLE FINISHING SANDER

Finish sanding, where only a small amount of material is to be removed, is accomplished with the finishing sander. There are two types of these sanders; the orbital and the oscillating. The pad of the orbital sander moves in a circular course. A straight line backward and forward is performed by the oscillating sander. The orbital sander cuts the material faster than the oscillating, which is used for fine finish work.

Standard sheets of sand paper may be cut down and used on either of the two types of finishing sanders. The paper is held on to the sanders in a variety of methods, either a clamping device or an adhesive system. The sander is started off the work and gently lowered to the work.

The sander is moved back and forth with the grain, in the same manner as the belt sander. Extra pressure beyond the weight of the sander is not necessary. When the operation is completed, raise the sander from the surface and turn it off.



SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ All work should be secured to a working surface.

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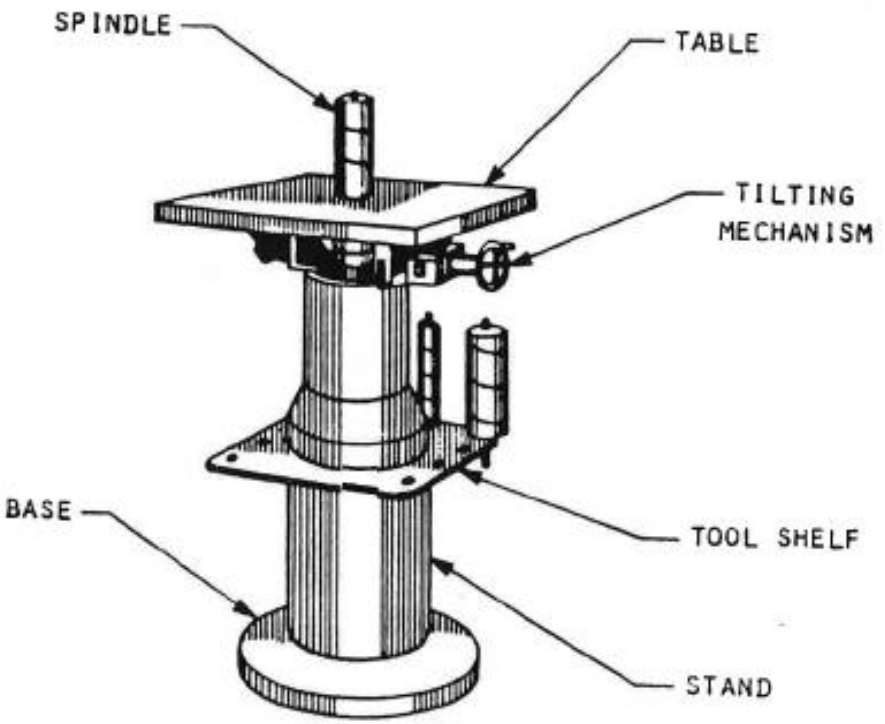
SPINDLE SANDER

Spindle sanders have a vertical sanding drum, which projects through a table. The drum revolves and at the same time oscillates up and down through the table. The table is adjustable to sand at various angles. This type of sander is especially useful for sanding concave curves.

Spindle sanders use drums of different diameters. The drums have abrasives glued to them. The diameter of the drum should be chosen according to the shape and size of curve to be sanded. The drums are mounted on spindles which are easily changed.



SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and WOOD PROCESSING SAFETY RULES.

- ✓ Check the spindle for proper mounting. It should not wobble
- ✓ Periodically tighten the retaining nut on top of the spindle.
- ✓ Never reach across the spindle.
- ✓ Never force the material against the spindle.

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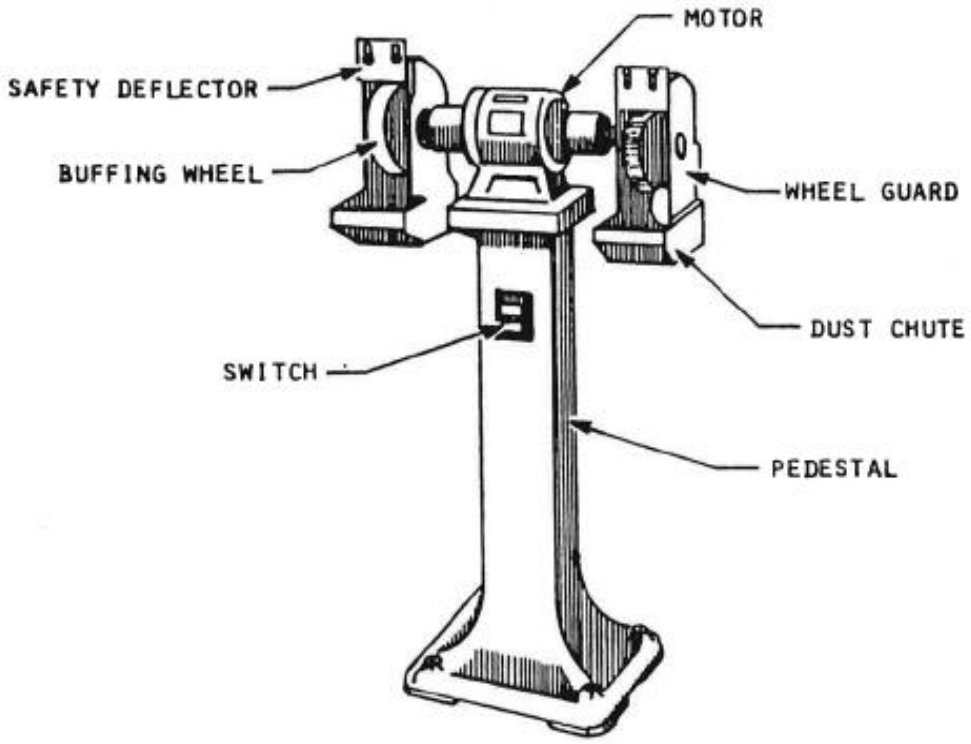
BUFFER

The buffer is used to polish work to a smooth bright finish. A buffing compound is applied to the wheel. Buffing wheels are made of cloth, felt or leather.



PARTS AND ADJUSMENTS

The buffing machine is very similar to the grinding machine. Most wheels have an arbor hole. The spindle of the buffer goes through the hole and is held securely by a nut.

OPERATION

Choose the proper buffing compound as listed in the chart:

METAL	ROUGHING	FINISH
Aluminum	Tripoli	Rouge
Brass	Tripoli	Lime
Copper	Tripoli	Lime
Pewter	Tripoli	Rouge
Steel	400 Silicon Carbide	Rouge

Buffing compounds are abrasive materials which do the actual polishing. Tripoli is a limestone material. Rouge is a light, soft iron oxide. Crocus is a darker colored and used for rough buffing.

Apply the compound to the wheel by holding it against the wheel under power. The wheel is ready for buffing when the compound coats the wheel.

Hold the work firmly and put it against the lower part of the wheel. The work should be kept moving to 'polish the entire surface. Do not force the work into the wheel, allow the compound to do its job applying excessive force only creates heat and damages the piece.

To change compounds, move to another wheel with the correct compound. Do not apply different compound to wheels. To finish work use the fine compound and buff until satisfied with the results.

SAFETY RULES

- ✓ Hold work in both hands.
- ✓ Always use the lower half of the wheel.
- ✓ Do not force the work.
- ✓ Never buff a leading edge.
- ✓ Use care when buffing around corners or openings which the wheel could catch.
- ✓ Never use gloves or rags to hold the work.

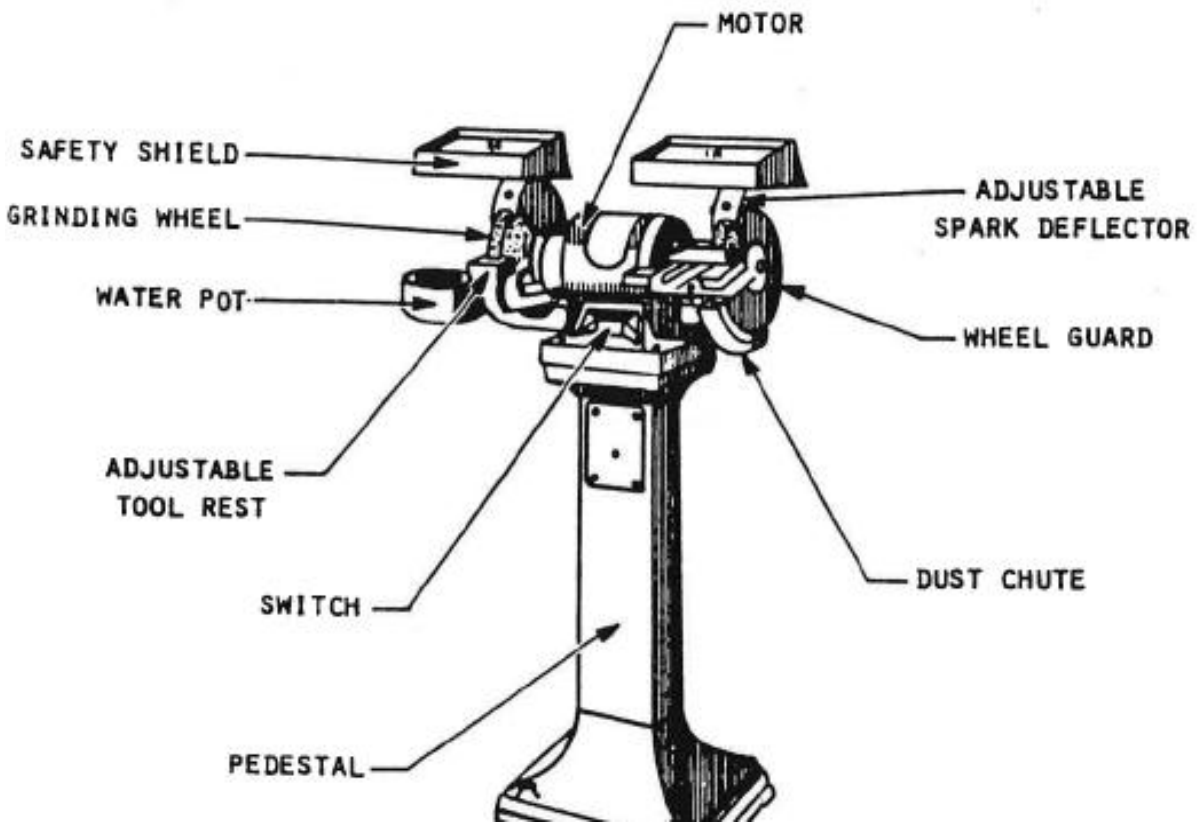
GRINDER

GRINDING SAFETY RULES

1. Abrasive wheel machinery shall not be operated without guards in place. Be aware of pinch points.
2. Tool rests on bench or pedestal grinders shall be set no more than **1/8 inch** from the wheel.
3. Never use a wheel that has been dropped or received a heavy blow, even though there may be no apparent damage. Such wheels may be weakened or unbalanced enough to fly apart on startup.
4. **Stand to one side when starting machine**.
5. Do not grind on side of wheel unless wheel is specifically designed for such use.
6. Do not use excessive pressure while grinding.
7. Report to the Area Supervisor immediately any cracked, broken or otherwise defective wheels.
8. Have the Area Supervisor mount and balance new wheels.
9. Keep the grinding wheel dressed. Dressing a small amount frequently is better than having to dress a lot later and will allow the wheel to cut faster, cooler and with a better surface finish.
10. Dressing is cleaning and smoothing the surface of the grinding wheel.
11. Hold work securely while grinding, use the tool rest to support the work when offhand grinding on bench or pedestal grinders.
12. **Do not grind aluminum**.
13. Wear goggles over safety glasses when grinding on bench or pedestal grinders.

GRINDER

Grinders are used for roughing material by hand. Grinders are used for removing burrs, sharp edges and other imperfections.



PARTS AND ADJUSTMENTS

The pedestal and bench grinders are the most common types of grinders. Both of these grinders employ a double shaft motor with a grinding wheel attached to each spindle. The left side spindle is threaded left and the right side spindle is threaded right.

The tool rest supports the work while grinding. The tool rest should be adjusted as close to the wheel as possible without touching.

The grinder should be equipped with a water pot, to cool work when grinding.

The grinding wheel should be nearly enclosed by guards. Guards keep sparks and bits of material contained. The guards also protect the operator in the event of a broken wheel.

Both sides of the wheels should be equipped with safety washers followed by flange washers. The safety washers are made of a soft material, which grip the grinding wheel when

tightened and locks it securely. The flange washers are large plates which aid in the mounting of the wheel and hold the wheel together in the event of breakage.

OPERATION

Mounting the wheel correctly is very important for safety. The wheel should not be forced on the shaft. First on the spindle is the flange washer, safety washer, grinder wheel, safety washer, flange washer and nut. After the mounting procedure is completed, stand to one side and turn on the power, checking for misalignment or wobble. If a true spin is not observed stop the grinder at once.

Be certain the recommended wheel rpm is the same as the grinder. Most wheels and grinders are rated at 4000 to 6500 FPM.

Hold the work firmly against the tool rest and apply pressure to begin grinding. Do not force the work into the wheel. Use both hands to hold the work.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and METAL PROCESSING SAFETY RULES.

- ✓ Set the tool rest and spark deflector to 1/16" to 1/8".
- ✓ Hold small work with a special set-up.
- ✓ Use only the face of the wheel.
- ✓ Move the work across the entire face of the wheel.
- ✓ Do not leave the machine until the wheels stop revolving.
- ✓ Stand to one side each time the grinder is started to prevent getting hit with lose material in the grinder.
- ✓ Apply only enough pressure to do the job.

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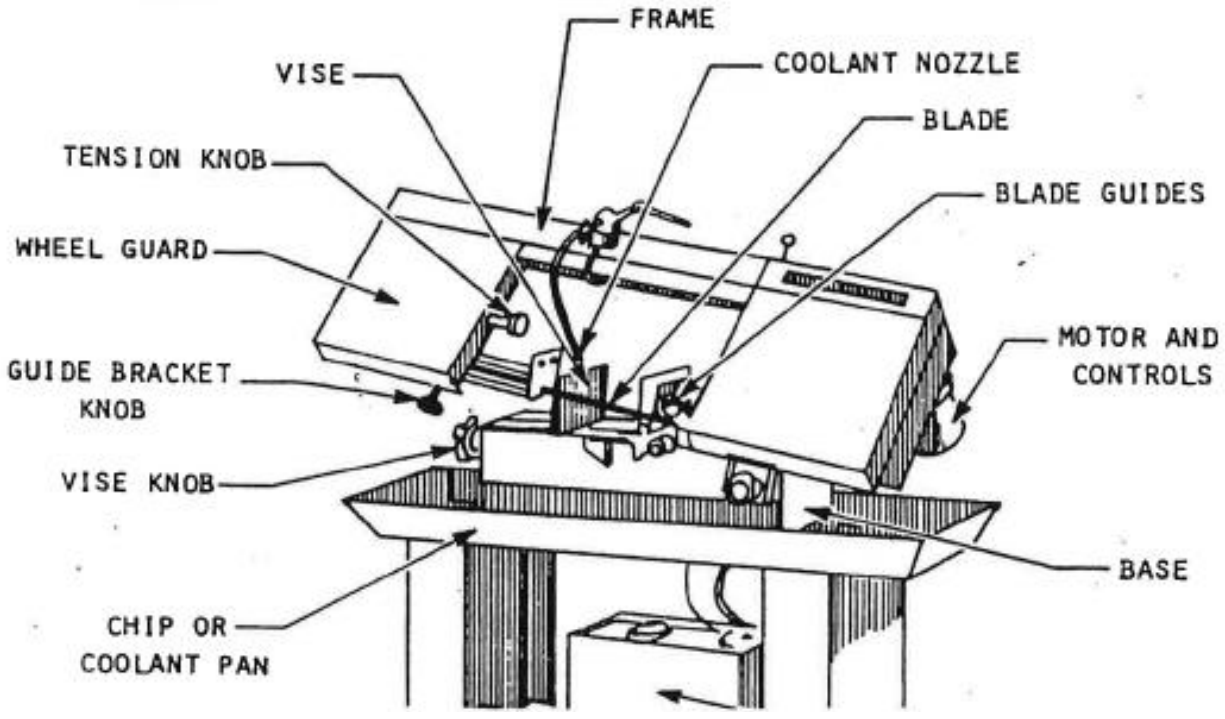
HORIZONTAL BAND SAW

HORIZONTAL BAND SAW SAFETY RULES

1. Clamp the work-piece firmly in the vise, but don't over tighten!
2. The vise jaws must be parallel. Use a spacer block when cutting short or odd shaped pieces to keep the jaws parallel.
3. Support the descent of the saw as it starts the cut, or for the entire cut when cutting thin stock or if the saw drops rapidly.
4. Use only the correct blade for the material being cut. (Fine blade for steel, coarser one for aluminum, plastic or wood.)
5. Adjust the blade guides and rollers properly, and adjust the speed. The leading saw guide should clear the jaws when it descends, but be as close to the jaws as possible.
6. Check the work-piece to be sure it is free of defects (i.e. broken off tool bits).
7. A minimum of three teeth must be engaged in the work-piece at all times or the teeth will be torn off of the blade.
8. Hold round stock securely with a "V block" in a vise.
9. The Horizontal Band saw is a flood coolant machine; the fluid that flows over the blade is re-circulated. If the fluid is not flowing inform the Area Supervisor immediately and it will be refilled.

The horizontal band saw is the most common saw for cutting metal stock. The saw produces a 1/16" kerf, which is considerably less than the power hacksaw or abrasive disc saws.



OPERATION

Blades of I" or wider are often used, because of their high strength. A regular tooth blade is used when cutting material up to I" thick. Hook tooth blades should be used for cutting thicker stock.

Cutting speeds and feeds vary with (1) the kind of blade material, (2) size of the blade, (3) the type and thickness of material to be cut, and (4) whether a cutting fluid is or is not used. Machines equipped with a swivel vise should be checked so the vise is set at the desired angle. The stock should be properly positioned in the vise. If the piece to be cut is too short to be held properly in the vise, an additional piece of stock should be placed on the opposite side of the vise. Fig. 14-1 Stock which is excessively long should be supported with a stock support. Fig. 14-2 lower the saw blade to rest lightly on the stock so that the stock can be adjusted for the cut. If several pieces need to be cut at the same length, a stop gauge or cutoff gauge should be used. Adjust the blade guides to the size of the stock.

Set the machine for the correct cutting speed and feed tension. On saws with power feed systems, start saw, turn on coolant and engage the feed system. The feed pressure should be adjusted to produce a steady flow of chips, with no signs of the saw straining or laboring. When the cut is complete, raise the saw frame, turn off the machine, and remove the stock.

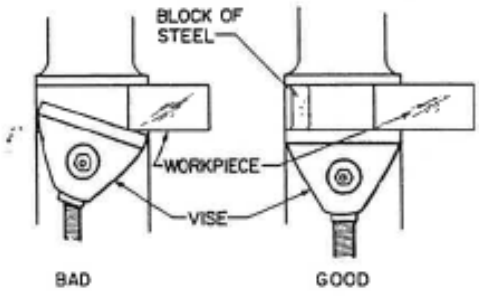


Fig. 14-1

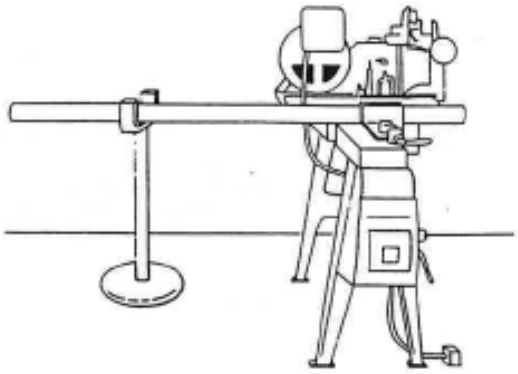


Fig. 14-2

SAFETY RULES

- ✓ Mount or remove stock only when the blade is stopped.
- ✓ Clamp the stock securely in the vise.
- ✓ Make sure blades are in good condition, and are the correct blade for the operation.
- ✓ Operate the saw at the proper speed and feed rate for the operation.

- ✓ Keep hands away from the saw blade.
- ✓ Support long pieces.
- ✓ Be careful of freshly cut edges.

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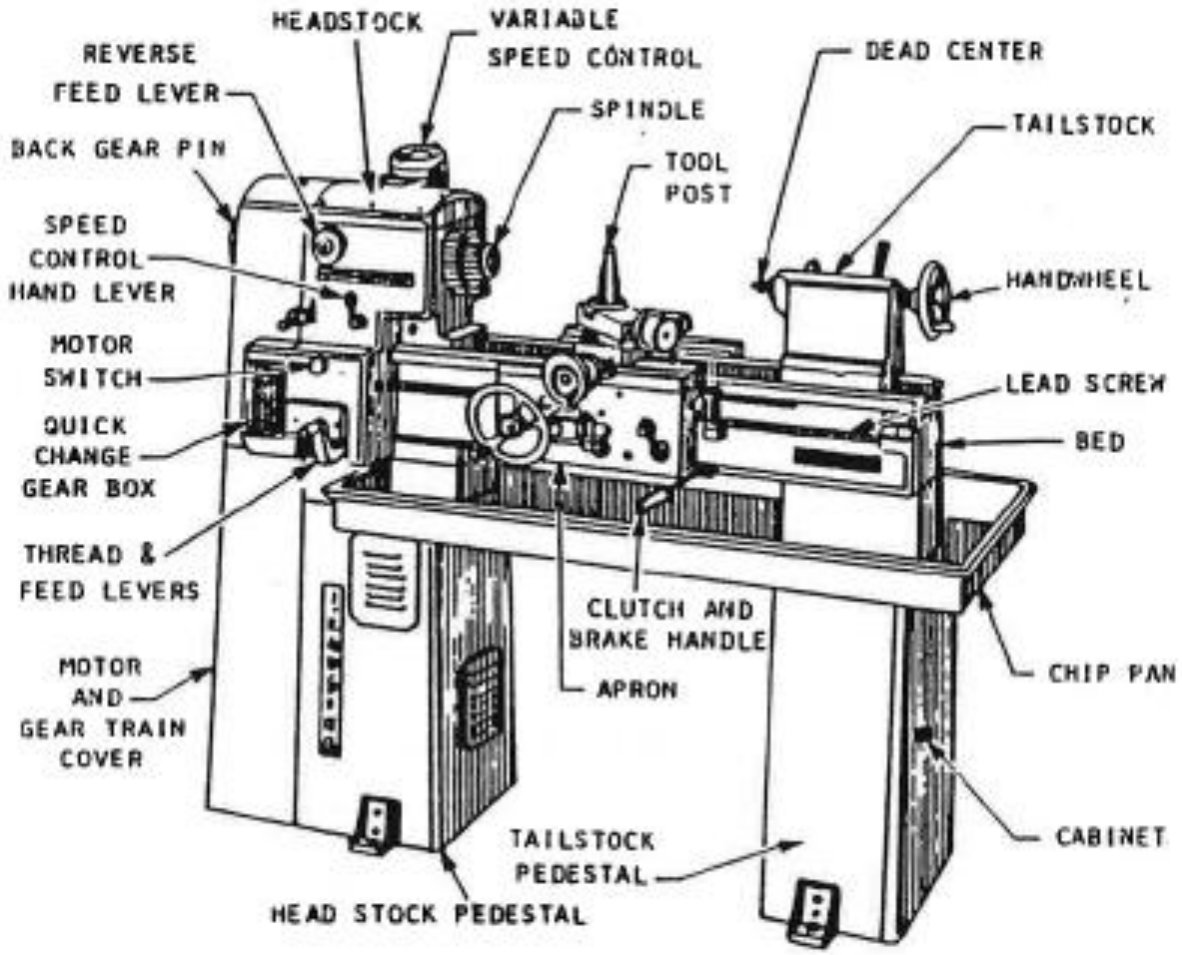
METAL LATHE

The metal lathe is a machine in which the work is held and rotated, while being shaped by a cutting tool. Lathe size is determined by the swing and bed length. -The swing size is the largest diameter of work which can be turned. The length of the bed is the length of the ways.



PARTS AND ADJUSTMENTS

The bed of the lathe is the foundation of the lathe to which all other parts of the lathe are attached. Machined ways are the rails of the lathe bed and provide alignment of the headstock and tailstock. Care should be given to handling tools or work over the ways.

The headstock contains the spindle to which the various work holding attachments are fitted. Speed control is also located in the headstock. Power is supplied to the spindle by a series of belts or gear train. Spindle speed is changed by moving the belt or by changing the gear ratio.

The tail stock is moved along the ways to accommodate different lengths of work. The other end of the work is supported by the dead center mounted in the tailstock. The tailstock

may also be fitted with cutting tools for drilling, reaming and threading. The unit is clamped to the ways by tightening the clamp nut. The spindle is positioned by rotating the hand-wheel and locked in position with the lock lever.

The carriage includes the saddle, apron, cross and longitudinal feed, compound rest and tool post. The cutting tool is supported and moved along the ways and cross slide by the carriage.

The feed mechanism provides a way of regulating the longitudinal movement of the carriage by transmitting power from the headstock through a lead screw to the carriage. The speed of the lead screw is controlled by a gear box in the headstock. The lead screw transmits its power only when the feed change lever is engaged on the carriage apron.

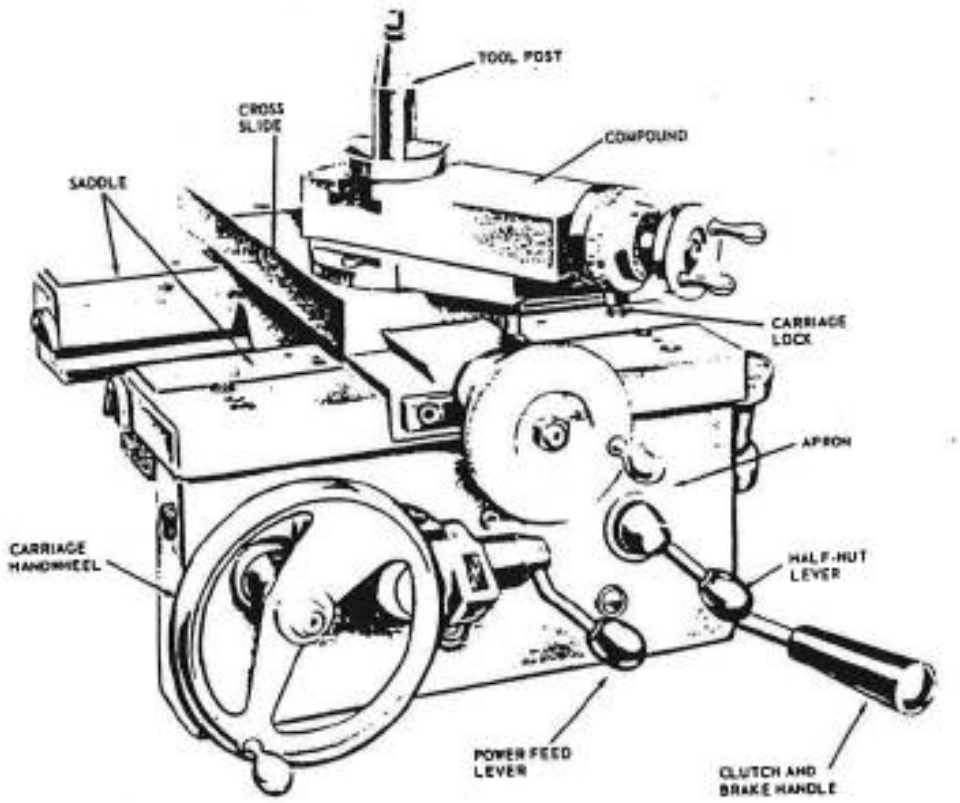


Fig. 15-1

OPERATION

Work can be mounted in the lathe by four methods; (1) between centers, (2) held in a chuck, (3) held in a collet, and (4) bolted to a faceplate.

To turn between centers, first the stock must drilled at both ends with center holes. Center holes are drilled using a combination drill and countersink. The special drill machines the center hole and provides a reservoir for lubricant. The center hole may be drilled on the lathe using a chuck in the tailstock and holding the stock in the headstock.

Turning between centers requires a faceplate threaded to the spindle nose and a sleeve and live center inserted in the spindle. A dead center is inserted in the tailstock. The work is placed between the centers. The power is transmitted to the work by the use of a lathe dog. The lathe dog is clamped to the work and the leg inserted in one of the slots in the faceplate.

Turning with a chuck is the method used for rapid mounting of the work. Drilling, reaming, boring and various other operations are easily done with the use of a chuck. Additional support is gained through the use of a dead center placed in the tailstock. The most common used chucks are; the 3-jaw chuck, the 4-jaw chuck, the Jacob chuck, and draw-in collet chuck. The 3-jaw chuck works in the same manner as the Jacob chuck. All the jaws move simultaneously to center the work as it is tightened. The 4-jaw chuck has four independent chucks. Each jaw must be tightened individually. The most accurate method of centering the work in the chuck is with the use of a dial indicator. The concentric rings machined in the face of the chuck can be used for initial adjustments. When using either one of these two chucks, the work should be firmly seated in the chuck. The Jacobs chuck is the standard drill chuck. This chuck is used for light work. The draw-in collet is used for turning small diameter work. Their advantage is in their ability to hold work securely for long periods of hard usage. The draw-in collet automatically centers the work. Various size and shape collets are available for this chuck.

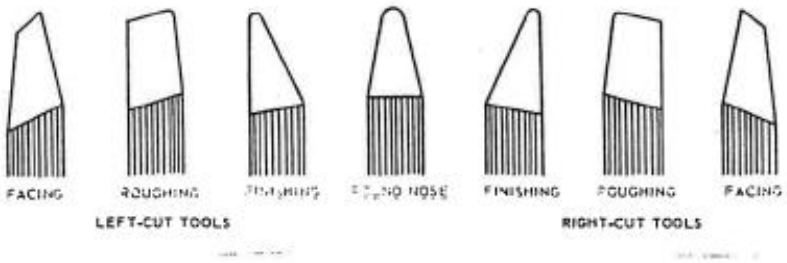
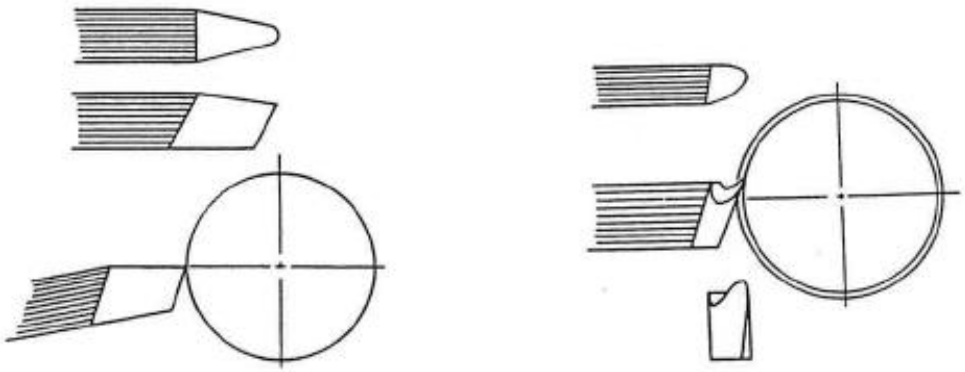


Fig. 15-2



When removing or mounting a chuck, always use a wooden chuck cradle or a board to protect the ways of the lathe. To mount chucks, hold the chuck against the spindle with the right hand and turn the spindle with the left hand threading the chuck onto the spindle. Do not use power to thread the chuck onto the spindle. To remove chucks, lock the spindle in back gear to keep position. Use the chuck key in the adjustment key or an adjustable wrench on one of the jaws, to provide the necessary leverage to remove the chuck.

After the work is mounted in the lathe, using one of the four methods described, a tool must be mounted. The cutting tool is mounted into a tool holder and tightened with the set screw. Tool holders are made in three shapes; a right-hand, a left-hand and a straight shape. To determine the shape of the tool holder, hold the head of the holder in your hand and note the direction of the shank.

Cutters are ground to cut in one direction only. Some common shapes of cutting tools are shown in Fig. 15-2. The left-cut tools are designed and ground to cut effectively when it travels from the left to the right. The right-cut tool cuts better in the opposite direction.

Roughing tools permit deep cuts at faster feed speeds. Finishing tools produce a fine finish cut. Facing tools are ground in a manner to minimize interference with the headstock or tailstock. The round nose cutting tool permits the cutting to be done in either direction. This tool, with an added negative rake ground into the top surface, is the general shape used for brass. A tool for aluminum is ground with a sharper rake and adjusted to slightly above the center of the work to prevent chattering. Figs. 15-3, 15-4.

Cutting speed is the distance the work moves past the cutting tool. This is indicated as distance in feet per minute. Feed is the distance the carriage moves the tool longitudinally along the work in one revolution of the work. The following chart is useful if using a high speed steel cutter.

MATERIAL	Roughing Cut 0.010 to 0.020 in. FEED	FPM	Finishing Cut 0.002 to 0.010 in. FEED	FPM
Cast Iron		80		100
Steel				
Low Carbon		130		160
Med. Carbon		90		100
High Carbon		50		65
Tool Steel		50		65
Brass		160		220
Bronze		90		100
Aluminum		600		1000

To convert cutting speed (FPM) to working speed (RPM) the following formula is used:

$$RPM = \frac{CS \times 4}{D}$$

RPM = Revolutions per minute
CS = Cutting speed of the metal being turned
D = Diameter of the stock

Adjust the lathe for a speed as close as possible.

The depth of the cut is the distance the tool is forced into the stock. This distance is easily determined by the micrometer dial on both the cross slide and the compound rest. Both of these dials are marked in graduations of thousandths of an inch (0.001). On most lathes, moving the cutter in 0.001" will reduce the diameter of the stock by 0.002". This is because the cutter removes 0.001" from the circumference.

Roughing cuts are done to quickly reduce the stock to the approximate diameter. The diameter should be left 0.03125 oversize to allow for finish cutting. The compound rest should be adjusted to a 30 degree position and locked. This setting permits the tool to cut as close as possible to the headstock. Check exactly how far the carriage can be moved to the left before beginning operations. Mount the right-cut tool in a left hand tool holder. The tool post with tool holder should be positioned at the far left of the compound rest T-slot. The tool holder should be positioned in the tool post as far as possible. Adjust the cutting tool to a position 1/16" above the center-line for each 1" of diameter. Fig. 15-5.

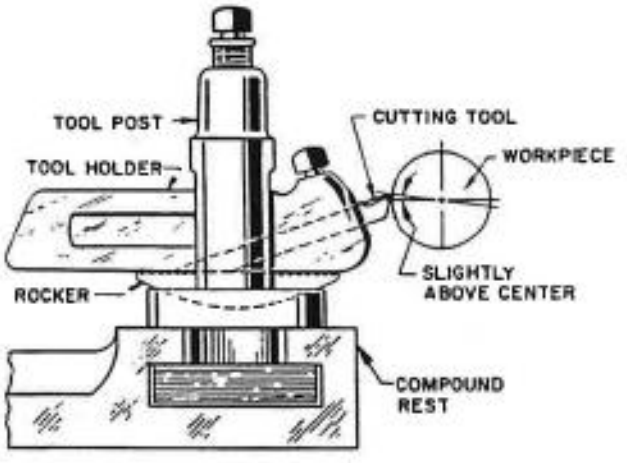


Fig. 15-5

The tool holder must also be positioned to allow for the possible pivot of holder caused by side pressure created by the longitudinal movement.

The finish cut produces the required *fine* finish to the correct diameter. A right-cut finishing tool is used for final cut. Re-adjust the lathe to a faster spindle speed. Move the cutting tool to allow for a light cut. Start the feed and run until an area is finished which can be measured. Stop the lathe and without moving the cross *slide,* measure the stock. If the diameter *is* correct, proceed with the cut. If more material must be removed, calculate the difference and move the cross *slide* in one half the distance. Proceed with the finish cut.

A facing operation *is* performed to reduce the length of the stock or to square the end. The stock is generally faced off before the *finishing* operation. To face the right end of the stock use a right-cut facing tool *in* a straight tool holder. Lock the compound rest at the 30 degree position. Bring the cutter up until it just touches the work and lock the carriage *in* place. Use the cross slide to feed the cutter. The left-cut tool should be used for the opposite end.

When it is necessary to turn several different diameters along the length of the stock, locate the change points on the stock with a hermaphrodite caliper. The method of turning the stock to the correct diameter is the same as described in the previous operations. When the correct diameters are achieved, shoulders are then cut. A right-cut facing tool is used to make square and angular shoulders. A round nose tool, ground to the proper radius is used to cut the fillets.

To cut material off after the final cut is completed a parting operation is performed. A parting tool is used for this operation. The blade is set at exactly 90 degrees. The height of the tool is set the same as for any other cutting. As the cut proceeds the tool may have to be re-adjusted to accommodate for the decrease in diameter. Spindle speed should be about 1/3 the correct speed for the material being turned. Do not attempt this operation when turning between centers.

SAFETY RULES

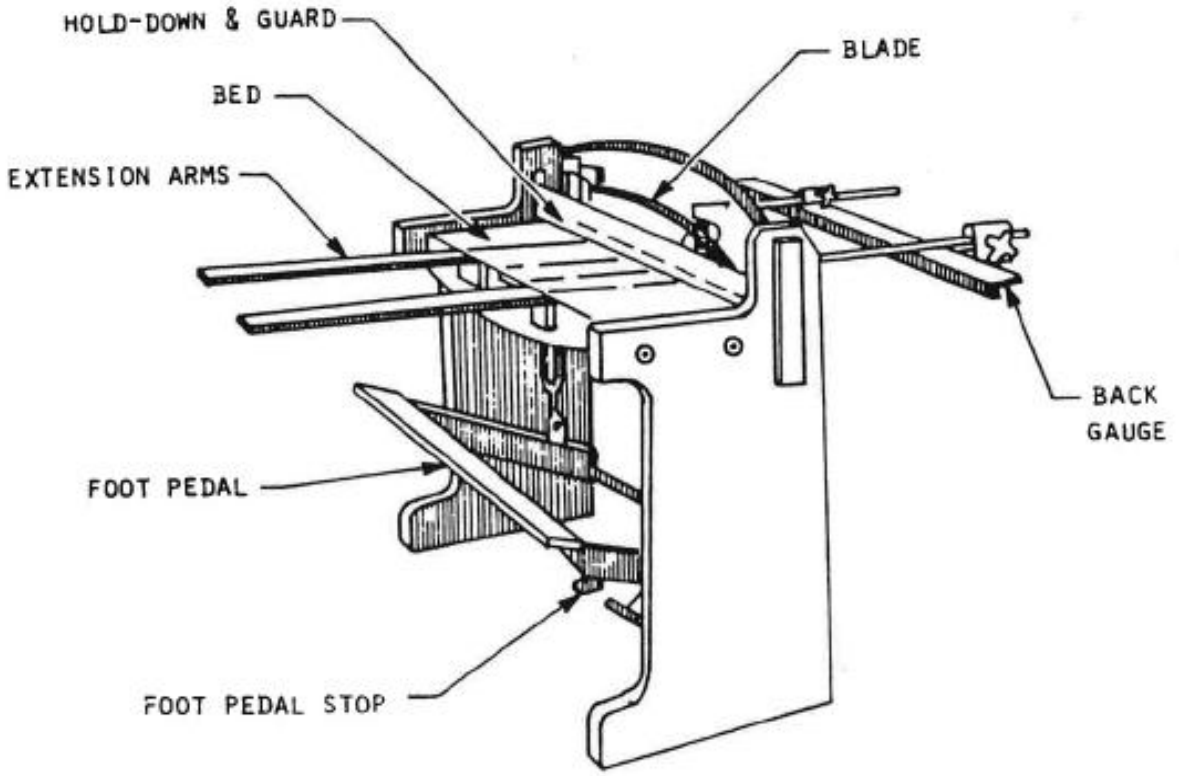
Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES, GENERAL POWER EQUIPMENT SAFETY RULES and METAL PROCESSING SAFETY RULES.

- ✓ Be sure to remove the chuck key before operating the machine.
- ✓ Check to see that all parts of the carriage will clear any part of the chuck over the entire length of the stock.
- ✓ Keep hands on the controls or at your sides when operating this machine.
- ✓ Be certain the work is held securely in the lathe.
- ✓ Set the lathe for the correct speed and feed.
- ✓ Always protect the lathe ways when mounting or removing a chuck.
- ✓ Never adjust the cutting bit in the holder except when holder is in place on the lathe.
- ✓ Do not stop the lathe by hand. Allow the lathe to come to a complete stop by itself.
- ✓ Remove the tool holder and post when filing or sanding.
- ✓ Allow the lathe to come to a complete stop before changing direction
- ✓ Do not remove chips by hand.
- ✓ Never use a rag or similar object to clean the work while the lathe is in operation.

SHEET METAL TOOLS

SQUARING SHEER

The squaring shear is used to square and trim large sheets of metal. The maximum capacity of the particular squaring shear in use is listed on a label or stamped on the machine. This capacity should not be exceeded when cutting sheet metal.



PARTS AND ADJUSTMENTS

The back gauge determines the length of the cut when the sheet is inserted in the front of the machine. The front gauge is used to cut to length when the material is inserted from the back. This gauge is seldom used. The side gauge is used to square the sheet to the cutting edge. The shear is operated by a foot pedal. When the pedal is pressed down approximately one half of its travel, the hold down lowers into position to secure the piece, this frees the hands from the operation. The final one half of the travel shears the sheet metal.

OPERATION

The cut is made by first setting the back gauge to the required length. The sheet is slid under the hold down until it is against the back gauge. The sheet is then positioned against the

side gauge. The foot pedal is lowered until the hold down secures the sheet. Remove your hands and continue the operation, shearing the sheet.

SAFETY RULES

- ✓ Gloves should be used when handling sheet metal.
- ✓ Do not shear sheet metal beyond the capacity of the shear
- ✓ Do not place fingers past the guard.
- ✓ Be certain to place one foot squarely on the foot pedal and the other foot clear of the down stroke of the pedal.
- ✓ Allow the trimmings to fall to the floor.
- ✓ Be careful of edges.
- ✓ Operate the machine from the front.
- ✓ Do not shear wire or bar stock on this machine.

BAR FOLDER

The bar folder is used to form edges and seams.

PARTS AND ADJUSTMENTS

The width of the fold *is* set by adjusting the depth gauge. The thickness of the fold is determined by the setting of the wing. The angle stop is used to make 45 and 90 degree bends.

OPERATION

Adjust the depth gauge for the correct width of the bend. Fig. 16-1

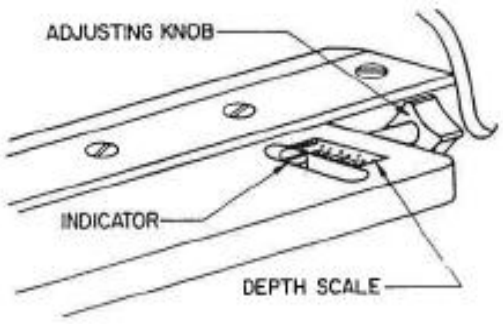


Fig 16-1.

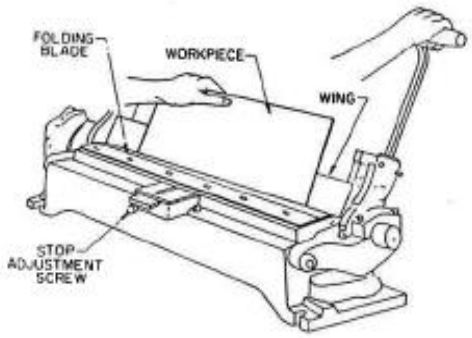


Fig 16-2.

Adjust the wing position for the desired thickness of the bend. Place the sheet into the machine against the gauge fingers. Hold the sheet with the left hand and pull the lever around with the right hand. Return the lever to the original position. *Fig. 16-2.*

To flatten the fold, place the fold on the beveled section of the blade and pull the handle down. Fig. 16-3.

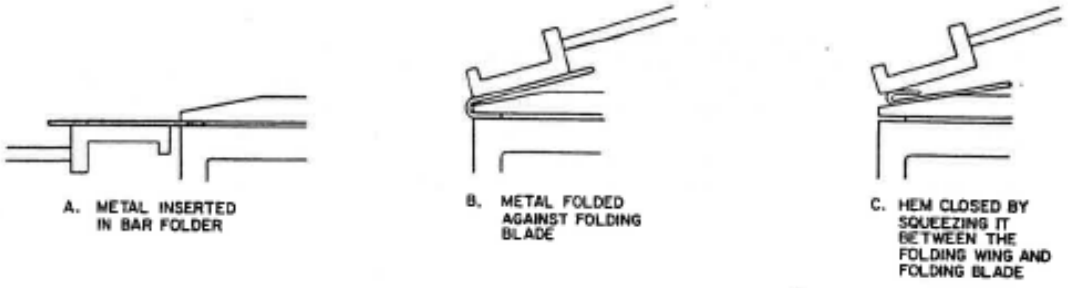


Fig. 16-3

BOX AND PAN BREAK

This machine is operated similarly to the bar folder. The box and pan brake permits the bending of all four sides of a sheet metal box. The upper jaw is constructed of a series of blocks of various widths. The blocks may be removed and arranged to accommodate the different sides of a box or pan. This arrangement allows all sides to be bent. Fig. 16-4

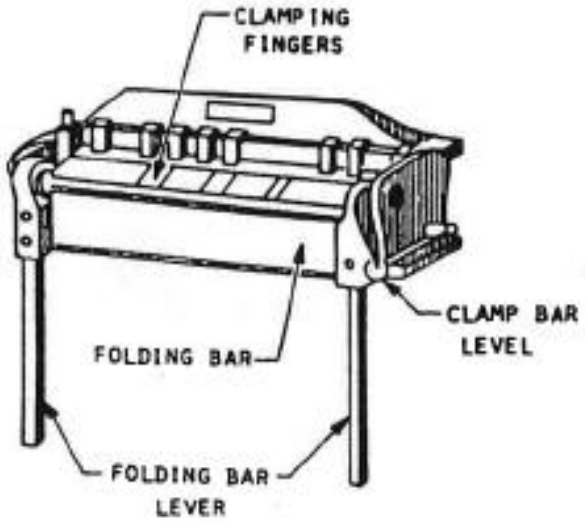


Fig 16-4.

SLIP ROLL FORMING MACHINE

This machine enables the operator to form smooth cylindrical and conical shapes. The slip roll forming machine consists of three rollers. The two rollers in the front feed the sheet into the machine. These rollers are adjusted for the thickness of the material. The third roller, to the rear, is adjusted for the desired curvature. The top roller is hinged to allow the cylinder to be removed from the machine after the operation is completed. Fig. 16-5, 16-6.

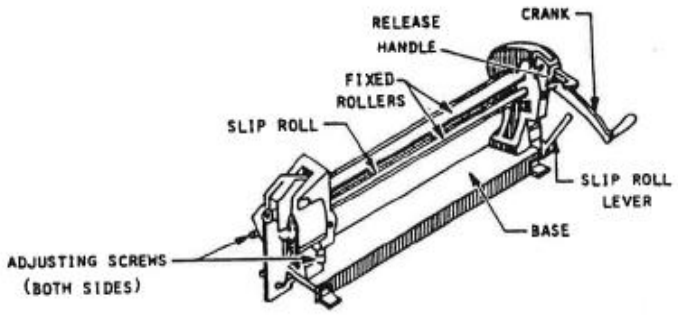


Fig 16-5.

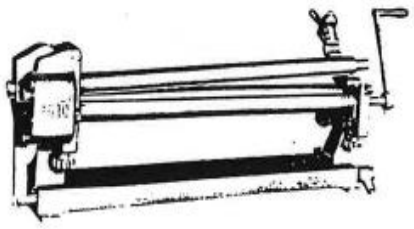


Fig. 16-6

VERTICAL MILLING MACHINE

Milling machines are a close second to the lathe, as the most versatile tool used for processing metal. The vertical spindle milling machine has its cutter in a vertical axis which is at right angles to the table and work. The cutter head may be raised and lowered and on some models tilted for angular cuts. Vertical milling machines can machine horizontal surfaces, angular surfaces, shoulders, grooves, keyways, dovetails, and T-slots. Vertical milling machines use end mill cutters to perform the various operations.

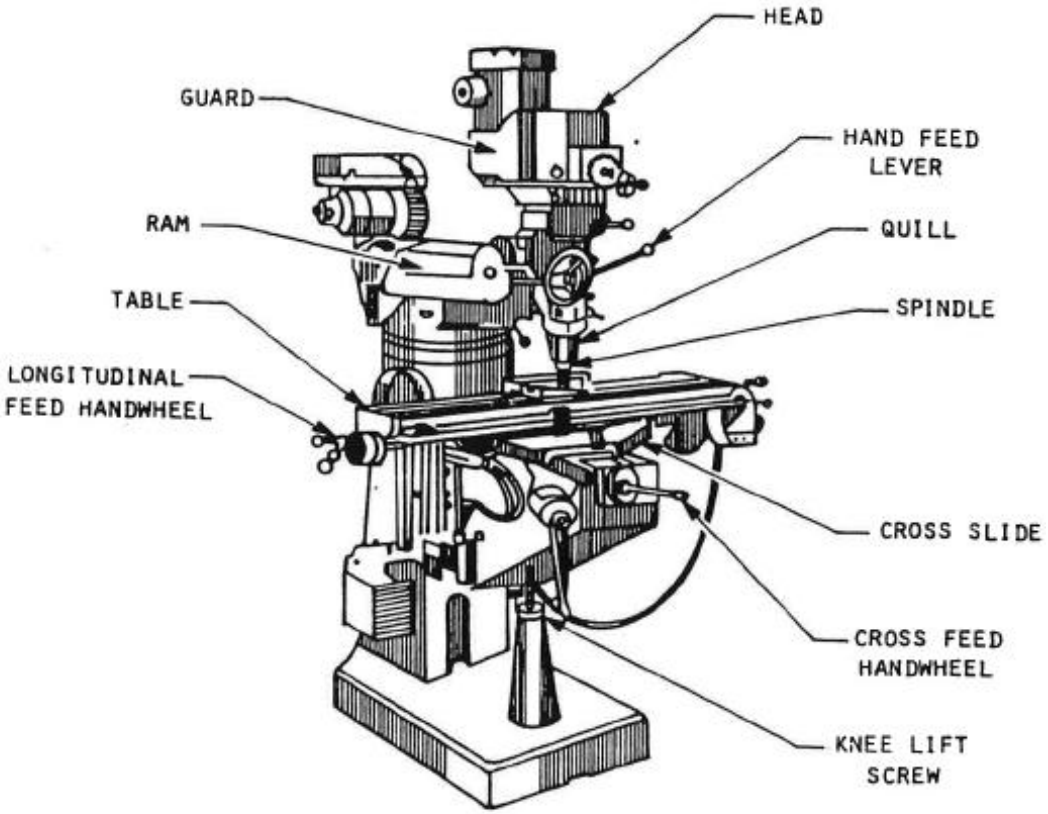


Fig. 17-1

PARTS AND ADJUSTMENTS

The vertical milling machine is classified as a column and knee type milling machine. This type of milling machine is so named because the moving parts of the machine consist of a column that supports the knee in the vertical position. The knee supports the table which provides the cross traverse and longitudinal movements. The frame of the milling machine is a massive casting that provides the support and stability for the machine.

The table of the milling machine has movement in three directions; (1) vertical or knee elevation, (2) cross and (3) longitudinal. The knee is raised or lowered to establish the cutting depth. On the vertical milling machine the depth is set with either the knee elevation or the vertical spindle hand lever. It is usually better to set the depth using the knee elevation. The

knee is adjusted using the vertical-feed hand lever. On the vertical-feed hand lever is a micrometer collar, graduated in 0.001" graduations. This collar is used to move the knee to a specific location. The other two direction controls have these same collars. A knee clamp locks the knee during milling operations.

The transverse or cross-verse movement is the movement of the table and saddle in the in and out direction. This adjustment is made with the cross-feed hand lever. After adjusting the cross-verse direction, the saddle is locked in position with the saddle clamp to reduce vibrations during operation. Saddle clamps must be loosened when making adjustments involving the cross-verse movement.

Longitudinal movement is the side to side movement of the table. This movement is created with the longitudinal feed hand lever. Some machines are equipped with a power feed in this direction of movement. A table clamp is used to lock the table in position during boring or other types of operations requiring no table movement.

Spindle speeds are set for various types of metals and the particular kind of operation. Spindle speed is rated in rpm's and selected on machines by turning the speed change dial to the correct spindle speed. Machines accomplish this in a various manners; shifting gears, variable-speed drive, or step pulleys. The spindle direction can also be changed on some machines by using the spindle-reversing lever.

On machines equipped with power feeds, the, feed rate is adjusted through the gear drive of the power feed. On manual machines, feed rate depends on the operator for the proper rate of feed.

OPERATION

Prepare the stock by removing burrs or irregularities by other methods. Mount a vise on the table. If possible, mount the work with its longest dimension parallel to the vise jaws. If the work piece is shorter than the vise jaws and cannot be centered in the jaws, use another, piece of stock on the opposite side. Fig. 17-2.

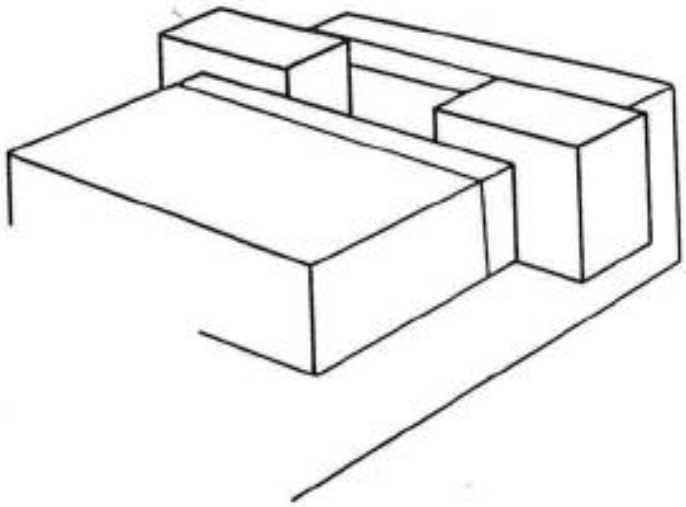


Fig. 17-2.

The vise will have to be aligned perpendicular to the machine column if the operation is more than just surfacing the entire face of a work piece. The use of a dial indicator permits the accurate alignment of the vise. Select the correct type and size cutter. Mount the cutter in the spindle using the correct arbor or adaptor. Mount the work squarely and firmly in the vise. If the work is down in the vise too far, the use of parallels will elevate the work, while keeping it parallel with the vise jaws. Fig. 17-3

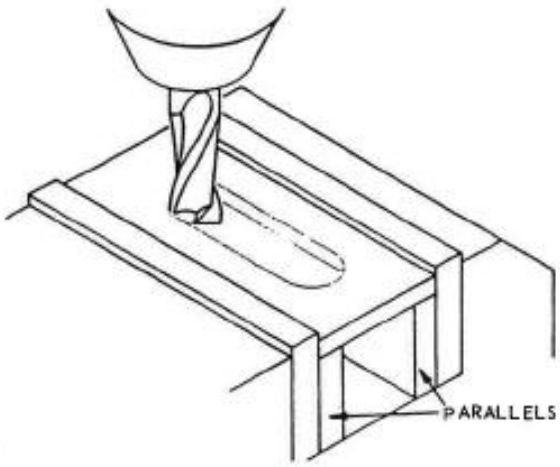


Fig. 17-3.

After snugging the work in the vise, give the work a tap with a lead hammer, and then firmly clamp the work. Determine the correct cutter speed and make the necessary adjustments. Make the adjustments to center the work along the cutter. Start the machine to check the proper rotation of the cutter. The cutter teeth should point in the direction of the spindle
rotation. Slowly advance the table until the cutter just touches the work. Adjust for a rough cut, leaving 0.010" to 0.030" for a finish cut. Lock all remaining table movements. Feed the work into the cutter about 1/8", back out, turn off the power, and measure the work piece. Make adjustments, if necessary and proceed with the cut. After the rough cut is done and the work is within dimension adjust the spindle speed for a finish cut. Start in the same manner as the rough cut. Feed in 1/4", back out, and turn off the power. Check the work piece and make adjustments if necessary. Restart the machine and complete the cut.

Surfaces requiring a bevel, chamfer or taper can be milled by tilting the spindle head to the required angle, or by placing the work in the vise at the correct angle. If the spindle head is to be tilted for a cut, the vise must be aligned using a dial indicator. Scribe or mark the angle and clamp it in the vise. Position the work and cut to the line. When using the other method for cutting an angle, the positioning of the work should be done very carefully. The use of a protractor or surface gauge will aid in the alignment of the work.

To cut a keyway or a slot, an end mill should be selected. The end mill must have a diameter equal to the width of the slot or keyway. The work is centered under the cutter and raised to cut to the required depth.

Internal openings are done with the end mill. The work is fed into the cutter in the same manner as a drilling operation. Once the slot is wider than the cutter, it is important the correct direction of .feed is maintained. The direction of feed should always be against the cutter rotation. Fig. 17-4.

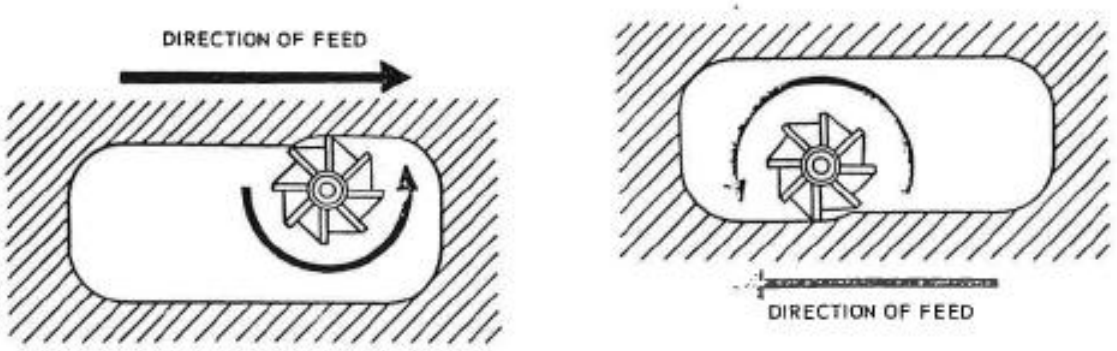


Fig. 17-4.

Milling multi-level surfaces is done by first scribing the levels on the work. Cutting proceeds until the layout lines are reached. The accuracy of the piece will be increased if a micrometer is used to check the work. Cutting speed is measured in feet per minute (FPM), represents the speed of the cutter at its circumference, the cutting edge. Different speeds must be used for different metals. Use the following chart as a guide to determine the correct FPM.

CUTTING SPEED FOR MILLING ROUGH CUTS
WITH HIGH SPEED STEEL CUTTERS

MATERIAL	CUTTING SPEED--FPM
Steel	
Low Carbon	80-100
Med. Carbon	75-95
High Carbon	60-80
Tool Annealed	60-80
Stainless	60-80
Cast iron	60-80
Aluminum	400-1000
Brass	200-300
Bronze	100-200

After the correct cutter speed is determined the machine must be adjusted for the correct RPM. The speed of the machine is measured in RPM's, which is different than FPM. RPM and FPM are two different measurements and should not be confused. A large diameter cutter must be run at a slower RPM than a small diameter cutter to achieve the same FPM. The following formula is used to calculate rpm from the cutting speed listed in the chart.

$$rpm = \frac{CS(fpm) \times 12}{D" \times 3.14}$$

CS = Cutting Speed
D = Diameter of cutter

SAFETY RULES

- ✓ Stock must be secured in a vise, clamp or chuck.
- ✓ Keep hands 4" away from the cutter.
- ✓ Never reach around the cutter.
- ✓ Remove chips with a brush, never the hands.
- ✓ Be certain the holding device is secured to the table.
- ✓ Clean the arbor, cutter and collars before mounting them in the spindle.
- ✓ Use a lead hammer to seat work in the vise.
- ✓ Select the correct rpm for the metal and size cutter.
- ✓ Be certain to loosen all table clamps before making any adjustment.
- ✓ Select the correct cutter for the job.
- ✓ Disengage control handles when using automatic feeds.

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WELDING EQUIPMENT – OXYACETLENE AND ARC

Welding is the process of joining metals by heating to a temperature high enough to cause them to melt and fuse together. This process may or may not require pressure and/or a filler metal. There are many welding methods available to industry and manufacturing, including a variety of kinds of gas, arc and resistance welding. This unit will be restricted to Oxygen-Acetylene and shielded metal arc welding.

There are five basic joints in any welding; butt, Tee, lap, edge and corner. The butt joint is two pieces of metal laid side by side. The gap is filled to make one larger plate. The tee joint is the joining of two pieces at right angles. The lap joint is one piece overlapped on another piece. A weld can be done on both sides. The edge joint is two pieces laid flat against one another and welded along the edge. The corner joint is a weld on the outside of a 90 degree joint. Fig. 18-1.

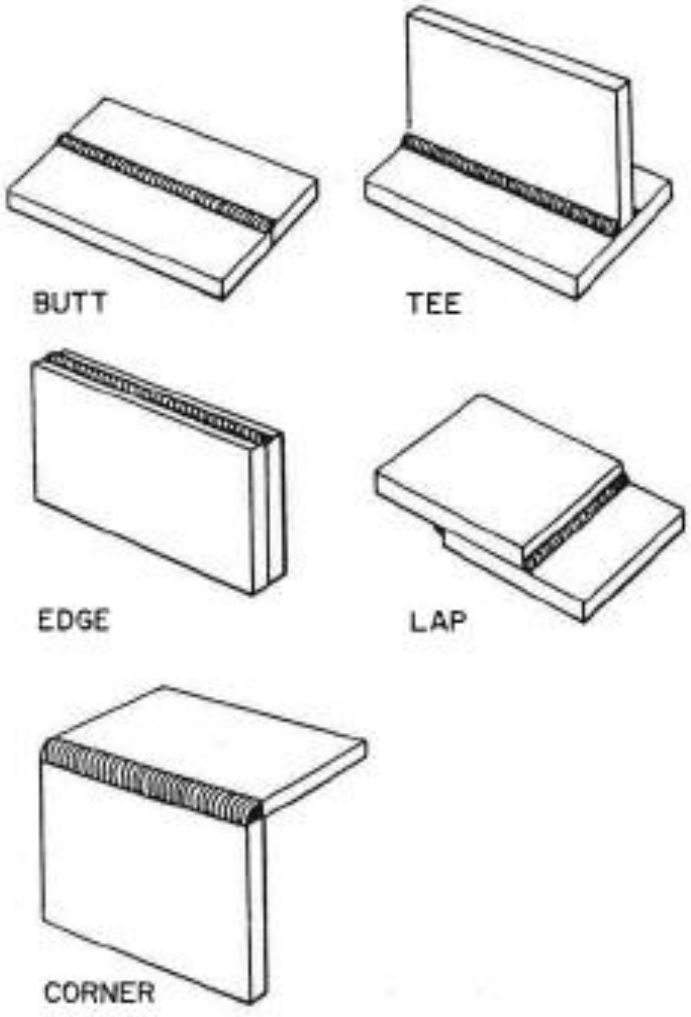

Fig. 18-1.

OXYACETYLENE WELDING

The heat in this method of welding is produced by burning acetylene and oxygen gases. The heat generated by the burning of these two gases is suitable for this operation requiring 6000 degrees. The edges of the base metals and the filler metal (welding rod) are heated to a melting temperature causing the metals to fuse together. If a proper weld is performed, the two pieces should be as strong as a single piece.

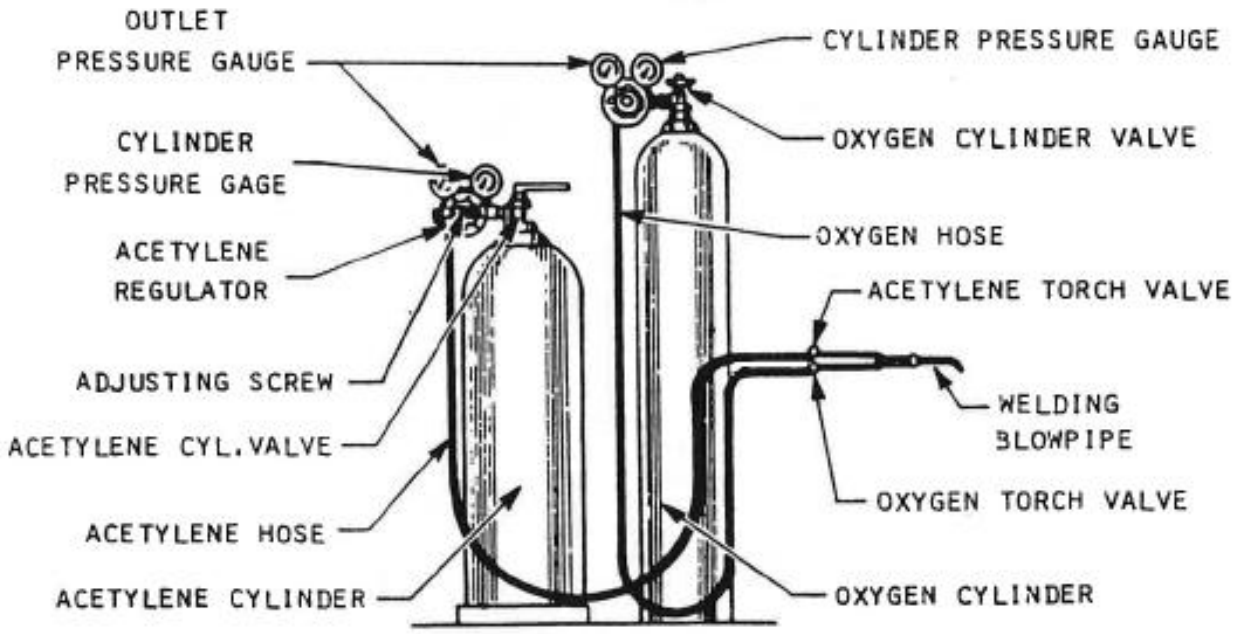

Fig. 18-2.

PARTS AND ADJUSTMENTS

The system for this method consists of; a cylinder of oxygen and a cylinder of acetylene, a regulator for each cylinder, hoses to carry the gases to the torch and a torch.

The oxygen cylinder is the taller of the two. The handling of this cylinder should be done with extreme care, since the pressure when full can be 2200 psi. This cylinder because of its high pressure has a double seated valve. The valve when opened should be opened all the way; this prevents leakage around the stem of the valve. The valve should never be just "cracked" opened. The acetylene cylinder is the shorter of the two cylinders. This cylinder, when full contains only 250 psi. Acetylene is the fuel. The valve of the acetylene tank should only be opened 1/2 turn. This is a safety precaution, in an emergency; the valve can be quickly turned off.

The regulators on both cylinders provide a constant, uniform supply of gas at a desired pressure. The pressure settings are established for various thicknesses of metals. Each regulator has two gauges, and a T-handle for the pressure adjustment. The first off the cylinder is the

high pressure gauge, which shows the pressure in the cylinder. The high pressure gas flows to the regulator, which is adjusted to the required pressure. The second gauge shows the regulated pressure, the pressure at the torch. Acetylene gas is unstable; never adjust the torch pressure higher than 15 psi.

The hoses used in this system are color-coded and threaded dissimilar. The red hose is always the acetylene hose and is threaded with left-hand threads. The green hose is always the oxygen hose and is threaded with right-hand threads.

The welding torch mixes the gases for combustion. The flame is adjusted with the torch. The torch has a variety of interchangeable tips. The selection of tips is dependent on the type of job and the thickness of the base metal.

OPERATION

Install the correct size tip for the job. Check to see the regulator keys are backed out all the way. This prevents unregulated high pressure gas from entering the low pressure regulators. Open the oxygen valve all the way. Open the acetylene valve 1/2 turn. Open the oxygen torch valve ½ turn. Adjust the oxygen regulator key to the desired pressure. Close the torch valve. Repeat the procedure with the acetylene. Check for leaks in the system.

Open the acetylene valve of the torch 1/2 turn. Light the torch with a torch lighter, never use a match or a cigarette lighter. Adjust the flame until it just leaves the tip of the torch. Open the oxygen, and adjust until a sharp, crisp inner cone is established. This flame is called a neutral flame.

To weld, adjust and clamp the two pieces to be welded. Tack the opposite end of the seam you from which you intend to start the weld. Apply the flame to the seam at a 45 degree angle to the direction of travel. The inner cone should touch the work. Hold the flame there until a puddle begin to form between the two edges. Place the filler rod into the flame at a 45 degree angle in the direction of travel. Move the torch in a U-shape around the filler rod to one edge of the base metal, then to the other by moving around the filler metal. At the same time move the procedure along the seam, causing the puddle to move. Continue in this manner until the seam is filled. Fig. 18-3.

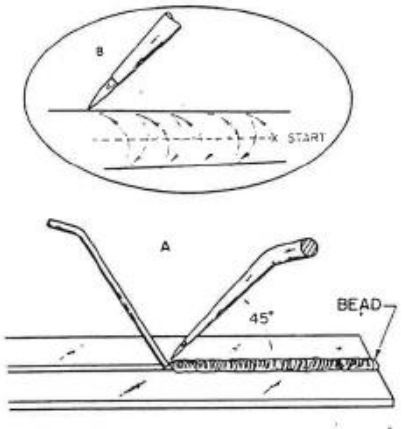

Fig. 18-3

If the weld is moved along too rapidly, the seam will not be filled completely. If the weld is moved too slowly, the base metal will melt through.

The oxyacetylene system can also be used to cut steel plate. A special cutting torch is needed for the job. Cutting tips have a center hole that is controlled by a separate lever on the torch. This hole provides a blast of pure oxygen. Around the center hole is a ring of holes, through which flows oxygen and acetylene which preheats the base metal. This flame is controlled by the two normal valves on
the torch.

Place the metal so the cut line is not directly on top of anything. Replace the welding torch with the cutting attachment. Follow the start-up procedure in the welding section. Open the normal oxygen valve on the torch (the one next to the acetylene torch valve) all the way. Open the acetylene valve and light. Adjust the flame as in the welding section. Open the pre-heat oxygen valve and adjust for a neutral flame. Each of the holes around the tip will have a tiny cone. Place the tips of the cones 1/16" above the cut. Heat the metal until it is bright red. Press the oxygen lever to release the stream of oxygen, which rapidly oxidizes the metal causing cutting action. Move the torch along as fast as the cutting action will allow.

To turn off the torch, first turn off the acetylene valve on the torch. Close the oxygen torch valve. Close the acetylene cylinder valve. Close the oxygen cylinder valve. Bleed the lines by opening the torch valves. After the gas has escaped close the valves. Back out the regulator keys. Coil the hoses neatly and replace them in their holder.

SAFETY RULES

Observe all safety rules listed under GENERAL LABORATORY SAFETY RULES and METAL PROCESSING SAFETY RULES.

- ✓ Be sure all cylinders are secured in a cart or in storage.
- ✓ When moving cylinders, remove regulators and cap.
- ✓ Keep equipment free of oil and grease.
- ✓ Always wear protective eyewear.
- ✓ Check condition of hoses.
- ✓ Do not weld containers.
- ✓ Never exceed 15 psi on the acetylene
- ✓ Use only a torch lighter to light the torch.
- ✓ Bleed hoses when finished.
- ✓ Close the acetylene torch valve first.
- ✓ Do not weld around flammable materials.

ARC WELDING

Arc welding is the use of an electric arc to produce the necessary heat to fuse the two metals together. The welding rod is both the electrode and the filler metal.

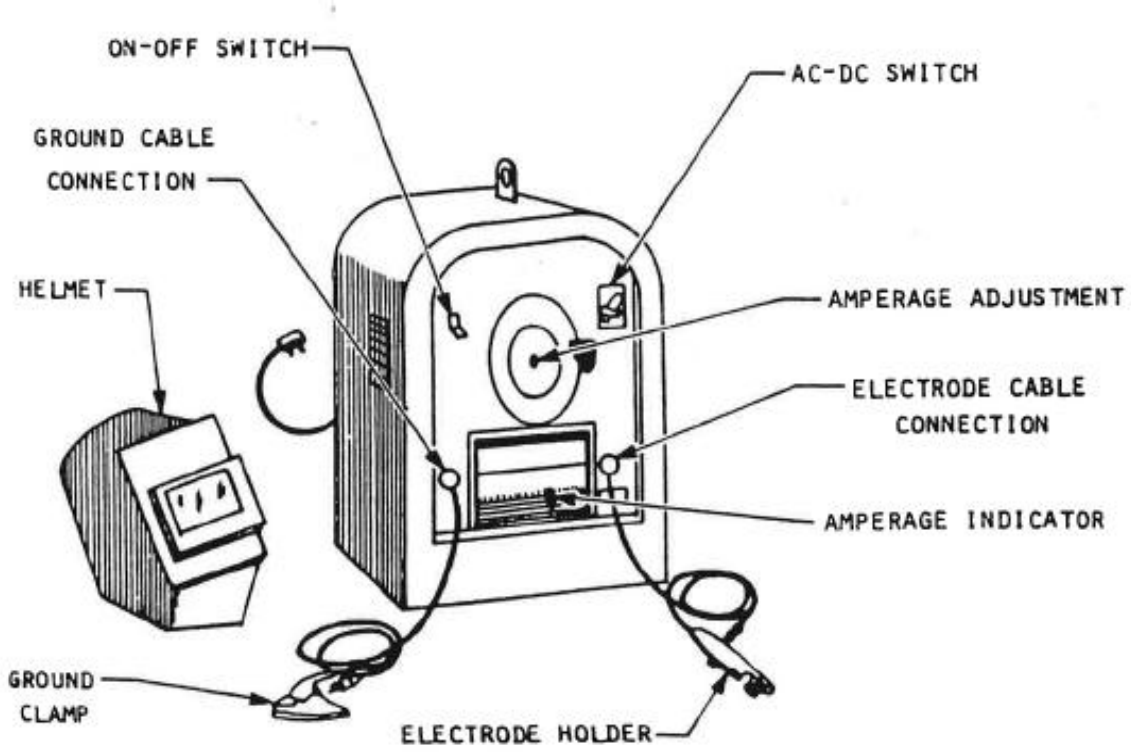

Fig. 18-4.

PARTS AND ADJUSTMENTS

The average size arc welder is in the 100-250 amperes range. Welding machines are available in DC and AC models, with the DC model the more favored. Two cables are required to carry the current from the welder to the work. Attached to one cable is the electrode holder. To the other is a clamp which is connected to the work.

A face shield is needed to protect the eyes against the rays of the arc and the face from the spatter of the molten metal. The hands must also be protected against the spatter. As a extra precaution leather jacket, pants and boots should be worn when arc welding.

Electrodes are alloys of the metal to be welded. They are coated with a baked on flux. The flux melts at the high temperature creating an atmosphere at the weld site to prevent oxidation of the base metals. The molten flux also covers the weld bead to insulate and slow down the cooling of the weld. Electrodes should be stored in a dry clean area. Moisture destroys the properties of the flux.

OPERATION

The base metals must be clean. Position the work and clamp. Check all connections. Adjust the welder for the manufacturer's recommended ampere setting of the electrodes. Clamp an electrode in the holder. As each welder differs in the actual ampere setting, make a few trial passes on a scrape piece of metal. Re-adjust the machine as required. Put on protective clothing. Hold the holder with two hands if possible to provide a firm, steady movement of the electrode. Place the electrode in the general area of the beginning of the weld. Lower your face shield. Lean the electrode 15-20 degrees in the direction of travel and 90 degrees in the other direction. Fig. 18-5

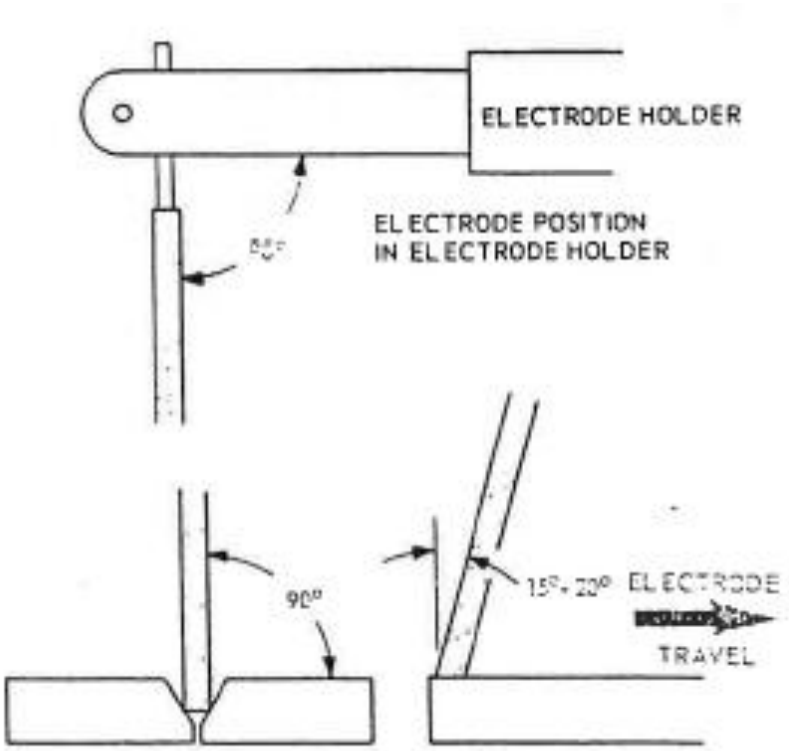

Fig. 18-5

Strike an arc, using a motion as if striking a match. "Bounce" the electrode across the metal to the seam. At the start point raise the electrode to maintain a 1/8" clearance between the base metal and the tip of the electrode. Fig. 18-6

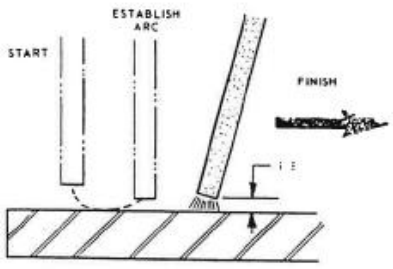

Fig. 18-6

As the weld proceeds the electrode will be consumed. This action will require pushing the electrode down to maintain the 1/8" as you move the electrode along. Proper speed is maintained by watching the puddle behind the electrode. A speed should be kept where the puddle fills the seam. A weaving motion with the electrode is required to fill large gaps. *Fig. 18-7*

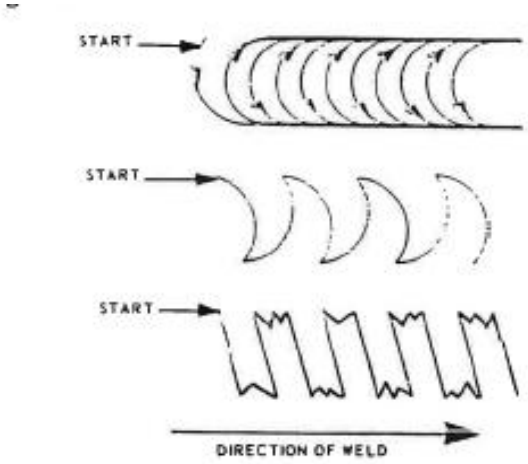

Fig. 18-7