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MECHANICS TECHNOLOGY

FORWARD

The instructional material is designed to provide a guide for the teacher to follow in teaching the minimum exercise in each of the twelve areas of Mechanical Technology in Agriculture. Reference material will supplement material found herein. The student will be provided study questions for finding related information and step-by-step procedure guide for performing skill development exercises. Competencies to be developed should be included on the progress chart for each unit representing the minimum exercises that is expected for each student to perform. At the end of the year, these exercises should be compiled as a report on the progress chart, provided by the Department of Workforce Education. Each unit of material provided herein should be placed in a folder and the folder placed in the respective area in the shop.

SHOP ORGANIZATION AND MANAGEMENT

Shop Organization

Shop organization is the key to the shop management and to making use of the procedure of teaching outlined in this material and consequently determines the possibility of a sound Mechanical Technology program. Organization is dealt with in the Agriculture Mechanics Program Handbook available from Workforce Education, Agriculture Education.

Shop Management

Items recognized as management problems are discussed in the next few pages.
Alternating students for working the various areas can be done as shown in the following table.

TABLE I

Student Name																AREA
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Joe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	(1) arc welding
Jim	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	(2) arc welding
Sam	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	(3) arc welding
Tom	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	(4) oxy acetly welding
Don	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	(5) oxy acetly welding
Bob	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5	(6) oxy acetly welding
Dick	7	8	9	10	11	12	13	14	15	1	2	3	4	5	6	(7) electricity
Bill	8	9	10	11	12	13	14	15	1	2	3	4	5	6	7	(8) electricity
John	9	10	11	12	13	14	15	1	2	3	4	5	6	7	8	(9) electricity
Rick	10	11	12	13	14	15	1	2	3	4	5	6	7	8	9	(10) gas engines
Dan	11	12	13	14	15	1	2	3	4	5	6	7	8	9	10	(11) gas engines
Ben	12	13	14	15	1	2	3	4	5	6	7	8	9	10	11	(12) gas engines
Tim	13	14	15	1	2	3	4	5	6	7	8	9	10	11	12	(13) sketch & draw
Paul	14	15	1	2	3	4	5	6	7	8	9	10	11	12	13	(14) sketch & draw
Jack	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(15) sketch & draw

In order to establish this table, note that the following items should be considered:

1. Number of students should equal number of areas to be worked in the shop. The amount of time needed for performing exercises is indicated at the beginning of each unit in each area. Allow 10 or 15 minutes over and above work time for discussion periods in each area represented in the schedule.
2. To make room for more students, the areas can be sub-divided such as; the gas engine area can be sub-divided such as compression, ignition, and carburetion. These sub-divisions can be alternated within the area. This would allow a student to work in each sub-area, or otherwise provide room for three more students in the gas engines area.
3. As many areas as needed can be added and sub-divided to accommodate the number of students in class.
4. Also, any number of days can be allotted to a particular area or sub-division by writing the area or sub-division down the number of times in the column under name of area. (See column, area or sub-area, Table I.)
5. Reading the table, assume you are Rick and in what area would you work on October 2, 6, and 14. First find the date October 2 at the top and follow down the same column to your name, Rick, where you find the number 11, which represents gas engines area on October 2, sketching and drawing on October 6, and electricity on October 1.
6. Students who complete their work sooner than the allotted time may be placed in a reserved area until the schedule provides a vacancy in the next area for them. These students may be used to maintain and repair machines and equipment in the shop to accumulate extra points or assigned individual project work. However, the following requirements should be met before undertaking "take home project work."
    a. be able to plan, sketch, and draw the project to be constructed
    b. be able to properly adjust, use, and sharpen the equipment, tools, or machines to be used in constructing the project
    c. be able to select and name the best joints for constructing the project whether using wood or metal
    d. be able to select proper material, figure the bill of materials and cost
    e. be able to finish wood or metal for varnishing, staining or painting, and be able to paint, varnish, stain wood and metal, and rework old finished jobs

A. **MAINTAINING MACHINES, TOOLS, EQUIPMENT AND PROVIDING SUPPLIES**

1. Maintenance of machines and equipment should be a part of the training program booklets such as operator's manual related to machines or equipment should be placed in cabinet doors or the appropriate place in the area.
2. Supplies for each area should be estimated in the budget at the beginning of the year and working supply placed in the doors of cabinets or the appropriate place in the area at all times while working in the shop.
3. Following is a form designed to record daily information that should help to keep tools, machines, and equipment maintained and supplies provided for each area:

Example:

Date	Item or Area	Specification	Broken-Cause	Lost How?	Supply Exhausted and need to be replaced
October 4	Arch Welding Metal	3/16" x 2" mild steel			Yes
October 7	Wood work No. 1 cab	Block plane	Broken-dropped on floor		Needs to be replaced

4. A folder containing the study guide and step-by-step procedure for each skill to be learned should be provided in the area on the bulletin board to serve as a guide for the student.

B. HOUSEKEEPING

There are several ways to handle the housekeeping problem. One of the most effective ways is on the job-time schedule. That is the worker will do one job one day or week and another job the next day or week. The alternate schedule may be handled by a spinning wheel, by blocks, or by a time table schedule. The table schedule will be illustrated here. First, determine the number of students in the class. Second, divide the job to be done into a number equal to number of students. Third, decide on the amount of time to alternate the jobs. The time may be by days or weeks, but the number of days or weeks must equal the number of students in the class. Fourth, with these facts in mind, draw up a table for entering these items as shown:

TABLE II

Number of Week											
Student Name	1	2	3	4	5	6	7	8	9	10	Job to be Done
John B.	1	2	3	4	5	6	7	8	9	10	(1) Sweep main floor
Frank C.	2	3	4	5	6	7	8	9	10	1	(2) Absentee job
Joe Z.	3	4	5	6	7	8	9	10	1	2	(3) Soldering area
Ben L.	4	5	6	7	8	9	10	1	2	3	(4) Mechanic tools
Troy K.	5	6	7	8	9	10	1	2	3	4	(5) Woodworking tools
Roy R.	6	7	8	9	10	1	2	3	4	5	(6) Foreman
Otis L.	7	8	9	10	1	2	3	4	5	6	(7) Sweep wood floor
Jack J.	8	9	10	1	2	3	4	5	6	7	(8) Clean tables, metal room
Bill S.	9	10	1	2	3	4	5	6	7	8	(9) Arc welding booth
Ron T.	10	1	2	3	4	5	6	7	8	9	(10) Bathroom

Reading the table:

Let's assume being Troy K. and it is the sixth week. What is the job? First, find the sixth week column, now come down to the line, Troy K., and number 10 job, read right under "Job to be Done", and number 10 is the bathroom. When the agriculture teacher wants to check the jobs after the shop cleanup is over, suppose that the bathroom is found unclean and he is interested in finding out who was responsible to clean the bathroom. He would read under the sixth week column until he found No. 10, the bathroom, then to the left of job No. 10, which would be the responsibility of Troy K. Responsibility can be pinpointed.

When a real clean-up sheet is being developed for a class, it is necessary to specify the actual duty to be done with the job to be done. You will notice that under jobs to be done, that one of them is "Do job for absentee." This is in case someone is absent, that job will not be undone.

The agriculture teacher should explain the nature of the conditions of the schedule to the students. Some of the jobs such as "Sweeping the floor" are larger jobs, and they should be listed as two or three separate jobs on the clean-up schedule. A schedule should be made for each class of boys or adults. The entire department can be kept in order with the schedule by including in the jobs to be done those items that would apply to the entire department.

This system is good because it pinpoints responsibility to each student, is fair to all students, guarantees that everything be in its place and the equipment and the building clean, and is simple for students to interpret.

C. EVALUATING AND RECORDING THE STUDENT'S WORK

A method that should be used in the shop is to keep a record of points on a progress chart placed somewhere available to the student's observation at all times.

SHOP SAFETY

OBJECTIVE

When you have completed this information sheet, you should be able to:

Dress safely
Identify major causes of accidents
Identify classes of fires and how best to extinguish them
Explain why a clean shop is safer than a cluttered one
Identify safety colors

I. INTRODUCTION

A. Because of the time you spend at work, you can expect at least half the accidents in your life to occur there. When you consider the possible dangers in a shop, you can add another 25%, so about 75% of the accidents you suffer during your working life will be in the shop. This information sheet will reduce your chances of an accident by telling you what to be aware of, how to protect yourself, and how to keep from hurting others.

B. If you take the following information to heart, you'll prevent many accidents from happening to yourself and your fellow students. If you ignore what you learn here, you can count on being injured. Severe ignorance or disregard of safety practices can lead to death.

C. Common causes of accidents in the shop are:
   a. Fooling around, horseplay, throwing things around the shop
   b. Not wearing safety glasses
   c. Grease and oil on the floor
   d. Equipment breaking
   e. The belief that "it can't happen to me"

II. SHOP SAFETY

Dressing for Safety
Safety in the shop means protecting yourself and fellow students.
Dressing for safety is up to you.
Safety is your job.

1. Eye Safety
   a. The fear of being blinded probably haunts us more than any other fear. This is understandable, because the loss of vision could mean the end of a career.
   b. The best way to protect your eyes is to wear safety glasses, goggles, and a face shield, if necessary. Always wear safety glasses when working with power tools; this includes such tools as grinders, drills impact wrenches, and other pneumatic and electric tools. Wearing safety glasses is mandatory in the shop.
   c. If you normally wear glasses for distance vision or reading, your optometrist can make your prescription in tempered glass just as regular safety glasses are made. However, this is not an option in the classroom shop. **Goggles must be worn**.

2. Jewelry
   a. Jewelry is nice, but it is not allowed in the shop. It's not uncommon to run across electrical wires that have energized with worn insulation. If you should touch one of these bare wires with a ring or a watch, and the other piece of jewelry touches a ground, you will short out the wire. The result will be to heat the ring or watch. If your hand should get stuck in a place with current passing through the ring or watch, enough heat would be generated to burn you. **Rings, watches, bracelets, and necklaces are not permitted in the shop area.**

3. Clothing

a. The easiest way to avoid problems with clothing is to remember not to wear anything that hangs or dangles. Shorts, sandals, parachute pants, frayed pants, football jerseys, and ties should not be worn in the shop.

4. Hair Safety
    a. If you have long hair, tie it up or wear a hat. Anything dangling from you can be caught in moving pieces of equipment.
    b. Hair gel or spray should not be worn, as it is highly flammable.

B. Fire Safety
    a. Flammable liquids—Fire will spread very quickly in a shop because many flammable liquids, such as gasoline, oils, and paints, are stored there. Probably the single greatest safety precaution in a shop is to prevent fires. One cup of gasoline has the same power potential as one stick of dynamite.
    b. Fire Triangle—For a fire to start, three components must be present: oxygen, fuel, and ignition. (See Figure 1.)
    c. Classes of fire (See Figure 2.)
    d. Types of extinguishers (See Figure 2.)
    e. Familiarize yourself with the emergency exits. In an emergency or drill, leave the building as quickly as possible without running.
    f. Fuel safety—Gasoline fumes are heavier than air. When an open container is sitting out, the fumes spill out over the sides and onto the floor. These fumes are more flammable than the liquid and they will explode.

C. Personal Safety
    a. Safety practices are extremely important in every area of the shop. Many accidents involving personal injury can be avoided if proper safety practices are followed. Shop fires resulting in expensive damage and personal injury have often been caused by careless safety practices.
    b. Shoes or boots should have soles that do not puncture easily. Footwear with steel safety toes is also advisable.
    c. Horseplay and/or practical jokes in the shop are not funny; they can send someone to the hospital. Such conduct as air-nozzle fights may end in tragedy. A strong blast of compressed air may penetrate the skin, and air bubbles in the blood stream can cause serious complications, even death.

D. Hand and Power Tool Safety
    a. Each person in a shop is responsible for good safety practice, which must be followed until the practice become habit. When hand tools and other equipment are used, observe these safety rules:
        1. Hand tools will be kept clean and in workable condition. Items such as loose hammerheads are dangerous.
        2. Always use each tool or testing device to do the job for which it was designed.
        3. Be sure your hands are free of grease, oil, and dirt when using tools.
        4. All tools must be treated as tools, not toys.
        5. Report all broken or damaged tools to instructor.

E. Shop Safety Rules

a. Floors and walkways must be kept clear and unobstructed at all times.
b. Workbenches should be kept clean. Parts that are stacked carelessly on workbenches may fall and result in serious injury.
c. Be very careful around belts, pulleys, wheels, chains, or any other driving mechanism. Be especially aware of leaning against a belt and pulley when it's not moving.
d. When working around an engine's drive belts and pulleys, make certain no rags, shop towels, or loose clothing comes into contact with moving parts. While it may not seem these parts are rotating or traveling at high rates of speed, they are. Hands and fingers can quickly be pulled into a revolving belt or pulley, even at engine idle speeds.
e. Do not pile oily rags or store rags in a wooden container.
f. Report all accidents.

F. Safe conditions

There are two areas of housekeeping for which you will be responsible: Your work area and the shop in general. A clean, organized work area will help you be a better student. If your area is clean and organized, chances are your work will be the same.

FIGURE 1

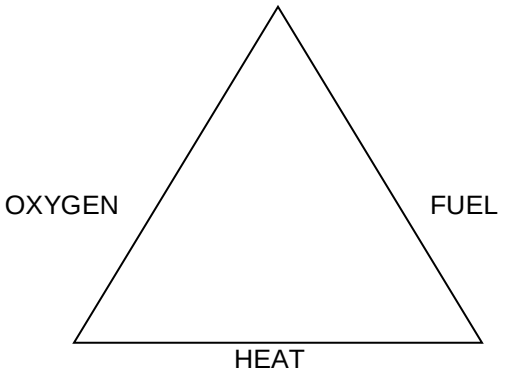


FIGURE 2

CLASS	TYPE OF MATERIAL	TYPE OF EXTINGUISHER	EXTINGUISHING ACTION
A	WOOD, PAPER, TEXTILES	SPRAY FOAM SODA ACID MULTIPURPOSE DRY CHEMICAL	COOLING, QUENCHING
B	GASOLINE, OIL, GREASE, PAINT	SPRAY FOAM CARBON DIOXIDE MULTIPURPOSE DRY CHEMICAL DRY CHEMICAL	SMOTHERING, BLANKETING
C	ELECTRICAL, COMPUTER, MOTORS	MULTIPURPOSE DRY CHEMICAL CARBON DIOXIDE DRY CHEMICAL	NON-CONDUCTING, SMOTHERING
D	COMBUSTIBLE METALS, STEEL WOOL	MULTIPURPOSE DRY CHEMICAL	SMOTHERING

The intent here is not to scare you, only to make you aware of the dangers.

Your instructor will demand that these rules be strictly followed and will, as necessary, add other rules that apply to particular instructions or situations.

SHOP SAFETY TEST

_____ 1. If a piece of equipment isn't working correctly, if it doesn't sound like it is working correctly, or you can see a problem:
   A. Try to fix it.
   B. Use it carefully.
   C. Tell the instructor.
   D. Ask a friend for help.

_____ 2. Which of the following is not part of the fire triangle:
   A. Spark
   B. Fuel
   C. Heat
   D. Oxygen

_____ 3. A student who receives any injury in the shop…
   A. Should report the injury only if it is serious.
   B. Should not worry about it.
   C. Should report to the school nurse at once.
   D. Should report to the teacher at once.

_____ 4. When using any machine you should…
   A. Not worry if you don't know how to operate it.
   B. Make sure all safety devices are in place.
   C. Start the machine to make adjustments.
   D. Get other friends to help you.

_____ 5. Shop safety is the responsibility of _____.
   A. the student.
   B. the instructor.
   C. the shop aide.
   D. everyone.

_____ 6. When welding, which one of the following is not considered proper dress?
   A. Long sleeve shirt.
   B. Boots.
   C. Frayed Pants.
   D. Denim jeans or pants.

_____ 7. You should wear safety glasses/eye protection…
   A. When using power tools.
   B. When cutting materials.
   C. When grinding.
   D. All of the above.

_____ 8. After using tools you should…
   A. Wipe off the grease and oil and place them in the cabinet.
   B. Assume someone will put them up for you.
   C. Leave them on the table for the next class.
   D. Leave on table for instructor to clean.

_____ 9. Use sharp tools…
   A. Toward your body.
   B. Away from your body.
   C. Only if someone is helping you.
   D. With one hand in front of the tool.

_____ 10. The person using equipment has control of the machine; no one else should operate it with him/her. If someone is using a machine:
   A. Offer to help.
   B. Tell them you want to use it next.
   C. Don't talk to them or distract them in any way.
   D. Stand where the operator can see you when you interrupt.

_____ 11. Which of the following liquids are flammable.
   A. Gasoline
   B. Paint thinner
   C. Diesel fuel
   D. All of the above

_____ 12. First aid kits and eye wash stations should be noted:
   A. When you enter the shop or job site.
   B. Not a concern as long as instructor is present.
   C. As soon as an accident occurs.
   D. None of the above.

TRUE/FALSE

_____ 13. Cracks in a grinding wheel are unimportant.

_____ 14. Vises should be left ajar with the handle in a vertical position.

_____ 15. Use tools only for their specified purpose.

_____ 16. If your tool has a ground prong and your outlet doesn't, you may cut the prong off since it does not carry any current.

_____ 17. If you spill oil or grease on the floor you should wait until the end of the period to clean it up.

_____ 18. Gasoline should always be stored in an approved safety container.

_____ 19. You should never grind around flammable materials.

_____ 20. When using a power tool, always keep the cord out of the way.

_____ 21. Oily rags may be piled up overnight if the janitor or towel company is coming the next morning to remove.

_____ 22. Safety glasses are required to be worn at all times in the shop.

_____ 23. Horseplay is only allowed at the end of the period when all of your work is completed.

_____ 24. Jewelry should not be worn in the shop or work place because of the potential to cause injury.

_____ 25. Utilize time wisely in the shop, warning signs, labels and color codes are not important.

SHOP SAFETY TEST KEY

1. **C**
2. **A**
3. **D**
4. **B**
5. **D**
6. **C**
7. **D**
8. **A**
9. **B**
10. **C**
11. **D**
12. **A**
13. **F**
14. **T**
15. **T**
16. **F**
17. **F**
18. **T**
19. **T**
20. **T**
21. **F**
22. **T**
23. **F**
24. **T**
25. **F**

MECHANICS TECHNOLOGY

AREA: ELECTRICITY

OBJECTIVES:

1. Introduce student to electrical terms and sources of electricity
2. Introduce students to practical wiring (western union splice, pigtail splice, knotted tap splice, hook end, single pole switch controlling a light)
3. Introduce student to electrical tools and devices

TIME: The time allotment for instruction in this area is five (5) hours.

COMPETENCIES TO BE DEVELOPED:

1. Identify electrical tools and devices
2. Identify electrical symbols
3. Identify electrical terms
4. Identify electrical wire colors
5. Demonstrate ability to make the following:
   a. make western union splice
   b. make a pigtail splice
   c. make a hook-end
   d. wire a circuit for a single pole switch controlling a light

REFERENCES:

House Wiring Simplified, by H.P. Richter/W.C. Schwan (Park Publishing)
Agriculture Mechanics Fundamentals and Applications, 3rd Edition by Elmer C. Cooper (Delmar)

STUDY QUESTIONS

1. Define electricity.

2. An electrical circuit is:
   a. an uninterrupted path of electrons along a conductor
   b. flow of volts toward watts of current
   c. a piece of an electrical outlet in the wall
   d. all of the above

3. Each 120 volt electrical circuit has:
   a. delivery (hot or live) wire
   b. a neutral wire
   c. a short circuit wire
   d. both (a) and (b)

4. Electricity is distributed to branch circuits by:
   a. an electric meter
   b. an entrance head
   c. a fuse
   d. a service entrance panel

5. Tubes that carry wires are called:
   a. cable
   b. conduit
   c. non-metallic sheathed cable
   d. pipe

6. A suitable wire for high temperature, high moisture locations is:
   a. type THHN
   b. type T
   c. type WVA
   d. type THW

7. A cable consisting of #14 wire, one black, one red, one white, and a groundwire will be stamped:
   a. 14-2
   b. 14-3
   c. 14-3 w/g
   d. 14-3 BRW

8. All electrical connections in a circuit are made:
   a. with a tape
   b. with solder
   c. by bolts
   d. in boxes or fixtures

9. All metal electrical boxes must:
   a. be securely fastened
   b. be grounded
   c. secure the cable or conduit
   d. all of the above

10. Neutral wires are attached to screws colored:
    a. white
    b. silver
    c. green
    d. yellow

11. The device that receives electrical plugs is a:
    a. cap
    b. box
    c. circuit breaker
    d. receptacle

12. In three-way switch circuits, electricity passes from one switch to the other by:
    a. neutral wires
    b. common terminals
    c. traveler wires
    d. none of these

13. The most common type of receptacle is:
    a. single pole switch
    b. duplex receptacle
    c. 3-way switch
    d. special outlet

14. Positive (hot) wires which carry current to appliances may be:
    a. black
    b. blue

c. red
d. all of the above

15. Neutral wires which carry current to appliances are:
    a. red
    b. white
    c. green
    d. black

ELECTRICITY

INFORMATION

1. Terms and Definitions
   a. Electricity - source of energy that can be easily converted into light, heat, or power
   b. Ampere - unit of measure of the rate of flow of electricity through a wire
   c. Volts - unit of measure of electrical pressure
   d. Voltage drop - the loss in electrical pressure from its source to its point of use
   e. Watt - unit of measure used to determine the amount of energy supplied
      Volts x Amperes = Watts
   f. Kilowatt Hour - refers to the use of 1000 watts of electricity for one hour
   g. Direct Current (D.C.) - current flows in one direction at a continuous rate
   h. Alternation Current (A.C.) - current reverses at regular intervals - the most frequently used is 60 cycle
   i. Underwriters Laboratories - an organization, nation in scope, which tests all types of wiring materials and appliances to determine whether they meet minimum standards for quality and safety
   j. Circuit - complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source
   k. Switch - device for opening and closing a circuit
   l. Circuit Breaker - safety device which opens the circuit by tripping a switch
   m. Transformer - device by which the voltage may be changed either higher or lower
   n. Hot Wire - wires in a circuit which carry the power and which are not grounded. The wire is usually red or black.
   o. Neutral Wire - grounded wire in a circuit (it is white or gray in color)
   p. Short Circuit - improper connection between hot and neutral wires or between hot wires
   q. Grounding - connection of outlets and appliances to a rod driven eight feet in the ground
   r. Conductors - wire which carries the electricity
   s. Cable - when two or more wires are put together inside an overall covering
   t. Insulation - the covering placed over electrical conductors to prevent the escape of electricity
   u. Meter - an instrument which records the amount of current used in kilowatt hours
   v. Fuse - a safety device which burns out when the current becomes too great or a short occurs
   w. Ampacity - the safe carrying capacity of a wire in amperes
   x. Resistance - opposition to current flow in a conductor
   y. Conduit - metal or plastic pipe used to house exposed wires

2. Wire Colors and Use:
   a. Black or red - hot wire
      1. Use - carries the primary current to the consumer or between switches and consumers

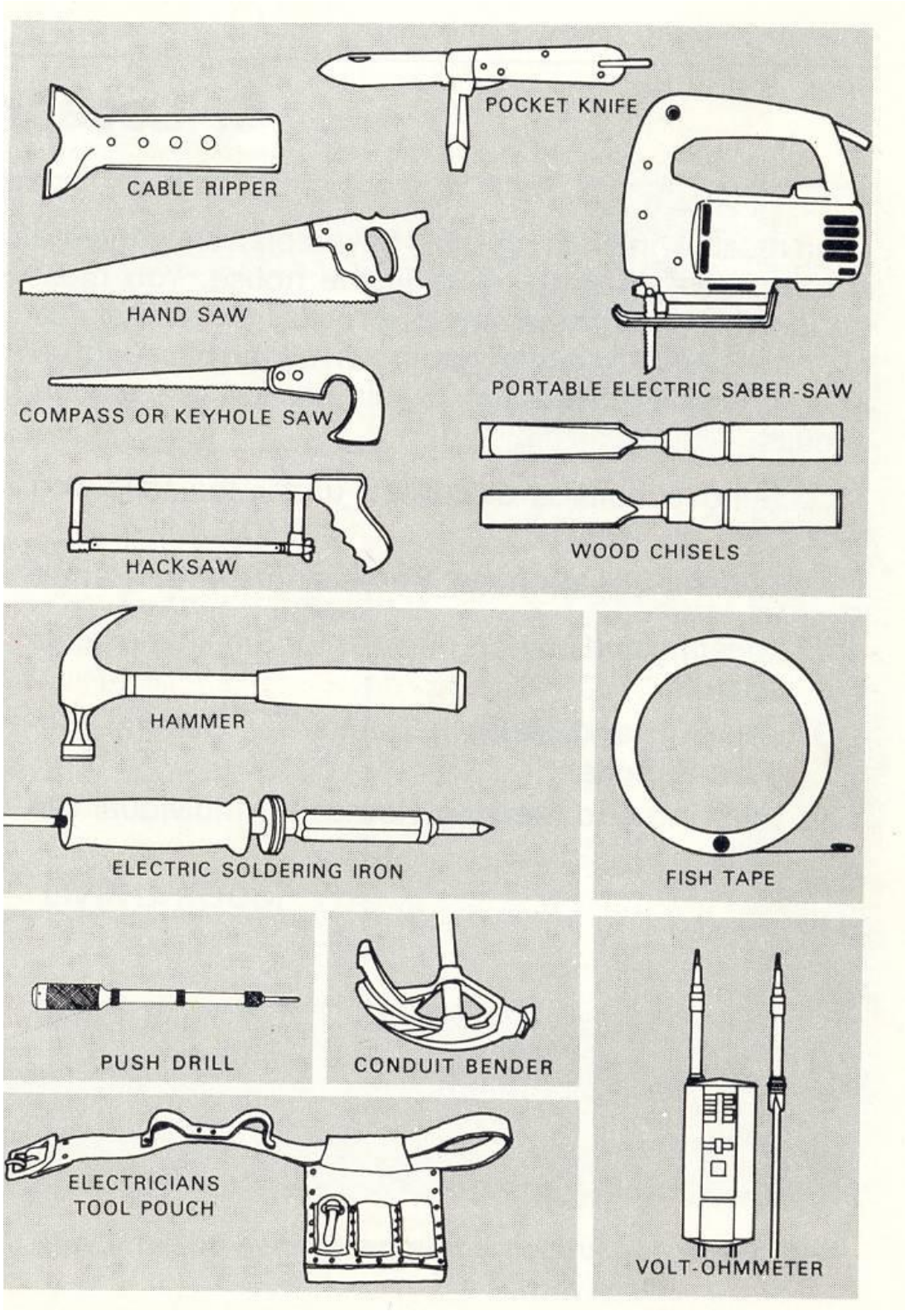
   b. White or gray - neutral wire
      1. Use - a current carrying wire that runs to every consumer a 120 volt circuit, but never to a switch or 240 volt receptacle

   c. Bare, green, green with yellow stripes - ground wire
      1. Use - a wire for safety purposes that is not current carrying in normal situations and must attach to every device on a circuit

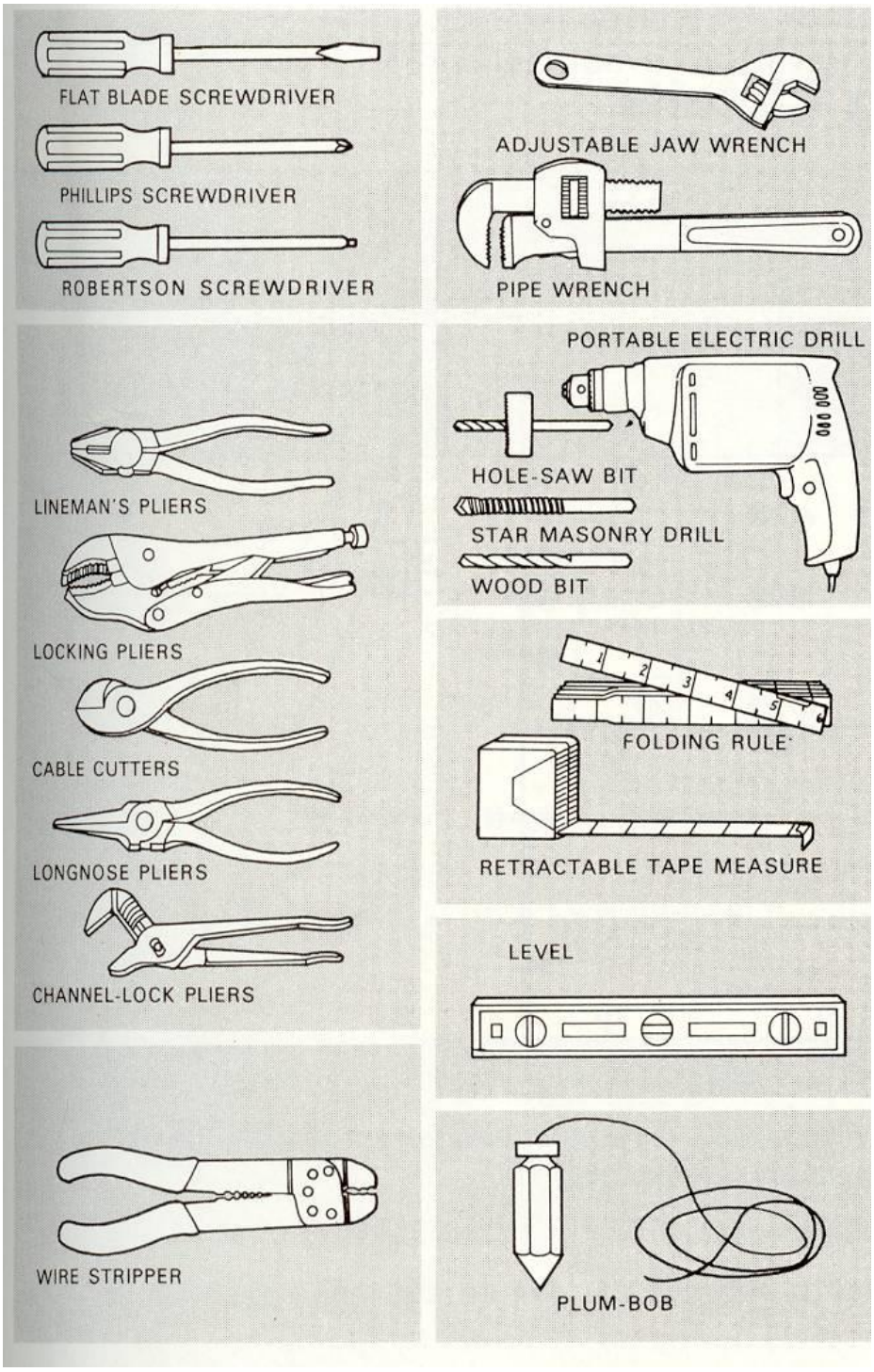
INFORMATION

TOOLS AND DEVICES

A. TOOLS

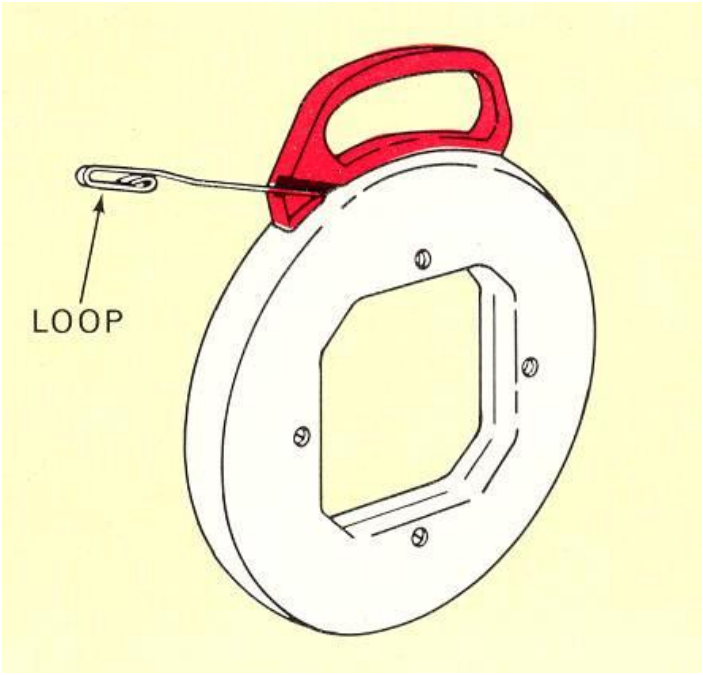


TOOLS (CONTINUED)



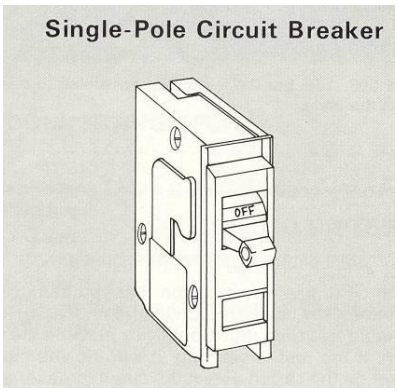
TOOLS (CONTINUED)

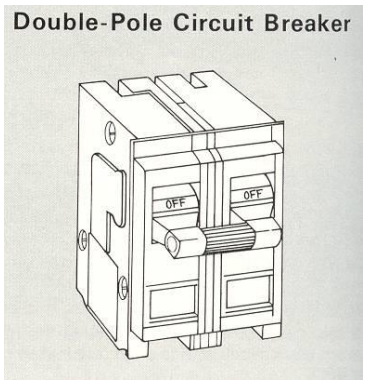
FISH TAPE



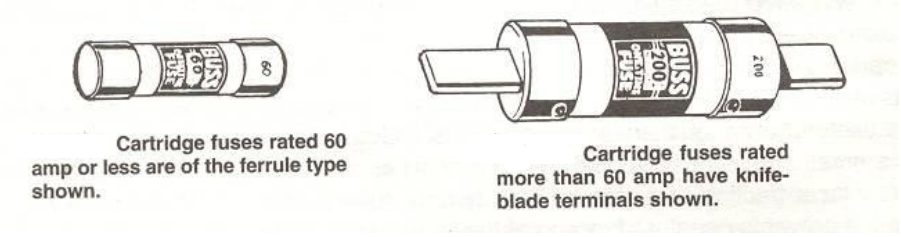
TEST LIGHT

B. OVERCURRENT DEVICES





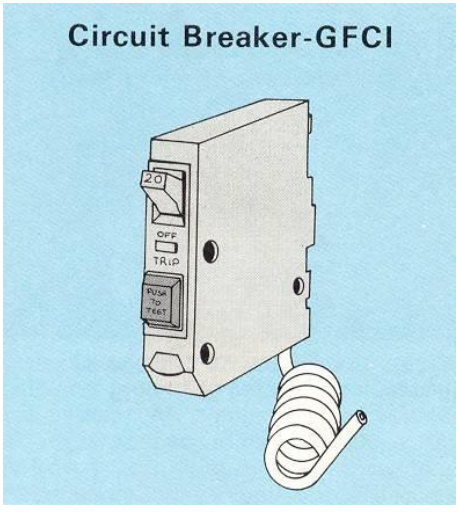
Plug Fuse



Cartridge fuses rated 60 amp or less are of the ferrule type shown.

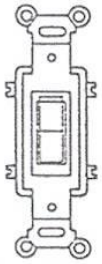
Cartridge fuses rated more than 60 amp have knife-blade terminals shown.

A typical Type-S non-tamperable fuse, and its adapter. Once an adapter has been screwed into a fuse-holder, it cannot be removed. This prevents the use of fuses larger than originally intended.

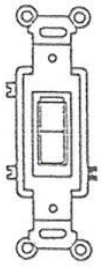


C. SWITCHES

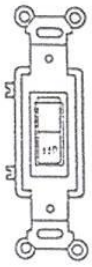
Single Pole



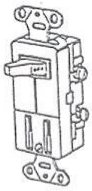
Three-Way



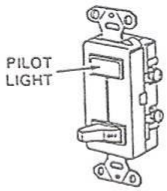
Four-Way



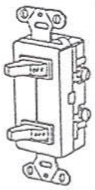
Switch and Receptacle



Switch and Pilot Light



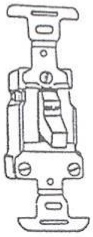
Two Switches on one Strap



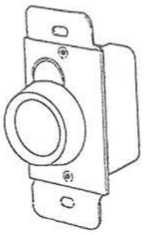
Push Button

Examples of combination

Time-Delay



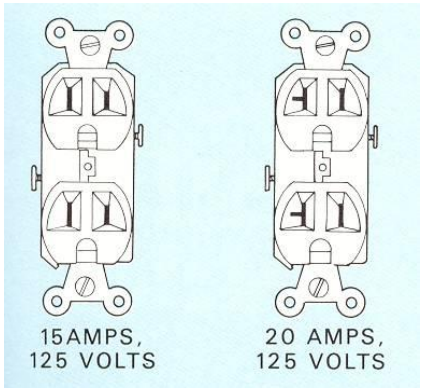
Rotary Dimmer

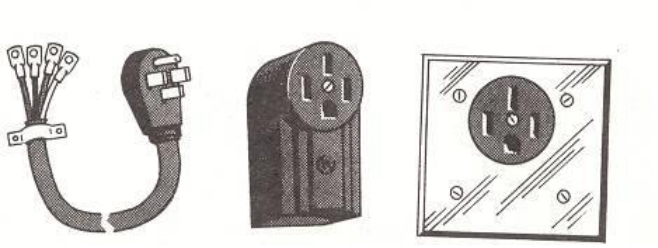


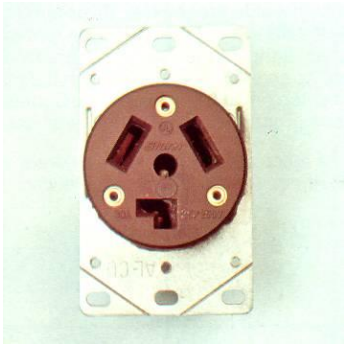
Rocker Switch

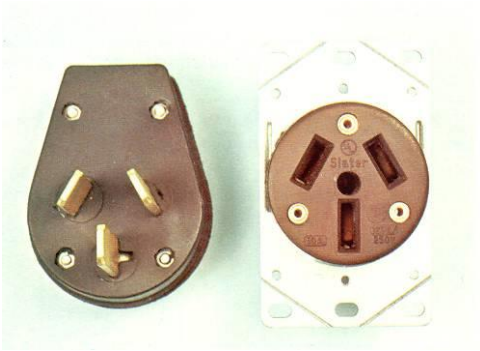
Time-delay and dimmer switches.

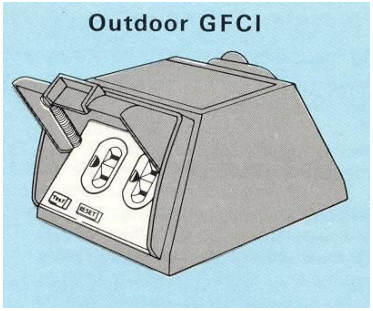
D. RECEPTACLES







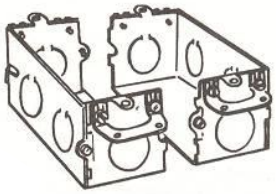




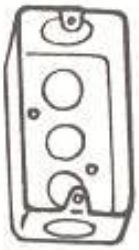
E. BOXES AND COVERS

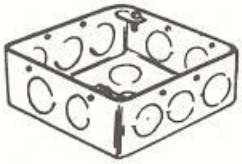
F.

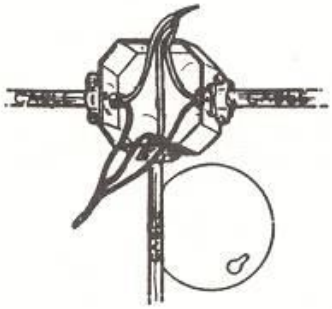
The common octagonal box.



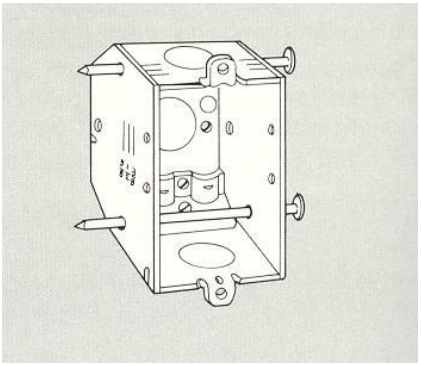
Two single boxes are easily changed into one larger "two-gang" box. Still larger boxes of 3 or 4 or more gangs are made the same way.







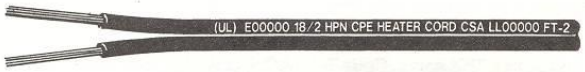
A junction box contains only the splices of several lengths of cable.



F. WIRES AND CORDS

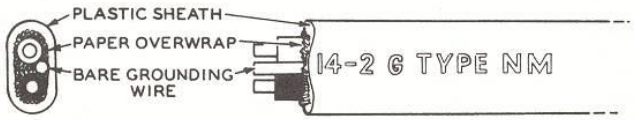
In Type SPT-2, the wires are imbedded in plastic. The cord is durable, attractive.

Types S and SJ cords are designed for severest use.

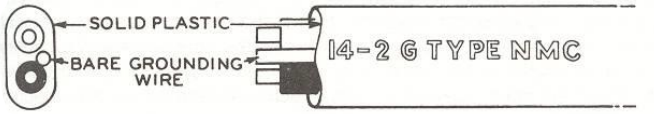


Type HPN cord is used on irons, toasters, etc.

Rubber-covered wire has rubber instead of plastic insulation. It may have a fabric or other nonmetallic flame-retardant outer covering.

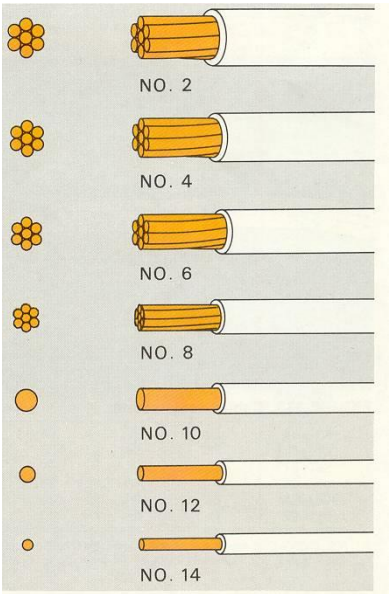


Nonmetallic sheathed cable consists of two or more individual wires, assembled into a cable. Type NM 2-wire with ground is shown, and may be used only in dry locations. The purpose of the ground wire will be explained in Chapters 7 and 10. Type NMC, for use in dry, damp, or corrosive locations, is described in Chapter 10.

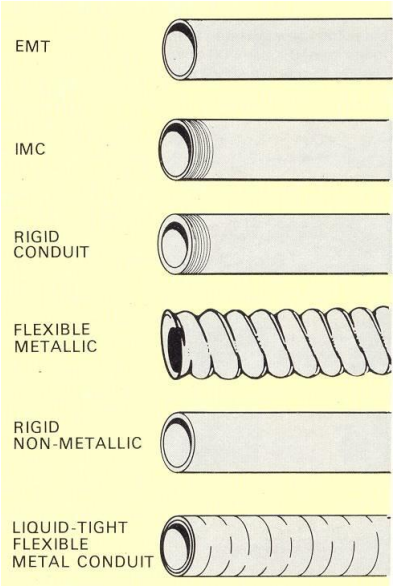


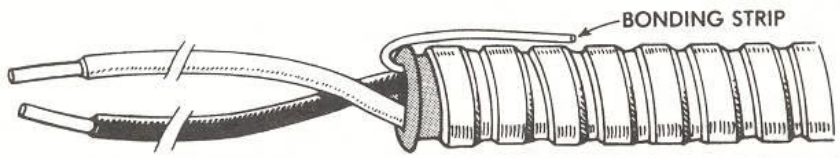
Nonmetallic sheathed cable, Type NMC, may be used in dry or damp locations.

Underwriters' Type USE cable is designed to be buried directly in the ground without further protection. It is available also as 2- or 3-wire cable.

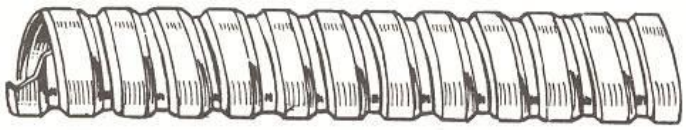


G. CONDUIT AND ARMORED CABLE



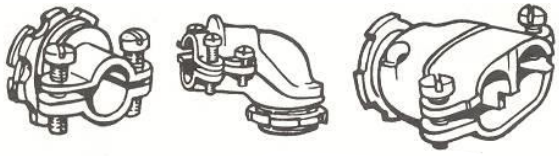


Armored cable consists of two or three wires, protected by a layer of tough paper and flexible aluminum or galvanized steel armor. Note the bonding strip under the armor.



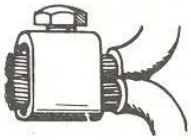
Flexible conduit is installed in the same way as armored cable, but wires are pulled into place later.

H. CONNECTORS AND CLAMPS



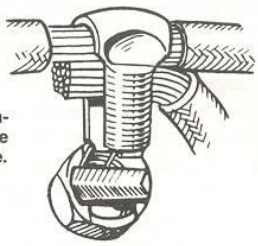
Connectors used in anchoring cable to boxes.

Solderless connectors of this type are used with heavy sizes of wire.

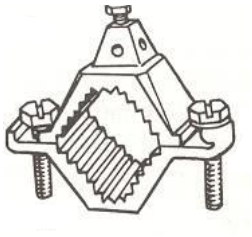


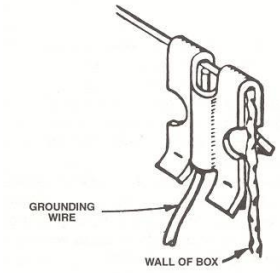
For heavier wires, use metal connectors. They must be taped.

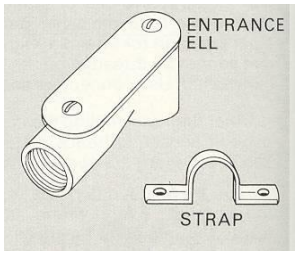
. Use this split-bolt connector when splicing a heavy wire to another continuous heavy wire.

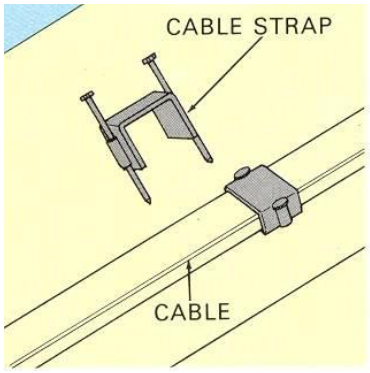


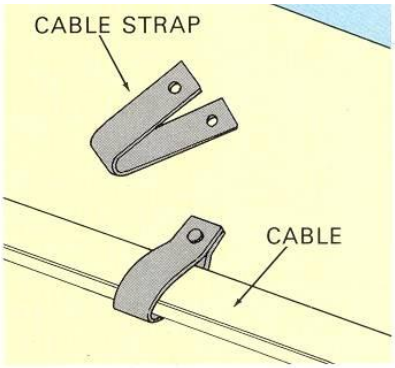
Solderless connector "wire nut"

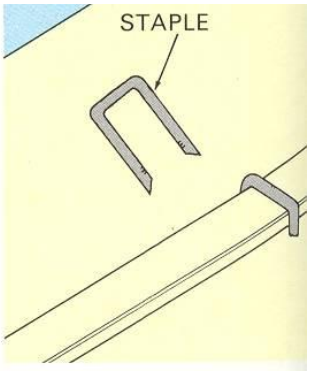


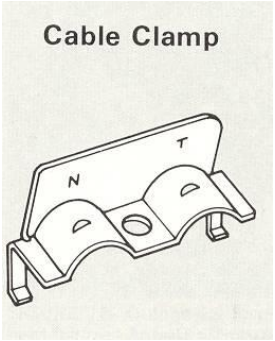


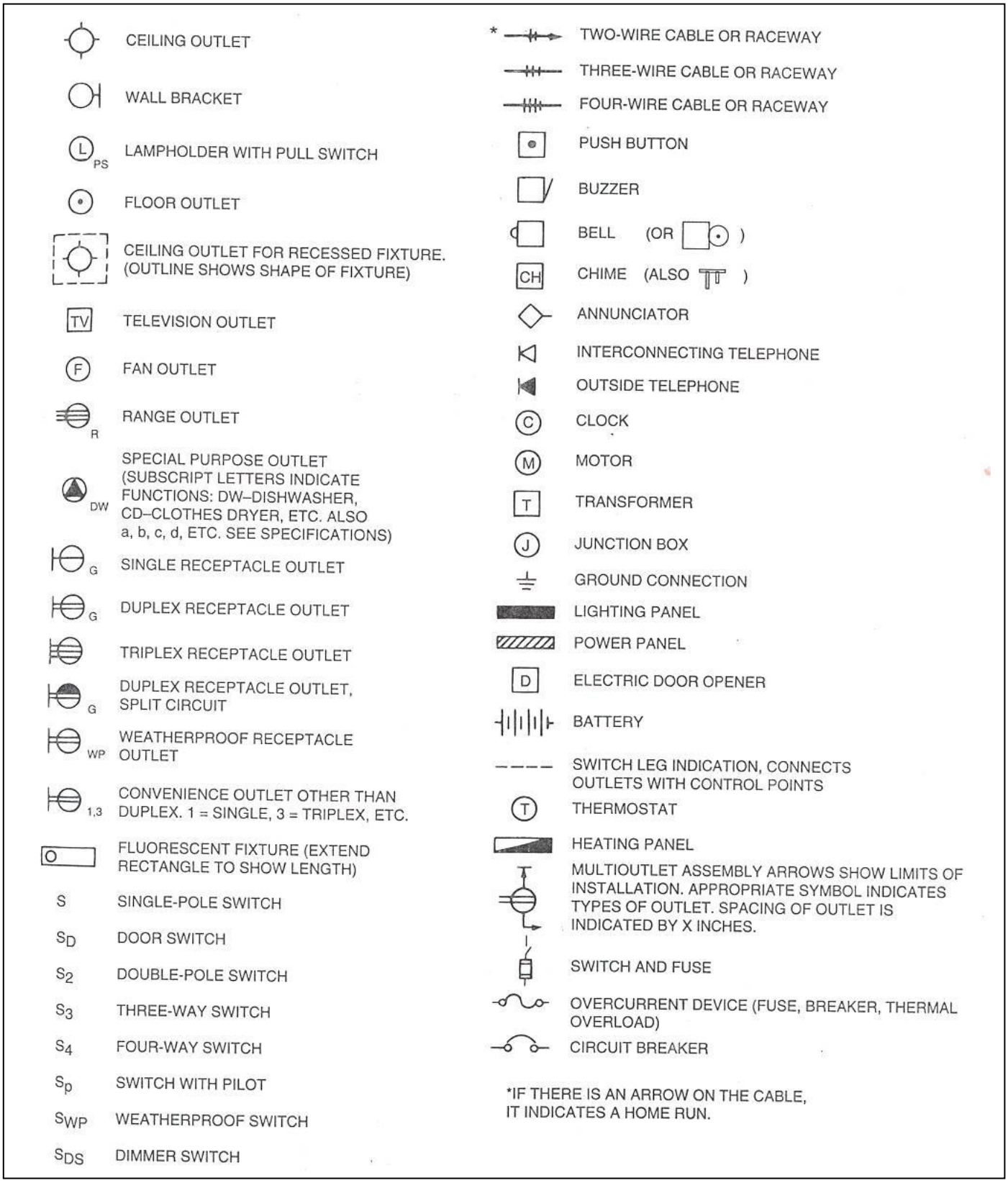












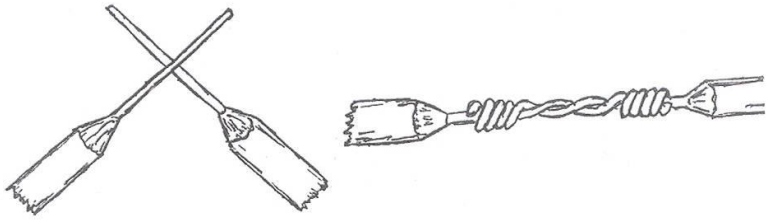
NOTE: A letter G signifies that the device is of the grounding type. Since all receptacles on new installations are of the grounding type, the notation G is often omitted for simplicity.

D. EXERCISES

EXERCISE A: Western Union or End Splice

1. Remove 3 inches of insulation from wires
2. Clean wires with knife before crossing them
3. Wind one end around other wire toward insulation
4. Keep windings close together (about 4 or 5 windings)
5. Make duplicate windings with other free wire
6. Cut excess wire close to splice leaving no sharp ends

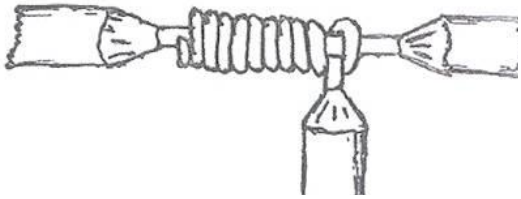
FIGURE I



EXERCISE B: Knotted Tap Splice

1. Remove 1 1/4" insulation on main wire
2. Remove 3" insulation from tap wire
3. Scrape wires clean
4. Start knot with tap wire crossing close to insulation on main wire
5. Make knot with tap wire, insulation near the main wire
6. Complete knot and wind tightly

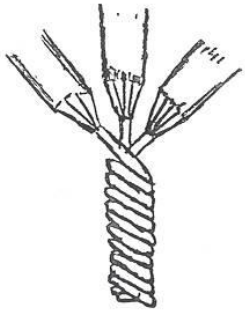
FIGURE II



EXERCISE C: Pigtail Splice

1. Correctly remove insulation from three wires
2. Clean wires with knife
3. Holding bare wire ends together, begin twisting all three wires together
4. Twist until windings are close to insulation
5. Solder to insure good permanent splice

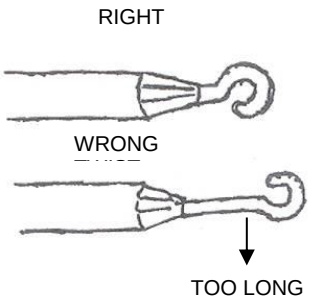
FIGURE III



EXERCISE D: Hook End of Wire

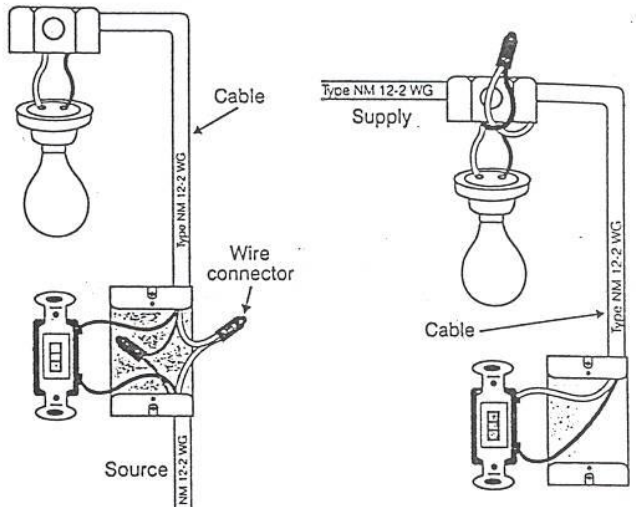
1. Remove 1 1/4" insulation from wire
2. Make hook in bare wire so it centers in line with wire
3. Make sure loop is made so a terminal screw tightens loop instead of spreading it

FIGURE IV



EXERCISE E: Single Pole Switch Controlling a Light

FIGURE V



1. Obtain material needed: 1 light fixture, 1 ceiling box, 1 wall box, 1 single pole switch, 2 pieces of 12-2 wire 2' long, 1 switch cover
2. Determine if the switch has screw terminals or push-in terminals. (Note: both terminals will be brass-colored. A single pole switch is only connected to hot wires.)
3. Prepare the wire
4. Connect the wire with black insulation to one of the brass-colored terminals
5. Connect the wire with the white insulation to the other brass-colored terminals. (Note: put a piece of black tape around the insulation on this wire. This will indicate to anyone working on the switch that it is a "hot" wire.)
6. Connect the un-insulated wire to the grounding screw (green)
7. Place the switch in the outlet box and attach with screws
8. Place the switch cover over the switch and attach to the switch

AREA: SMALL ENGINES (TWO-CYCLE AND FOUR-CYCLE)

OBJECTIVE:

Introduce students to engine construction and principles of operation

COMPETENCIES TO BE DEVELOPED:

1. Identify appropriate procedures in the small engine shop
2. Identify appropriate tools used in working with small engines
3. Describe the strokes and their function in a four-cycle engine
4. Describe the strokes and their function in a two-cycle engine
5. Define basic engine terminology
6. Discuss the different fuel systems of small engines and name the parts of those systems
7. Name and identify the different types of carburetors
8. Understand the basic ignition system and its operation
9. Name and discuss the different types of ignition systems
10. Discuss and understand the lubrication system of a small engine
11. Describe the basic functions of the cooling systems

Time: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *Small Gas Engines* by Alfred C. Roth (Goodhart Wilcox)
2. *Agricultural Mechanics, 3rd Edition* by Elmer L. Cooper (Delmar)

STUDY QUESTIONS

1. List in order the four strokes that take place in normal engine operation in a four-cycle engine.
2. Describe the function of each stroke.
3. Compare the strokes of a two-cycle engine to those of a four-cycle engine. (See Figure I and II.)
4. List three (3) systems that each internal combustion engine must have to operate.
5. List ten (10) safety precautions that must be observed when working with small engines.
6. Why should you stop an engine before refueling?
7. Why should you disconnect the spark plug cable before making any adjustments on machines powered by the engine?
8. What is piston displacement? (See Figure III.)
9. What is compression ratio? (See Figure IV.)
10. If the crankshaft is placed sideways in an engine, the engine is classified as _____-_____.
11. What controls the upward and downward movement of valves? (See Figure V.)
12. What is the function of the carburetor?
13. Describe gravity feed, suction feed, and fuel pump type carburetors.
14. What is the function of the ignition system?
15. Name the two circuits of a magneto?

FIGURE I

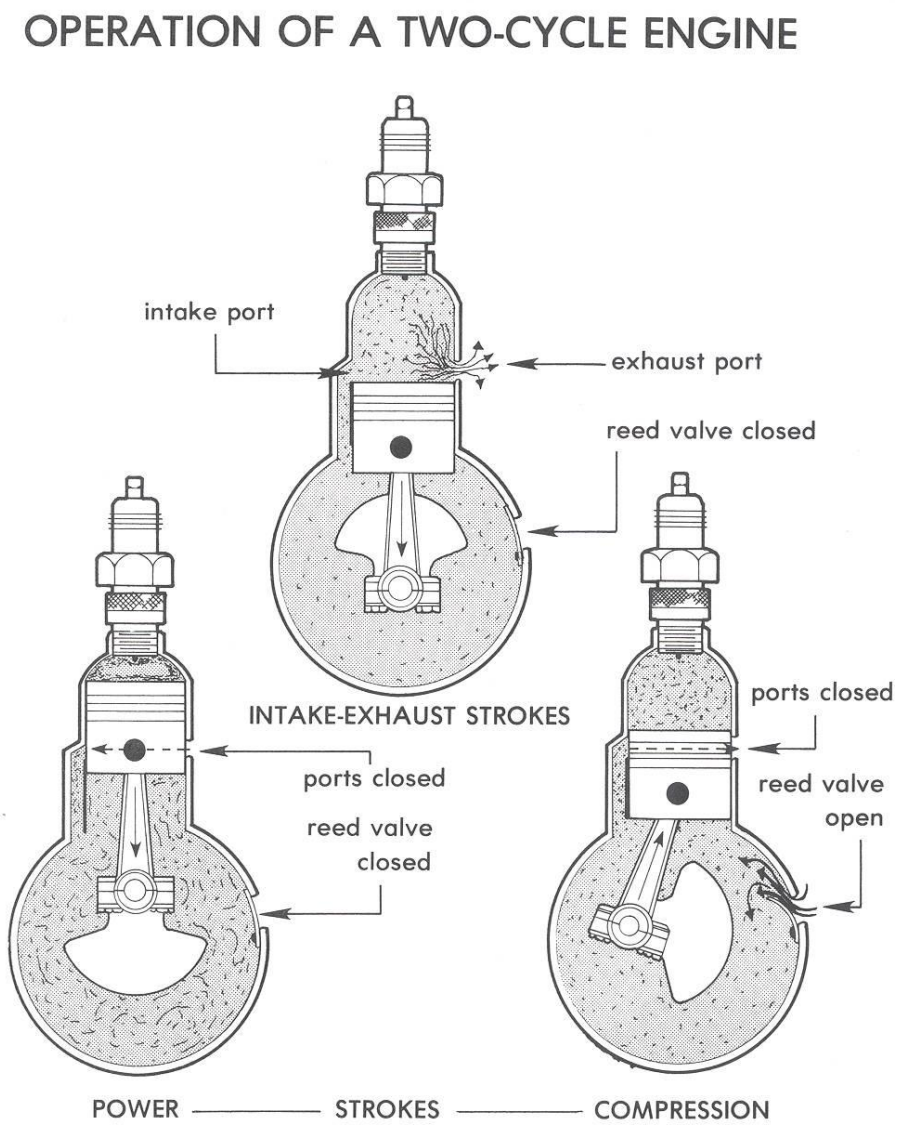

OPERATION OF A TWO-CYCLE ENGINE
intake port
exhaust port
reed valve closed
INTAKE-EXHAUST STROKES
ports closed
reed valve closed
ports closed
reed valve open
POWER
STROKES
COMPRESSION

FIGURE II

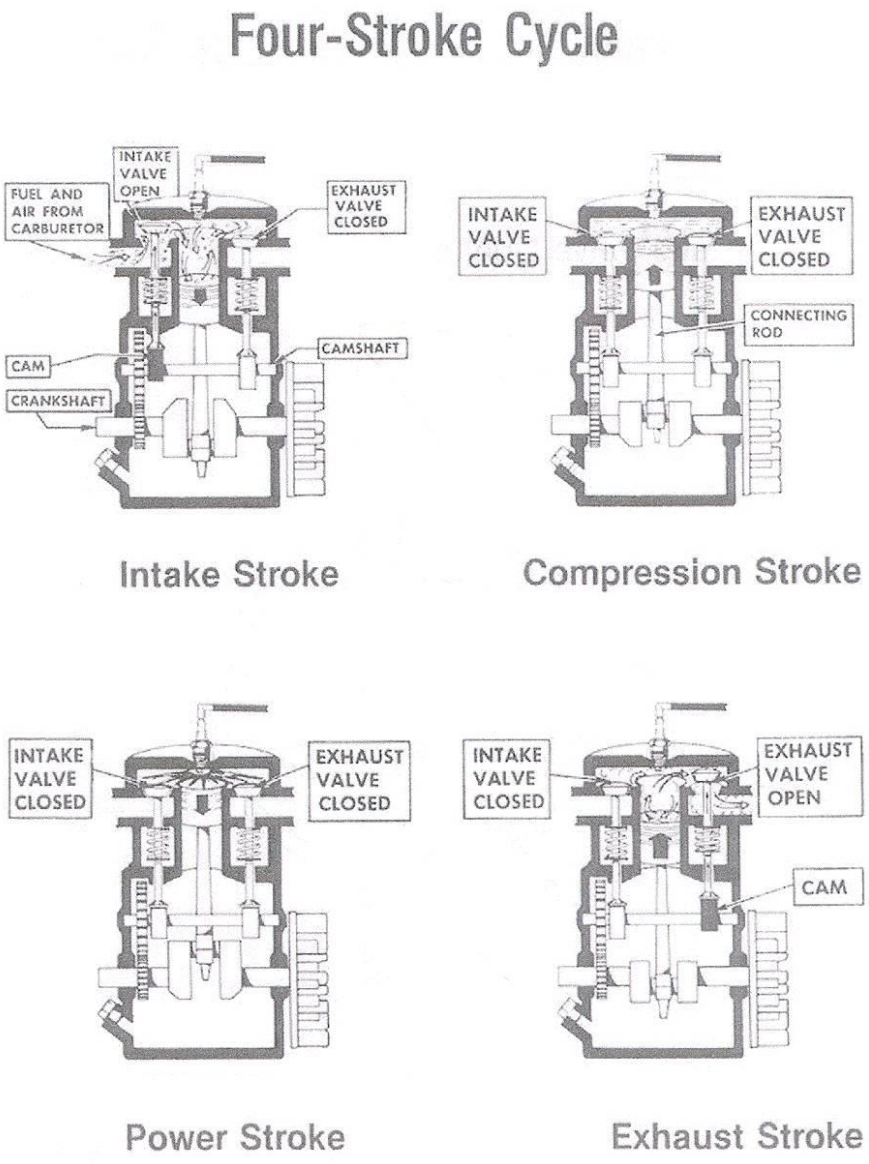

Four-Stroke Cycle
INTAKE VALVE OPEN
FUEL AND AIR FROM CARBURETOR
EXHAUST VALVE CLOSED
CAM
CAMSHAFT
CRANKSHAFT
Intake Stroke
INTAKE VALVE CLOSED
EXHAUST VALVE CLOSED
CONNECTING ROD
Compression Stroke
INTAKE VALVE CLOSED
EXHAUST VALVE CLOSED
Power Stroke
INTAKE VALVE CLOSED
EXHAUST VALVE OPEN
CAM
Exhaust Stroke

FIGURE III

EXAMPLE:

Formula For Piston Displacement:

Bore x Bore x 1/4π x Stroke, OR Bore x Bore x .7854 x Stroke

Once we know the piston displacement of one cylinder, we can determine the size of the whole engine by adding the number of cylinders to the formula.

SIZE = Bore x Bore x .7854 x Stroke x Number of Cylinders

NOTE: Knowing how to convert cubic inches into liters or liters into cubic inches may become necessary.

1 Liter	**=**	**61.02374 Cubic Inch**
1 Cubic Inch	**=**	**.016387 Liters**
1 Liter	**=**	**1000 Cubic Centimeters**
1 Cubic Inch	**=**	**16.387064 Cubic Centimeters**

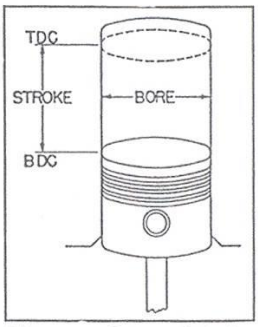
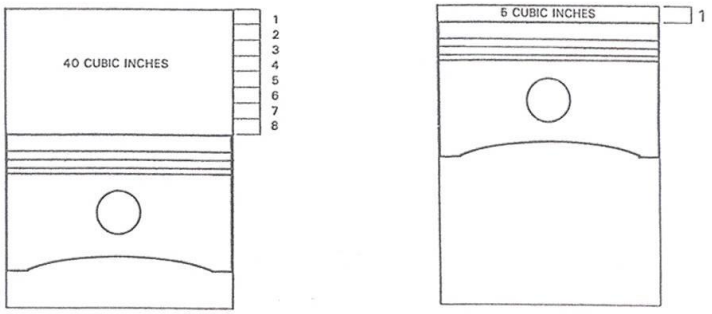


Figure . Bore and stroke of an engine cylinder

FIGURE IV

Compression ratio is the comparison of a cylinder's volume with the piston at BDC to the volume with the piston at TDC. In other words, how much is the cylinders volume being compressed by the piston. The compression ratio of most modern engines is between 7.0 to 1 and 10.0 to 1. Power output of the engine is directly proportional to compression ratio.

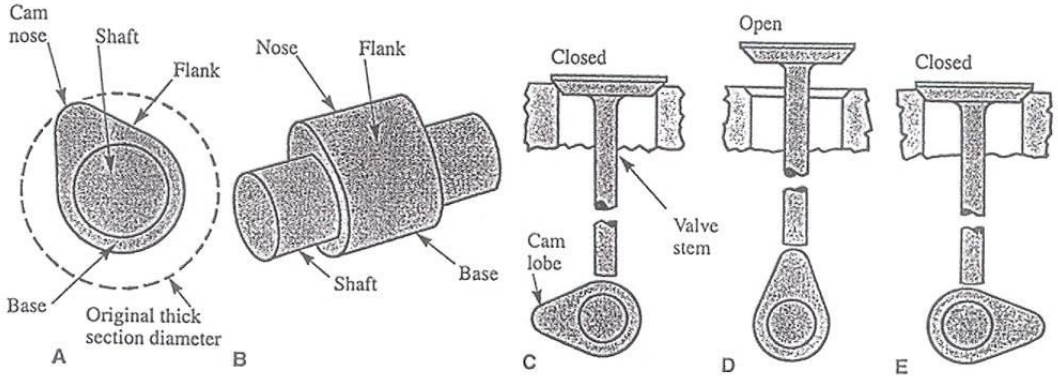
EXAMPLE: Maximum cylinder volume at BDC (40 cubic inches) divided by Minimum cylinder volume at TDC (5 cubic inches) equals a ratio of 8.0 to 1 (maximum volume 8 times bigger than minimum volume).



Compression ratio

FIGURE V

A, B----By grinding a round shaft into a cam shape, a camshaft is formed. C, D, E----When is revolved, cam lobe will open valve.



SMALL ENGINES

INFORMATION

Everyone must take responsibility for safety when working with small engines. Some of the safety precautions that must be observed are listed below.

1. Clean work area.
2. Use and handle hazardous materials such as gasoline properly.
3. Maintain proper clothing while working with small engines.
4. Maintain proper ventilation.
5. Use hand tools in a safe manner.
6. Use power tool in a safe manner.
7. Use compressed air in a safe manner.
8. Lift heavy objects in a safe manner.
9. Use proper electrical wiring/grounding procedures.
10. Operate gas engines in a safe manner.
11. Always follow OSHA requirements.
12. Stop an engine before refueling to prevent igniting the fuel.
13. Disconnect the spark plug cable before making any adjustments to prevent accidental starting of the engine.

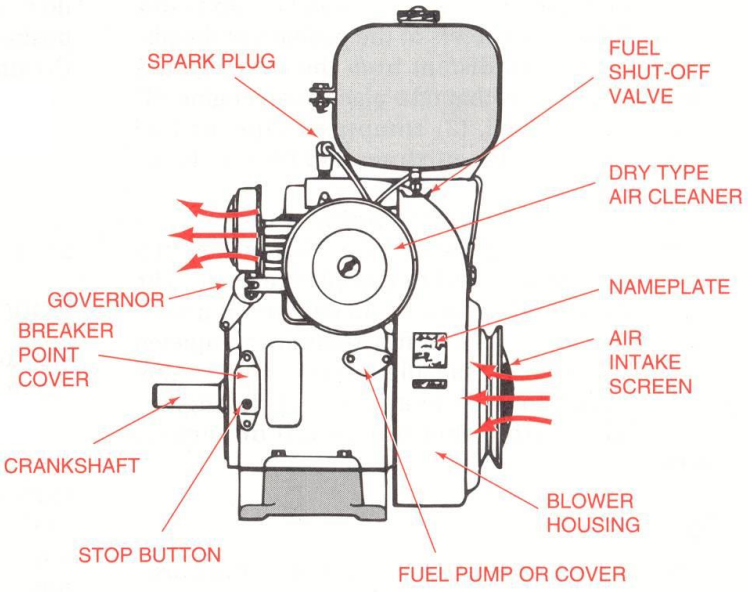
INFORMATION

ENGINE CLASSIFICATION:

Small engines are classified by the position of the crankshaft.

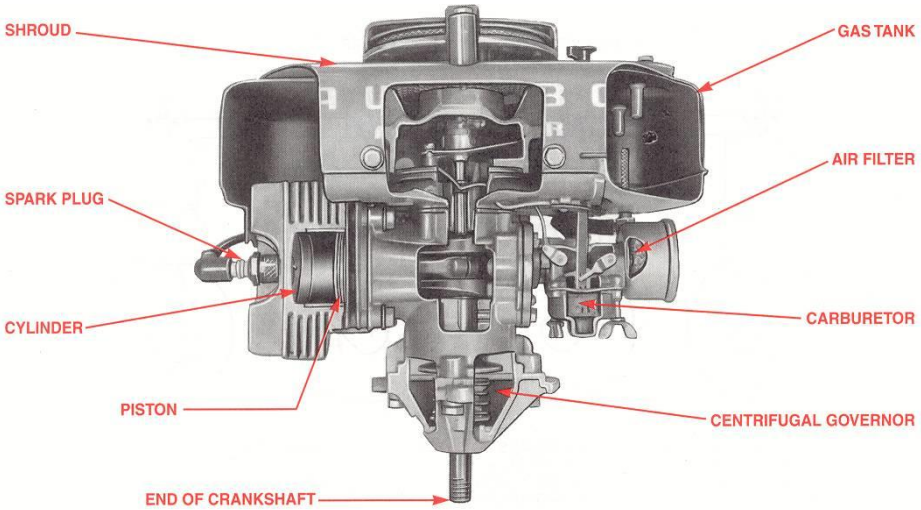
1. Horizontal shaft engine - the crankshaft is placed sideways in the engine. (See Figure VI.)

FIGURE VI



2. Vertical shaft engine - the crankshaft is in an up and down position. (See Figure VII.)

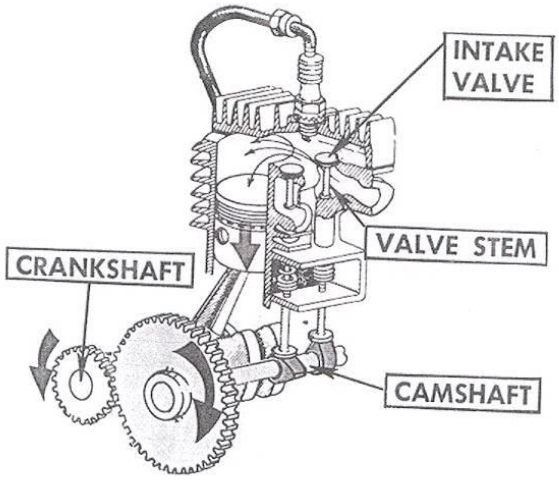
FIGURE VII



Camshaft and Valves

The camshaft is a shaft that has a lobe for each valve along with a gear. The camshaft gear meshes with the crankshaft gear. As the gear turns, the lobes on the camshaft will open the valves. (See Figure VIII.)

FIGURE VIII



Ignition

The ignition of a small engine must produce a high-voltage spark to ignite the fuel and air mixture. The magneto type system is made up of two types of circuits.

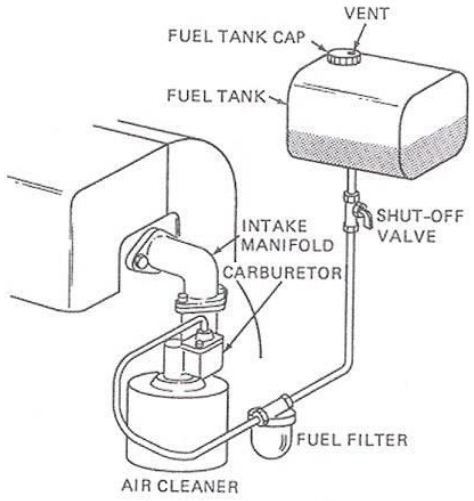
1. Primary circuit (low voltage), which includes a permanent magnet located in the flywheel, primary windings in the coil, breaker points and condenser.
2. The secondary circuit includes the secondary winding of the coil, spark plug wire and spark plug.

Carburetor

The carburetor provides fuel and air to the engine in the correct proportions and volume. The speed, power and acceleration are controlled by the carburetor. Carburetors for small engines will be from one of the following types:

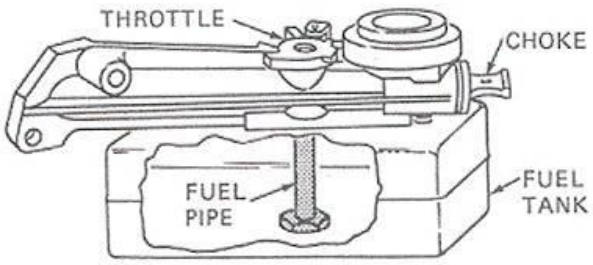
1. Gravity flow. The fuel tank is located above the engines and the use of gravity moves the fuel from the tank into the engine. (See Figure IX.)

FIGURE IX



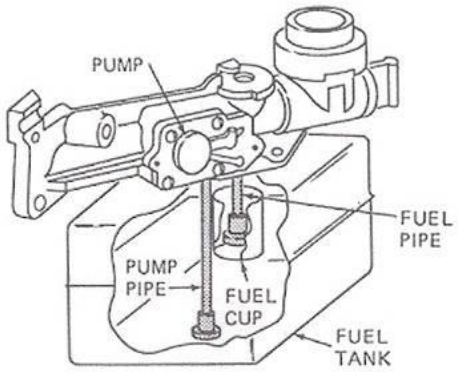
2. Vacu-jet or Suction Feed. This type of carburetor is used when the fuel tank is below the carburetor. It uses the force of atmospheric pressure to move the fuel from the tank to the carburetor. (See Figure X.)

FIGURE X



3. Fuel pump (Pulsa-jet). This carburetor uses a diaphragm type fuel pump to keep a constant level in the fuel chamber. (See Figure XI.)

FIGURE XI



EXERCISES

EXERCISE A:

1. Make one safety poster warning of the potential dangers of inadequate ventilation when working with small engines.

2. Make one safety poster warning of the potential dangers of wearing improper clothing when working with small engines.

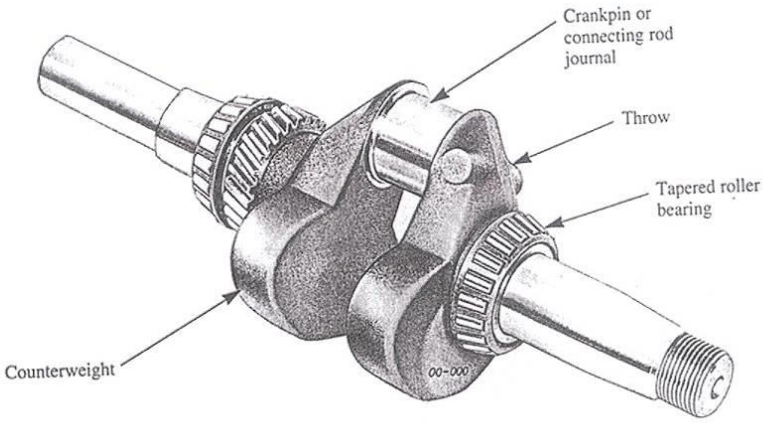
3. List danger that exists with compressed air.

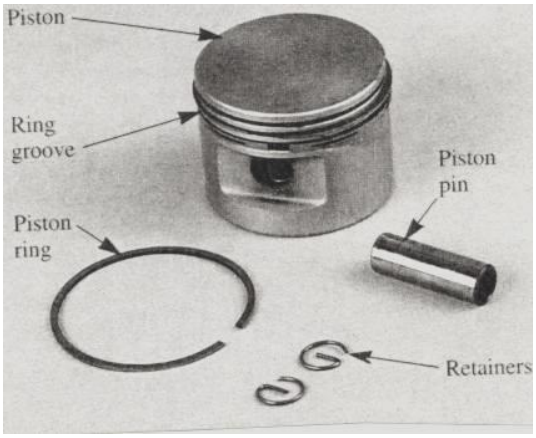
4. List dangers of electrical wiring when working with small engines.

EXERCISE B:

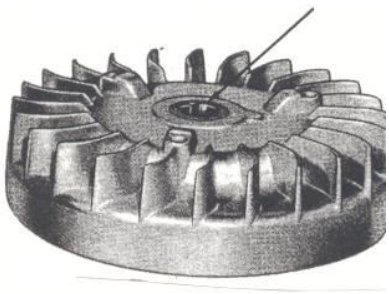
1. Secure a complete engine for disassembly (a small 3.5 hp, 4 cycle).

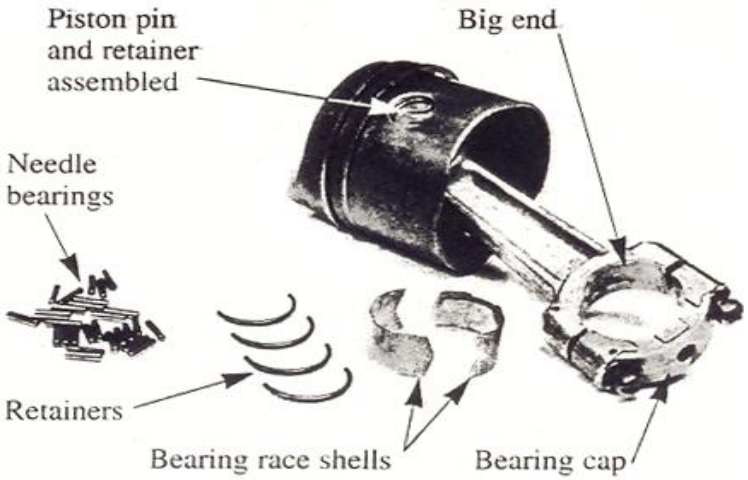
2. Locate the following parts and list their functions:
   a. flywheel
   b. connecting rod
   c. piston
   d. rings (compression and oil ring)
   e. head
   f. ignition module or points, condenser, coil
   g. carburetor
   h. valves (exhaust, intake)

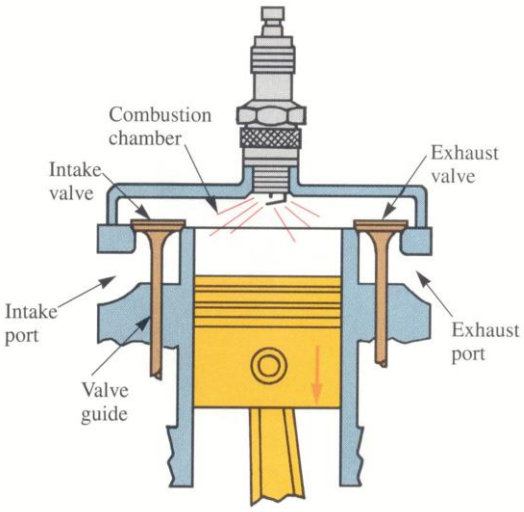




Flywheel







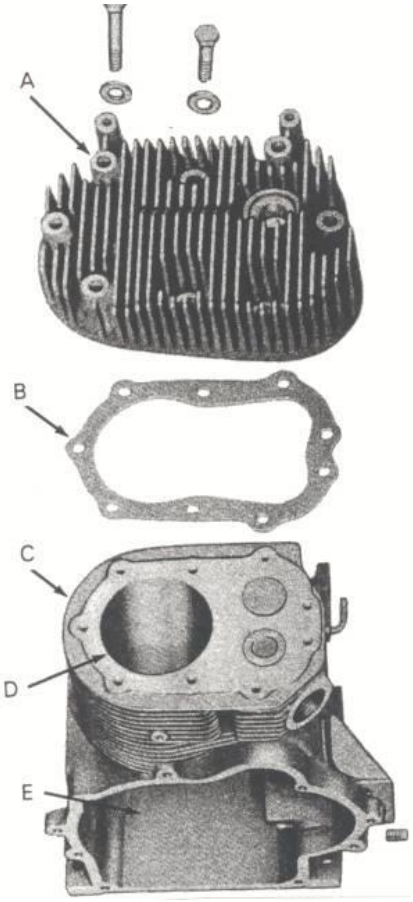
HEAD

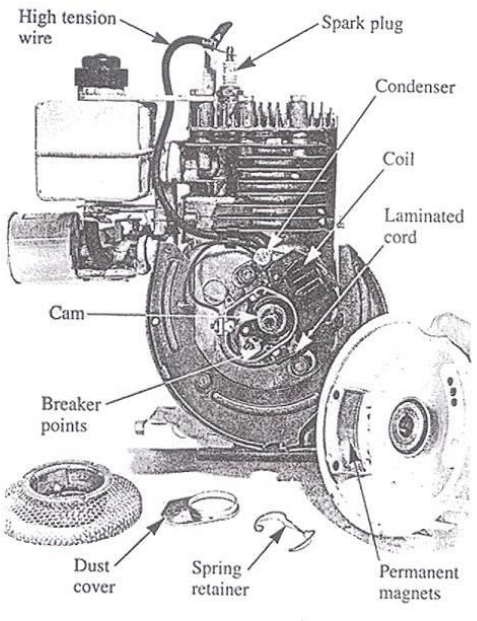
HEAD GASKET

COOLING FINS

CYLINDER

CRANK CASE

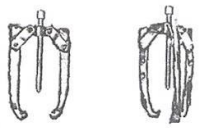




3. Re-assemble the engine to the point you received it.

EXERCISE C:

1. Secure an example of the following tools and lay on your table and identify each.
   a. open-end wrench
   b. box-end wrench
   c. combination box/open-end wrench
   d. adjustable wrench
   e. allen wrench
   f. socket set
   g. torque wrench (inch pounds)
   h. pliers
   i. vise grip
   j. needle nose pliers
   k. retaining ring pliers
   l. 3 different types of screw drivers
   m. ball peen hammer
   n. center punch
   o. drift punch
   p. gear puller
   q. screw pitch gauge



Gear Pullers

Screw Pitch Gauge

Box end Wrench

Allen Wrenches

Drift Punch

Combination

Ball Peen Hammer

Retaining Ring Pliers

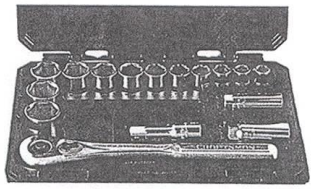
Open end Wrench

Adjustable Wrench

Torque Wrench

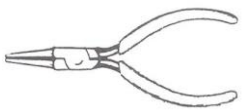
Reed and Prince

Pliers



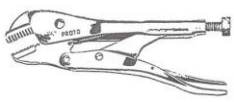
Socket Set

Phillips Screwdriver



Needle Nose Pliers

Slotted Screwdriver



Vise Grips

EXERCISE D:

1. Prepare a display of the major components of a small four-cycle engine.

EXERCISE E:

1. Prepare a display of the major components of a small two-cycle engine.

EXERCISE F:

1. Study Figure I and be ready to discuss the four cycles of a four-cycle engine, starting with the intake stroke going to compression stroke, power stroke and the exhaust stroke.

2. Give direction of piston movement (up or down) and position of each valve (open or closed).

MECHANICS TECHNOLOGY

AREA: METAL TECHNOLOGY (SHEET METAL AND COLD METAL)

OBJECTIVE:
Introduce students to jobs that involve different metal working skills and safety

COMPETENCIES TO BE DEVELOPED:

1. Learn to identify different metals
2. Learn to use metal working tools
3. Learn to mark metal
4. Learn to cut metal
5. Learn to solder
6. Learn to use pop-rivets

TIME: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *AgriScience Mechanics,* by Lloyd J. Phipps, Glen M. Miller (Interstate)
2. *Agricultural Mechanics,* by Elmer L. Cooper (Delmar)

STUDY QUESTIONS

1. Define ferrous metals. Give four (4) examples.
2. Define non-ferrous metals. Give four (4) examples.
3. Define the word "alloy".
4. Define "anneal".
5. Define "tempering".
6. The correct hacksaw blade will have ____ teeth on the metal at the same time.
7. Snips or shears are used to cut _____.
   a. sheet metal
   b. mild steel bars
   c. cast iron
   d. wrought iron
8. Name three (3) tools to mark metal.
9. A hacksaw cuts on:
   a. the backward stroke only
   b. the forward stroke only
   c. both the forward and backward strokes
   d. None of the above
10. Why is it important to wear goggles when doing metal work?
11. Why should a chisel or punch with a mushroomed head not be used?
12. What is a center punch used for?
13. List three (3) devices to fasten metals together.
14. List three (3) different types of taps used to cut threads in a blind hole.
15. Solder is a mixture of _____ and _____.
16. A 50/50 solder is made of ____% tin and _____% lead.
17. What is solammoniac used for?
18. When you join metal by melting a different metal between two pieces you are:
    a. gluing
    b. soldering
    c. washing
    d. welding

19. To make a hole in a piece of heavy metal, you will need to use:
    a. an auger bit
    b. a punch
    c. a high speed twist drill
20. The screw used to fasten this metal is called a _____screw.
21. The process of covering the tip of the soldering copper with solder is called _____.
22. How are files classified?
23. What is a file card used for?
24. What is a cold chisel used for?
25. Name four (4) types of punches.
26. What is a caliper and what are they used for?
27. What is a micrometer?
28. List three (3) kinds of vises.
29. What is a tap used for?
30. What is a die used for?
31. What is a pop rivet used for?

METAL TECHNOLOGY

INFORMATION SHEET

Identifying Metals

All metals can be classified as either ferrous or non-ferrous. Ferrous metals come from iron ore. Non-ferrous metals do not contain iron. The distinction is necessary because ferrous metals are used differently than non-ferrous metals.

Most metals are not used in their pure metallic state. They are usually combined with one or more other metals. The combination of two or more metal elements is called an alloy. Alloys have characteristics that make them different from the original metals that were used to form the alloy.

Tool Steel

Tool steel contains a certain amount of carbon which permits it to be hardened. Anneal means to heat a metal to the proper temperature and then slowly cool it. The process of annealing softens and hardens steel.

Tool steel can be hardened by heating to the proper temperature and then rapidly cooling the steel. The degree of hardness is determined by controlling the temperature of the metal and the speed of cooling after heating. Only tool steel can be tempered. Tempering is the process of carefully controlled reheating and cooling of steel after it has been shaped. Tempering results in specified degree of hardness, relieves stress, and prevents cracking in steel. Tool steel can generally be identified by the exploding sparkling nature of the sparks given off when the metal is ground.

Marking Metal

The scratch awl, scriber, file, soapstone, dividers, and center punch are tools used to mark metal.

Cutting Metal

Metal can be cut or formed by sawing, shearing, filing or grinding. Since metals are harder to work with than wood, the choice of tools used are the hacksaw, file, snips, and cold chisel. The hacksaw is the tool used most often for cutting metal. When using a hacksaw, a blade should be selected that is fine enough to allow at least three teeth at a time on the metal. Standard hacksaw blades come in 10-inch or 12-inch lengths. They may be bought with 14, 18, 24, or 32 teeth per inch. The blade with 32 teeth per inch has very small teeth and should be used to cut very thin. The thicker the metal, the coarser the teeth should be so the blade will cut faster. Hacksaws are designed to cut on the forward stroke. Therefore, blades must be installed with the teeth pointing away from the handle.

Safety is always very important. Because small bits of metal are made by working with metal, safety goggles must be worn at all times.

Files

Files are classified by length, shape, design, teeth and coarseness of teeth. Files used in most shops generally are 8 inches to 12 inches long. A file that has straight teeth going in one direction is a single cut file. A file that has teeth going in two directions is a double cut file.

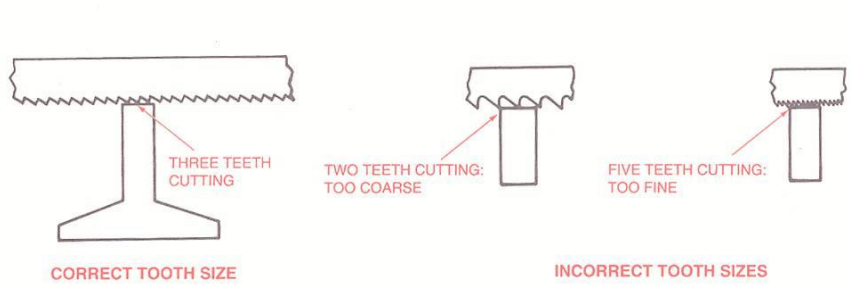
Center Punch

Center punches are used in metal work to mark the metal or locate the point to drill a hole in the metal.

Metal may be fastened together by single bolts, screws, or rivets. Metal may also be fastened by soldering it together.

Cutting Metal with a Hacksaw

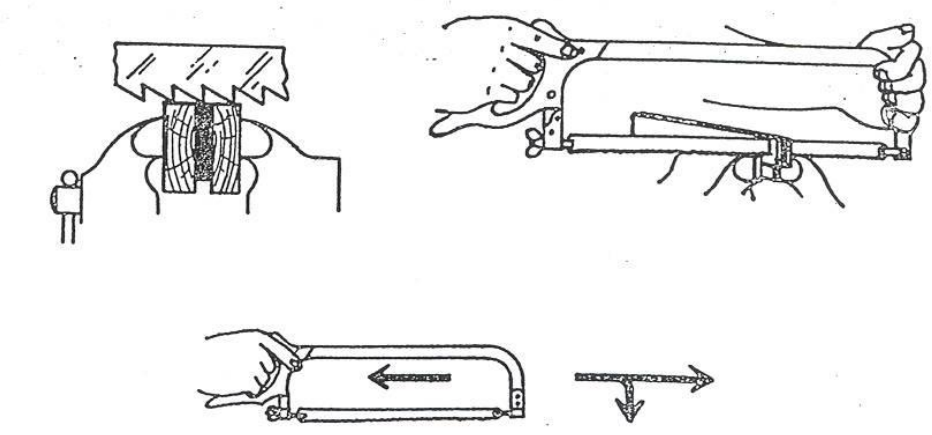
Cutting the stock with a hacksaw is one of the most common ways of cutting cold metal. The length of blades may vary from 8 to 12 inches and they are 1/2" wide and .025 inch thick. Blades are available in 14, 18, 24 and 32 teeth per inch.



When cutting mild steel or cast iron over 1/8" thick, use a coarse blade (18 teeth per inch).
Hard steel, pipe, and heavy sheet metal can be cut with a medium blade (24 teeth per inch).
Thin sheet metal tubing should be cut with a fine blade (32 teeth per inch).

Steps in Making the Cut with a Hacksaw

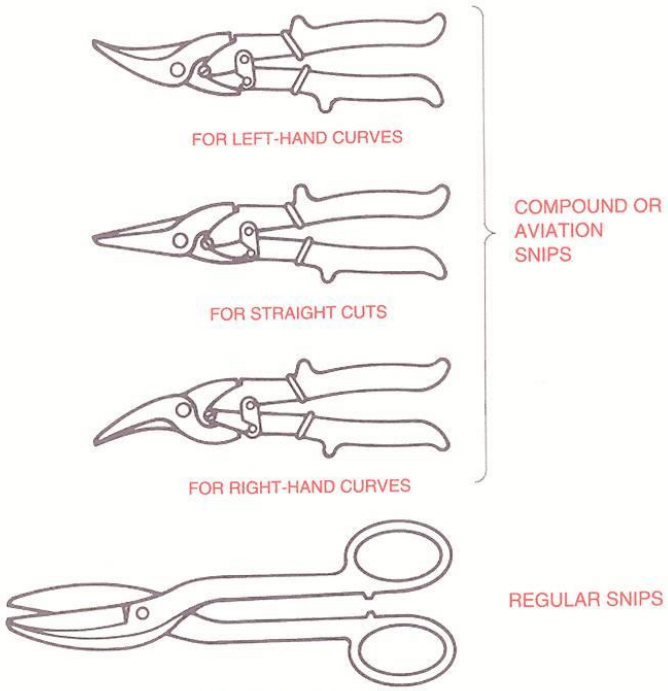
1. Mark the metal to be sawed and place it in a vise. The mark should be placed near the jaws, especially if the metal is thin. It may be necessary to use boards between the vise jaws to prevent scarring the work. Mark over the original mark with a file.
2. Hold the saw with both hands and start the cut by pulling it toward the body (backward stroke). The kerf may be started without filing a notch on the metal. As the saw is pulled backward, a very small amount of pressure should be applied.
3. The right amount of pressure should be applied as the saw is pushed forward. No pressure should be used on the back stroke after the saw begins cutting.
4. Steady strokes from 40 to 50 per minute is the correct speed for sawing.



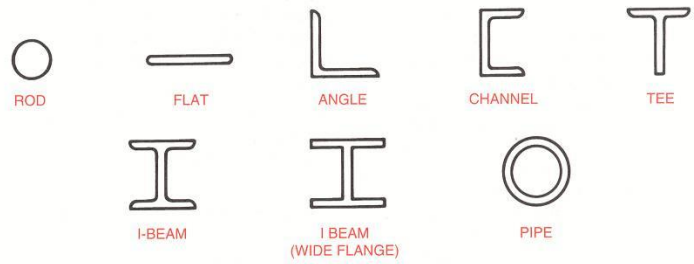
INFORMATION SHEET

Snips

Snips are used mainly to cut sheet metal. The most common snips are: straight (for straight cutting) and curved (for cutting inside curves both right or left).



Identifying Metal by Shape



INFORMATION

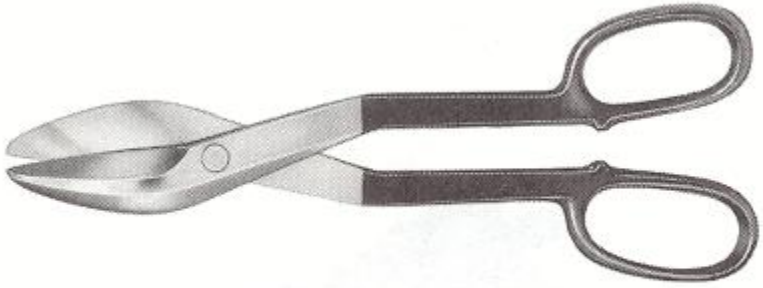
TOOLS AND SUPPLIES

POP RIVETER

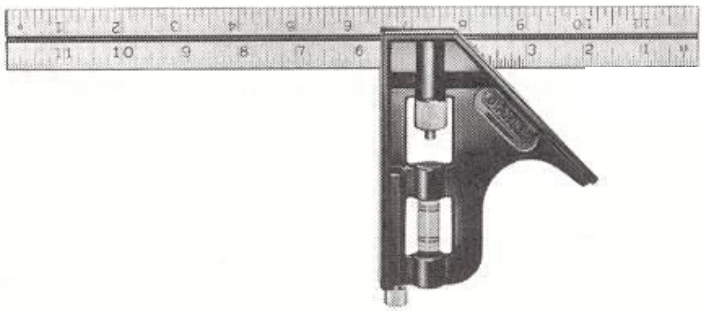
POP RIVET AS PURCHASED

POP RIVET AFTER IT IS INSTALLED

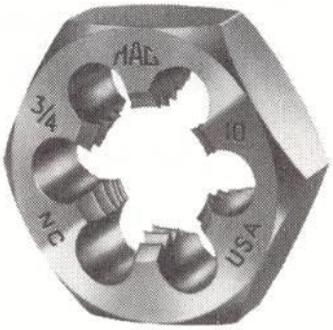
SCRATCH AWL



TIN SNIPS



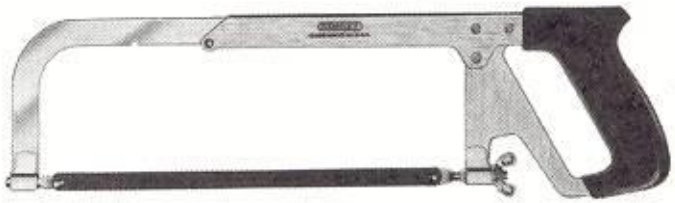
COMBINATION SQUARE



DIE

INFORMATION

TOOLS AND SUPPLIES (CONT.)



HACKSAW

COLD CHISEL

DIE STOCK

TWIST DRILL

TAP WRENCH

TAP

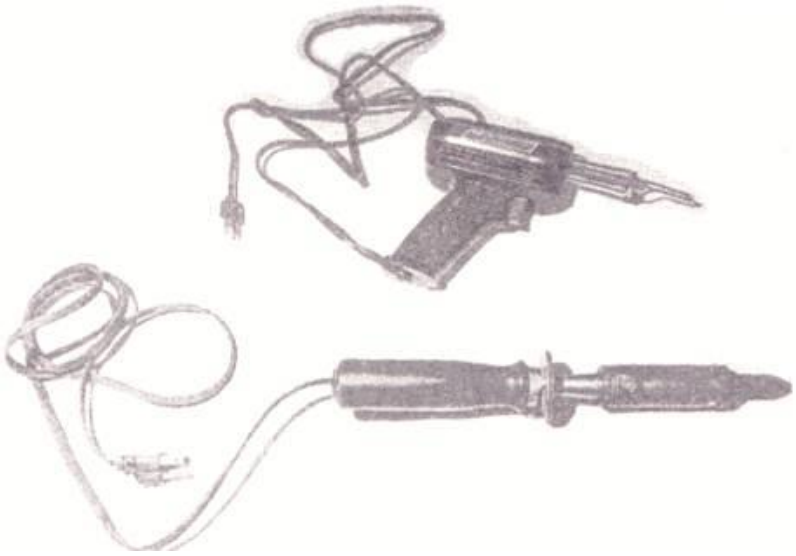
CENTER PUNCH

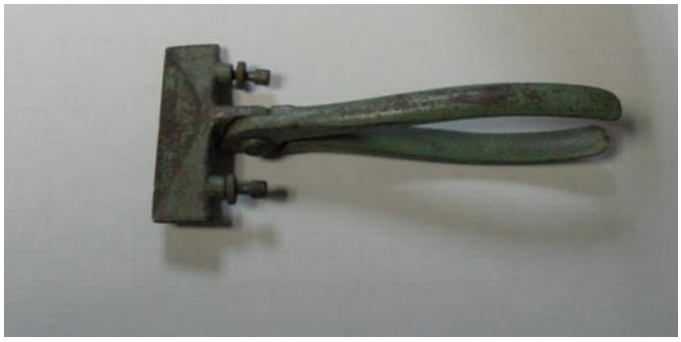
INFORMATION

TOOLS AND SUPPLIES (CONT.)

BALL PEEN HAMMER

SOLDER





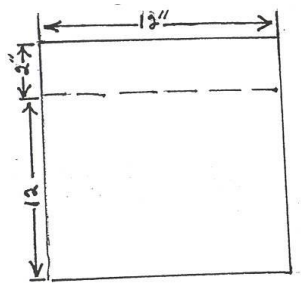
HAND SEAMER

EXERCISES

Exercise A:
1. Secure a piece of 18 gauge galvanized sheet metal 12" x 12".
2. Lay metal on sheet metal table flat.
3. Measure 2" from the right edge of the metal.
4. Scribe a mark with a scriber.

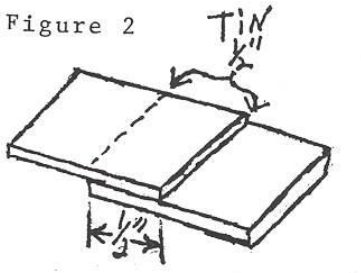
Exercise B:
1. Use the metal from Exercise A.
2. Use a pair of straight time snips cut across the line scribed. You should have a piece of metal 10" x 12" and one piece 2" x 12".
3. Repeat Exercise A and B to give you two pieces of metal 2" x 12". (See Figure I.)

Figure I



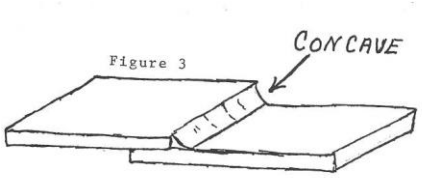
Exercise C:
1. Clean the edge to be soldered with sandpaper or file. Use approximate flux with solder. Tin 1/2" width on each edge to be lapped.
2. Lap one edge over the other 1/2".
3. Make sure lapped piece is flat.
4. Solder edge of lapped over to the second piece. Hold soldering iron properly. (See Figure II.)

Figure II



5. Solder only one side.
6. A well-soldered joint is concave. (See Figure III.)

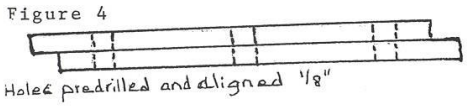
Figure III



Exercise D: Fastening Metal With Pop Rivets

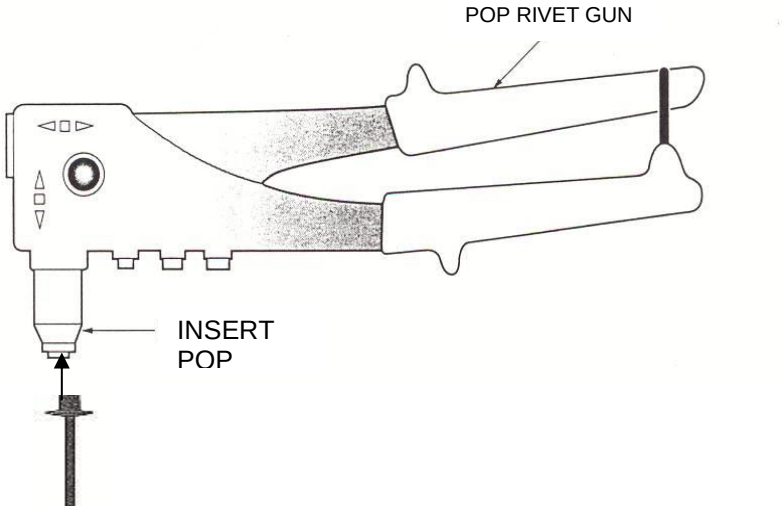
1. Secure two (2) pieces of 18" gauge sheet metal that are 4" wide and 6" long.
2. The metal must be pre-drilled with three (3) holes 1/8" in diameter. The holes must be aligned with each other. (See Figure IV.)

Figure IV



3. Secure a pop rivet gun and three (3) 1/8" diameter pop rivets.
4. Load the pop rivet gun with a pop rivet by inserting the stem. (See Figure V.)

Figure V

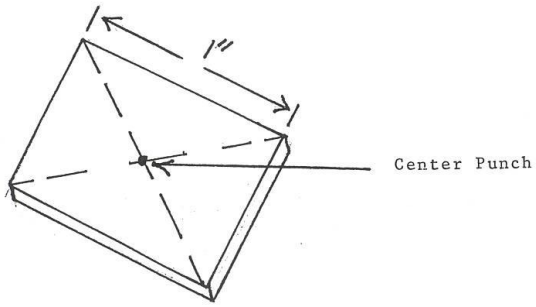


5. Insert the large rivet through both pieces of sheet metal and rivet by closing the handles of the gun together until the stem pops from the rivet.

Exercise E: Drilling Flat Stock

1. Obtain a length of 3/8" x 1" flat stock from the instructor.
2. Using a tape measure, measure and mark two (2) pieces 1" in length.
3. Using the hacksaw, cut the flat stock where it is marked.
4. Using the two pieces of 3/8" x 1" flat stock, mark the center of each piece by measuring each corner to the opposite corner.
5. Place a center punch where the lines intersect and using a ball peen hammer, strike the end of the center punch. This will give you a starting point for the drill bit. (See Figure VI.)

Figure VI

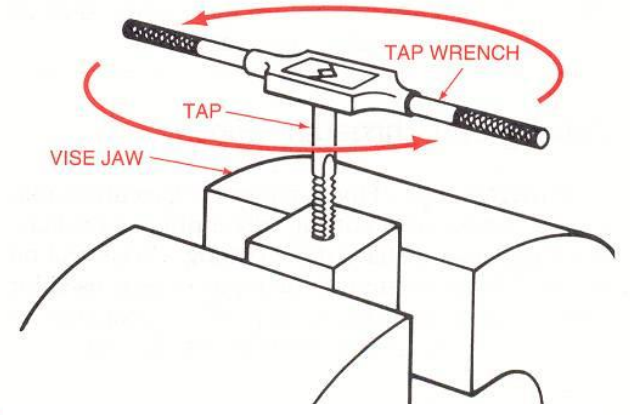


6. Obtain a 5/16" twist drill bit from the instructor and place it into the drill press chuck and tighten securely.
7. Place one of the 3/8" x 1" piece of flat stock in the drill press vise and tighten.
8. Line the drill bit up into the mark made by the center punch and drill completely through the flat stock. Use oil to keep the drill bit cool and help the drilling process.
9. Take the second piece of 3/8" x 1" flat stock and repeat the process.

Exercise F: Threading Flat Stock Using a Tap

1. Place both pieces of 3/8" x 1" flat stock cut in Exercise E in a vise and tighten securely.
2. Obtain a 3/8" - 16 NC taper tap from the instructor and place it into the tap wrench and tighten securely.
3. Insert the tap into the top of the flat stock and turn it to the right. Grasp the tap wrench with the hand directly over the tap and turn clockwise to start the tap until it starts to feed itself. (See Figure VII.)

Figure VII

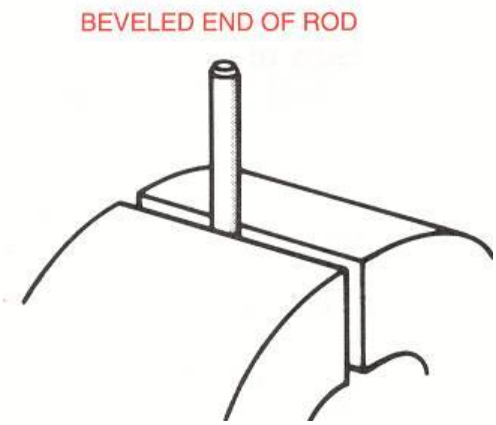


4. Using both hands, grasp the handles and turn slowly using even pressure on the handles to prevent breaking the tap.
5. After the tap has been properly started, turn it one full turn clockwise and back it up 1/4 turn to break away the chips.
6. Continue this manner until the tap goes through the bottom of the hole.
7. Back the tap out slowly and clean the tap.
8. Repeat the process to the other piece of 3/8" x 1" flat stock.
9. Clean the tap, and then turn it in to the instructor.

Exercise G: Threading Round Stock

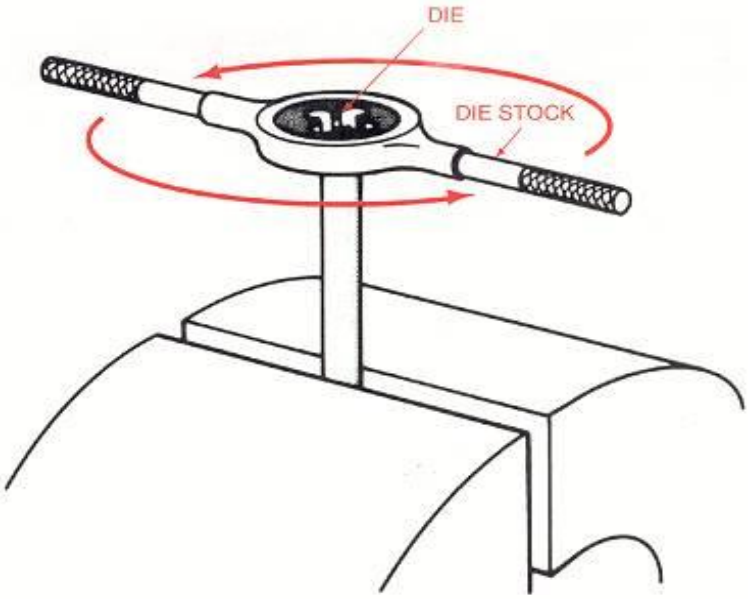
1. Place 3/8" x 6" piece of round stock in a vise and bevel each end. (See Figure VIII.)

Figure VIII



2. Obtain from the instructor a 3/8" - 16NC die and insert it in the die stock so the tapered side of the die will start the threads.
3. Place the tapered side of the die onto the beveled side of the rod applying pressure with one hand and using the other to start the threads. Make sure the die stock is held square so the threads are started straight. (See Figure IX.)

Figure IX



MECHANICS TECHNOLOGY

AREA: ARC WELDING

OBJECTIVES:
To learn to select arc welders, equipment and supplies needed for Arc Welding in Agricultural Mechanics.

COMPETENCIES TO BE DEVELOPED:
1. Be familiar with safety activities while arc welding
2. Striking an arc
3. Correctly setting up an arc welder
4. Running a flat bead
5. Weld a flat butt joint

TIME: Time allotment for instruction in this area is five (5) hours.

REFERENCES:
Agricultural Mechanics Fundamentals and Application, 3rd Edition, by Elmer Cooper (Delmar)
AgriScience Mechanics, by Lloyd J. Phipps and Glen M. Miller (Interstate)

STUDY QUESTIONS

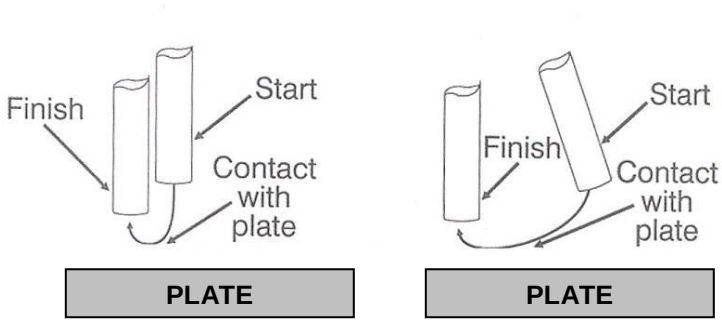
1. Define Arc Welding.
2. Define Shielded Metal Arc Welding (SMAW).
3. Define Stick Welding.
4. Discuss duty cycle.
5. Define ampere or amp.
6. Define voltage or volt.
7. Define watt.
8. Define alternation current (AC).
9. Define direct current (DC).
10. Define polarity.
11. List two (2) types of polarity.
12. List four (4) welding positions.
13. What is an electrode?
14. What does AWS stand for?
15. Tell what number E6013 on an electrode means.
16. Name three (3) different types of arc welders.
17. Describe a MIG welder.
18. Describe a TIG welder.
19. List five (5) safety precautions dealing with Arc Welding.
20. Define an arc.
21. What is a bead referring to in welding?
22. List four (4) different welds as to position?
23. Describe a butt weld.
24. Describe a fillet weld.
25. List five (5) pieces of Arc Welding equipment.

EXERCISES

EXERCISE A: Striking an Arc

1. Secure a piece of metal (mild steel) 4" x 6".
2. Set up the welder by connecting the ground clamp to work table and setting the welder on 90 amps.
3. Place 1/8" E6011 electrode in a 90-degree position in the electrode holder.
4. Secure welding booth by closing the curtains and warning other people that you are about to start. You must say "cover up."
5. Turn on the welder.
6. Place the tip of the electrode about 1/8" above practice metal.
7. Lean the electrode slightly in the direction you plan to move. (See Figure I.)
8. Lower the face shield over your eyes.
9. Lower the electrode until it touches the metal and lift it about 1/8" until there is an arc established between the electrode and practice metal.
10. If the electrode sticks to the metal use a quick whipping sideways to free it.
11. Repeat until you have learned the procedure.

FIGURE I

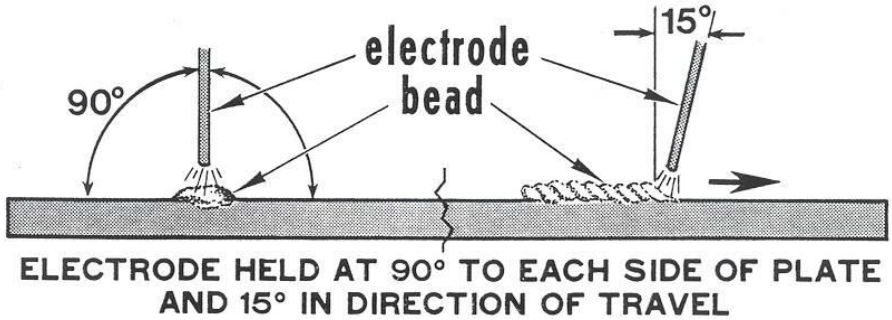


EXERCISE B: Running a Bead

1. Secure a 1/4" x 4" x 6" piece of mild steel.
2. Set the welder at 110 amperes.
3. Turn on the welder.
4. Place a 1/8" E6013 electrode in the holder at 90 degrees. (See Figure II.)
5. Strike the arc and move the electrode to the starting point.
6. Watch the puddle, feed the electrode keeping the arc at about 1/8" above the metal.
7. Move from left to right across the pad.
8. Observe the angle of the electrode.
9. Run the bead until you reach the edge of your metal. Repeat the process until you can strike the arc and run a good bead over and over again.

FIGURE II

Correct Electrode Angle – When making a flat pad weld, the correct angle should be 15 degrees from 90 degrees in the direction of travel. Hold the electrode perpendicular to the base metal.



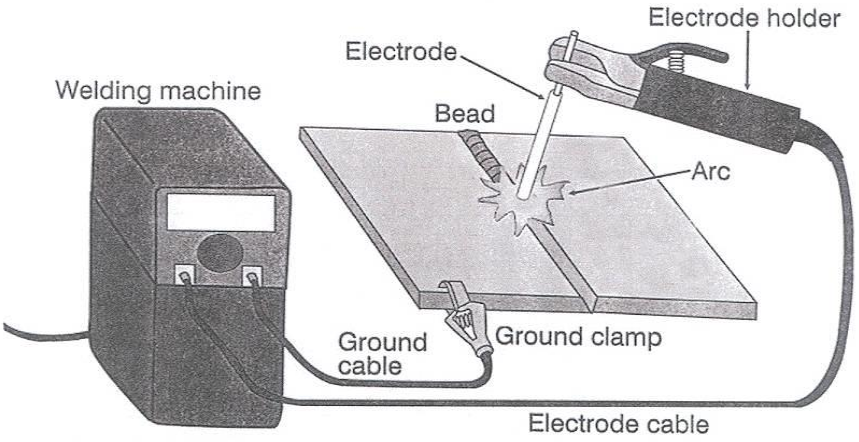
ARC WELDING

INFORMATION

Arc Welding has been in use for 100 years. This type of welding is the process of fusing two or more pieces of metal together by using the heat produced from an electric arc welding machine. (See Figure III.)

FIGURE III

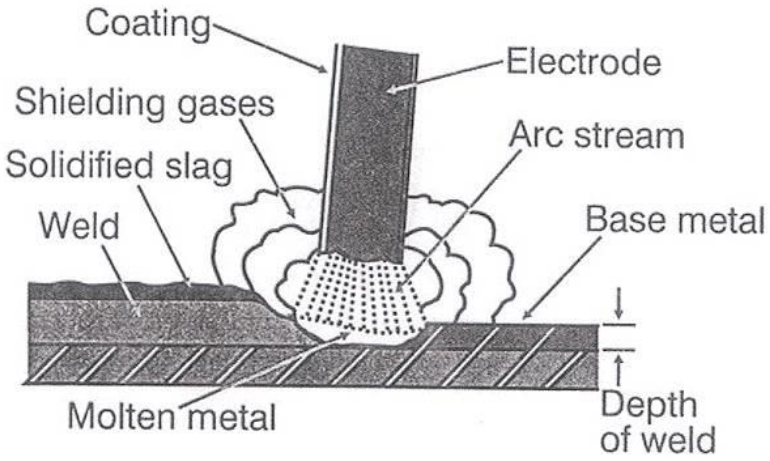
Arc welding uses an electric arc between a base metal and a coated electrode. This method is commonly known as shielded arc welding or stick welding. A welding machine is used to provide the electrical current to best suit the needs of the welding process.



Components of an arc welding system.

Shielded Metal Arc Welding (SMAW) is sometimes used to identify the arc welding process. The coating on the electrode produces a gas which acts as a shield keeping the atmosphere away from the process as the electrode melts. This is referred to as stick welding. (See Figure IV.)

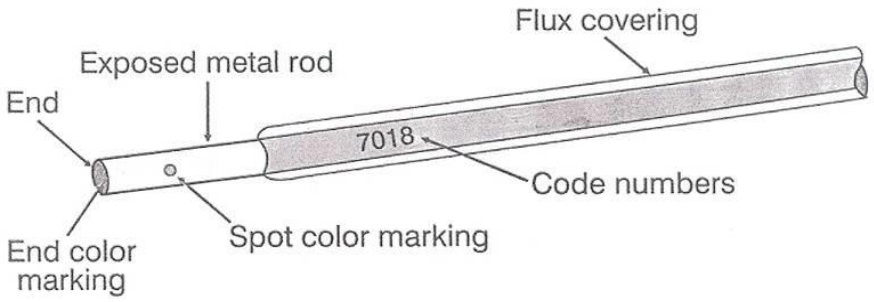
FIGURE IV



The Tungsten Inert Gas (TIG) and the Metallic Inert Gas (MIG) uses a gas to protect the fusion area from the atmosphere. The most common type of welder is the one that produces alternation current (AC) and direct current (DC). Each of these type welders has their own advantages. Polarity refers to the direction that current flows.

The *American Welding Society* (AWS) has set up a color code and a classification numbering system that is used by industry. The meaning of the AWS numbering system (for example) an electrode that has the number E6013 means the following: (See Figure V.)

FIGURE V



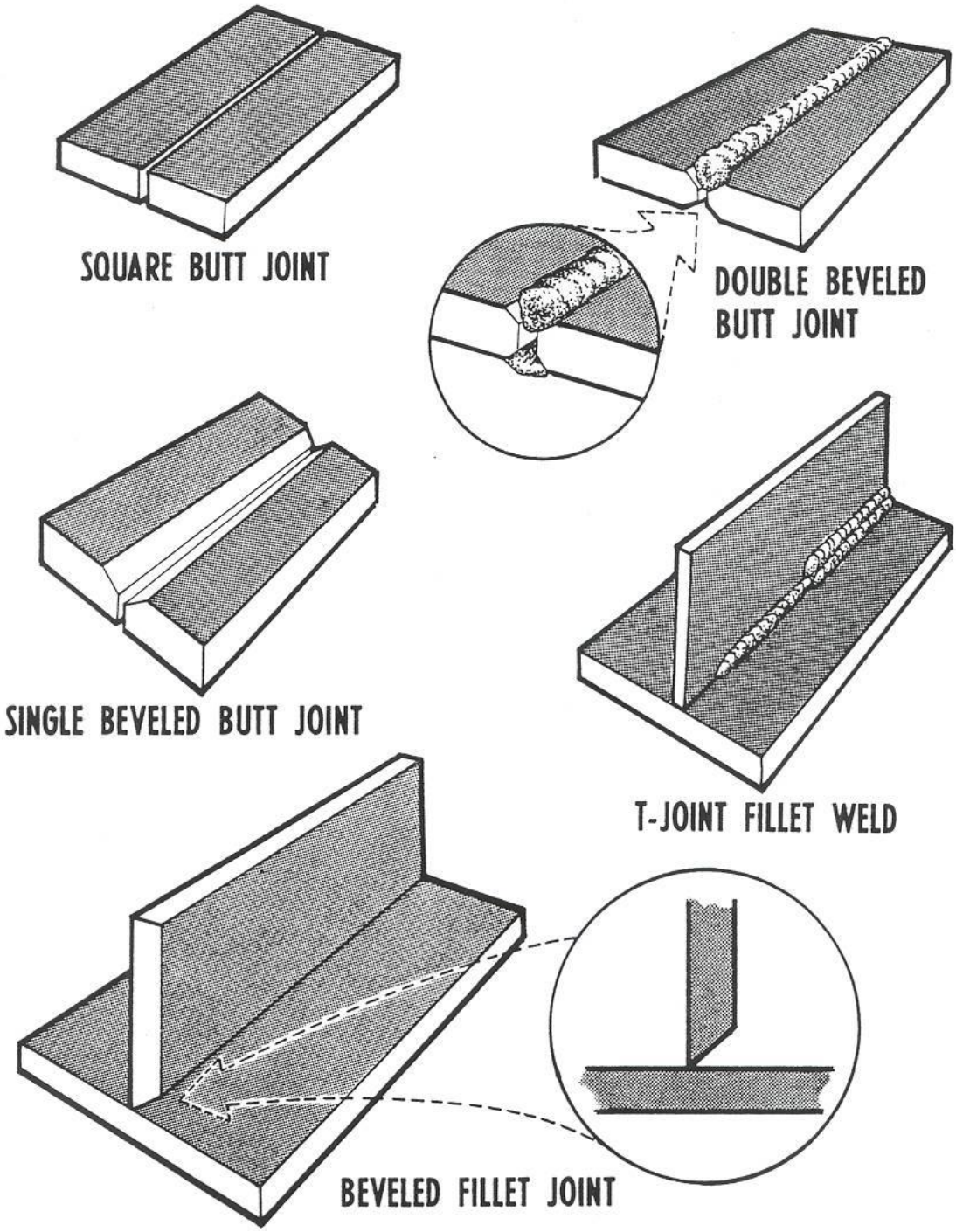
Major parts of a welding electrode.

1. (E) - electrode
2. 60 - give the tensile strength of the electrode metal (60,000 psi).
3. 1 - means the electrode can be used in all welding positions. If the number is a 2, it can only be used for flat and horizontal welding or if the number is a 3, it can be used only in the flat position.
4. 3 - gives the type of flux, polarity, and current (AC or DC) of the electrodes.

There are basically two types of joints used in arc welding, the butt and fillet.

a. The square butt joint is unbeveled if the metal is less than ¼ inch thick, and the pieces are spaced about ½ their thickness apart to permit good penetration.
b. Single beveled and double beveled joints insure penetration and fusion of the metal. The pieces are spaced apart 1/16 to 1/8 inch. Metal that is over ¼ inch is usually beveled.
c. Tee fillet joints are made by placing two pieces of metal together to form a “T”. (See Figure VI.)

FIGURE VI



As you start to learn the welding process, you may be using the stick welder, which requires an electrode. (Study Figure II.)

MECHANICS TECHNOLOGY

AREA: GAS WELDING

OBJECTIVES:

Introduce students to gas welding and cutting equipment safely

COMPETENCIES TO BE DEVELOPED:

1. Identify major parts of oxyacetylene welding equipment
2. Set up and assemble the oxyacetylene equipment
3. Turn on and adjust oxyacetylene controls
4. Light and adjust oxyacetylene torches
5. Make a fusion weld without filler rod
6. Make a fusion weld with a filler rod
7. Cut a piece of metal using a cutting torch
8. Pierce a hole using the cutting torch

REFERENCES:

Agricultural Mechanics Fundamentals and Application by Cooper (Delmar)
Mechanical Technology in Agriculture by Johnson Harper, Lawver, and Buriak (Interstate)
Agriscience Mechanics by Phipps, Miller (Interstate)

STUDY QUESTIONS

1. Define the welding process.
2. Name the gases that are used in oxyacetylene welding.
3. Acetylene may be dangerous because it is:
   a. compressed
   b. flammable
   c. explosive
   d. all of these

4. List ten (10) safety precautions when working with gas welding equipment.
5. Describe the proper method in setting up equipment.
6. Name the three types of flames produced by the welding torch.
7. Which gas is not a fuel used for torches?
   a. acetylene
   b. oxygen
   c. propane
   d. none of these
8. Oxygen hoses and related equipment are color coded:
   a. green
   b. ivory
   c. orange
   d. red

9. Acetylene hoses and related equipment are color coded;
   a. green
   b. ivory
   c. orange
   d. red

10. The acetylene pressure to light a torch should be:
    a. 5 psi
    b. 15 psi
    c. 25 psi
    d. 50 psi

11. What is the best way to check for gas leaks?
12. Give the procedure to turn the torch off.
13. What is meant by "backfire"?
14. What is meant by "flashback"?
15. How should pieces to be welded be prepared?

GAS WELDING

INFORMATION

1. The process of infusion by the use of heat is called welding.
2. Oxyacetylene welding uses heat from burning the gas acetylene and oxygen to create fusion.
3. Acetylene is a colorless gas that burns rapidly and is stored in steel cylinders that does have the potential to explode.
4. When setting up oxyacetylene equipment always follow the instructions of the manufacturer.

The oxygen and acetylene hoses are color coded with the oxygen being a green color and the acetylene hose being red in color. Different size tips require different amounts of pressure (psi) as a rule on small tips the acetylene and the oxygen pressure should be set at 5# (psi).

When you are ready to turn the torch off, the following sets should be made:
1. Close the acetylene valve completely.
2. Close the oxygen valve completely.
3. Close the acetylene regulator valve.
4. Close the oxygen regulator.
5. Open the acetylene valve on the torch to drain the hose.
6. Open the oxygen valve on the torch to drain the hose.
7. Turn off both acetylene and oxygen valves on torch.

Safety is very important when welding with the acetylene welder. Besides the precautions already discussed, you must avoid a flash back. This is a situation where the fire goes up into the blowpipe and into the tank of the acetylene. Also backfire occur when the acetylene goes out with a loud snap.

TABLE II **CUTTING**

Tip Size	Pressure in Pounds Acetylene	Oxygen	Maximum Cutting Range
0-4	3	8-12	Up to 1/8"
1-4	3 1/2	10-15	Up to 1/4"
2-4	4	15-20	1/4" to 1/2"
3-4	5	20-25	1/2" to 3/4"
4-4	6	25-30	3/4" to 1"
5-4	7	30-40	1" to 2"

EXERCISES

EXERCISE A: Assembling Equipment

1. Tie cylinders securely to cart. (See Figure 1.)
2. Open cylinder valve on oxygen slightly to blow out dust then close cylinder valve. (See Figure 1.)
3. Attach oxygen regulator. Open cylinder valve again to blow dust out of regulator. Close cylinder valve. (See Figure 1.)
4. Attach green hose and repeat the process of blowing out dust. Use wrench only.
5. Attach oxygen blowpipe to the hose and repeat the blowing out dust process.
6. Oxygen fittings have right hand threads and acetylene fittings have left hand threads.
7. Care must be taken being sure that the valve on the regulator is closed before opening the valve on the oxygen cylinder; full cylinder pressure could blow the diaphragm on the oxygen regulator.
8. Connect the No. 4 tip to the torch.
9. Test for leaks by applying soapy water at the joints and placing fingers over end of tip when oxygen pressure is applied to joints. Never use grease or oil on fitting, this could cause an explosion.
10. Repeat the same procedure for acetylene as used with oxygen.

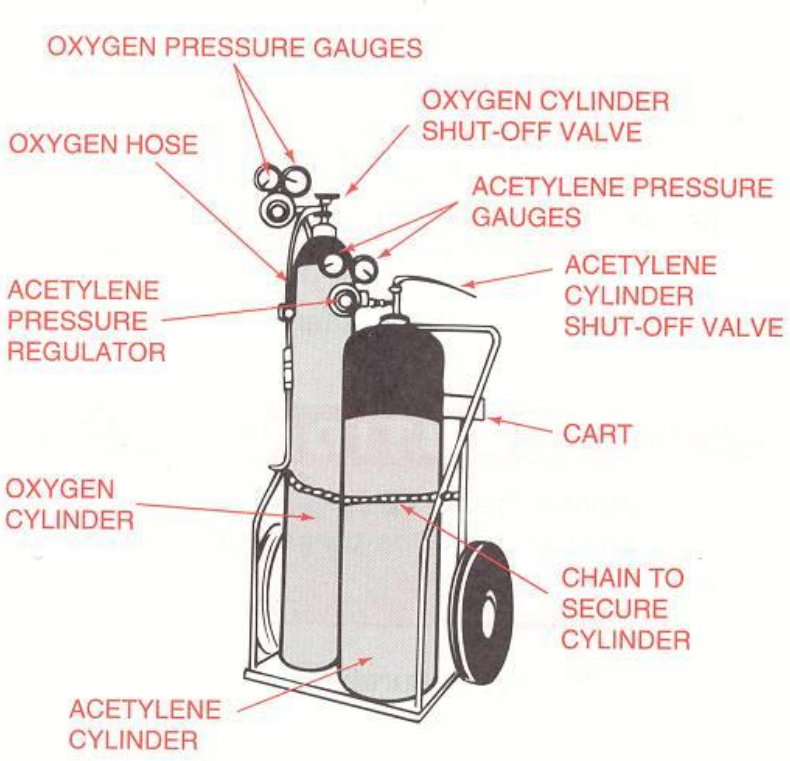
Acetylene Side

- *Acetylene cylinder*
- *Cylinder valve*
- *Red cylinder pressure valve*
- *Regulator*
- *Hose pressure gauge*
- *Red hose*
- *Acetylene valve on torch*

Oxygen Side

- *Oxygen cylinder*
- *Cylinder valve*
- *Green cylinder pressure gauge*
- *Regulator*
- *Hose pressure gauge*
- *Green hose*
- *Oxygen valve on torch*
- *Torch mixing chamber*
- *Torch tip*

FIGURE I



EXERCISE B: Regulate and Find Working Pressure

1. Back out regulator screws for welding 3/8" thick mild steel on oxygen and acetylene until they are free.
2. Open cylinder valves until high pressure gauge of the regulator shows full pressure of each cylinder. Open oxygen valve wide until it stops; open acetylene valve only one-half turn.
3. Set working pressure for acetylene first. This is done by opening torch acetylene valve one-half turn. Screw in regulator adjusting screw until four pounds pressure is obtained. Close acetylene torch valve. The same procedure is used for obtaining the oxygen working pressure.

TABLE 1: APPROXIMATE TIP SIZES AND GAS PRESSURES FOR WELDING

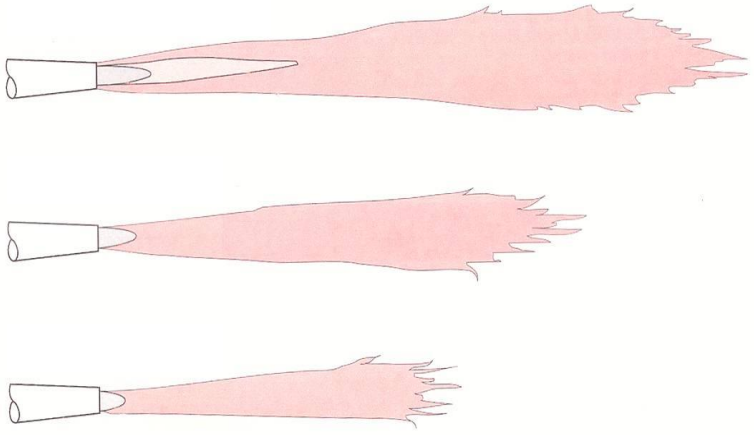
Thickness of Metal (Inches)	Oxygen (lbs. per sq. in.)	Acetylene Pressure (lbs. per sq. in.)	Tip Size (Orifice Drill Size)	Tip Size
1/32	1	1	74	00
1/16	1	1	69	0
1/8	2	2	57	1
1/4	3	3	52	2
3/8	4	4	45	3
1/2	5	5	42	4
5/8	6	6	36	6
3/4	6	6	36	6
1	6	6	36	6

EXERCISE C: Light and Adjust Torch for Welding 3/3" Thick Mild Steel

1. Open acetylene torch valve one half turn and ignite with striker. Make sure flame is pointed in safe direction. Turn it on until flame attempts to leave tip, then adjust until it rests on surface of tip. Add oxygen by adjusting oxygen torch valve until neutral flame is obtained.

2. Types of flames available: (See Figure 2.)
   a. Obstructed tip causes irregular shaped flame.
   b. The oxidizing flame occurs when excess oxygen is used. It gives a sharp-pointed inner cone which is purple in color. This flame is used for brazing.
   c. The neutral flame is most used. It is obtained by turning acetylene until flame stands away from tip. Reduce the acetylene until flame returns to the end of tip. Add oxygen until a smooth inner-blue cone without the featheredge is obtained.
   d. Carbonizing flame or excess acetylene is obtained by reaching a neutral flame and adding acetylene until the inner-cone shows a rough featheredge.

FIGURE 2



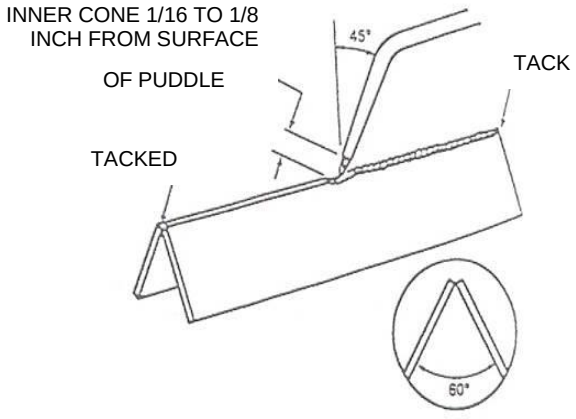
3. Turning off the torch:
   Complete steps (a) and (b) while working and the torch is not in use.
   a. Close acetylene torch valve (always first).
   b. Close oxygen torch valve.
   Complete the following at the end of the period:
   c. Close acetylene and oxygen cylinder valves.
   d. Open acetylene and oxygen torch valves.
   e. Close the oxygen and acetylene regulator valves.
   f. Close the acetylene and oxygen torch valves.
   g. Remove the welding tip and store.
   h. Wind the hose in place.

EXERCISE D: Making a Fusion Weld Without Filler Rod

1. Secure two pieces of 1/8" thick mild steel metal 1/2" wide and 3" long.
2. Place two pieces to form a tent shape. (See Figure 3.)
3. Select proper tip size for welding 1/8" thick metal. (See Table 1.)
4. Light torch as in Exercise C and adjust to a neutral flame. Put on goggles.
5. Hold the torch handle horizontally to the floor. Touch the tip of the blue cone to the V between the two pieces of metal. When the metal starts to melt move the tip on a rotary motion letting the tip of the blue cone touch the V and both edges of metal that forms the V. (See Figure 4.)
6. Once the puddle is formed, keep it moving forward. If the puddle is moved too fast, it will get smaller. If it is moved too slow, it will become larger and burn through. Move it so that the same size is maintained at all times.
7. Be cautious not to make the following errors:
   a. loss of neutral flame
   b. dipping tip end in puddle will cause popping
   c. excess oxygen will cause blowing of puddle and sometimes popping
   d. excess acetylene causes smut and is difficult to form a puddle

FIGURE 3

FIGURE 4

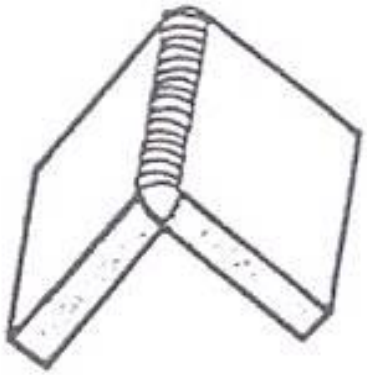


MAKING A CORNER WELD

WITHOUT A FILLER ROD.

8. If a proper weld is made, a regular uniform bead will be present. (See Figure 5.) When broken, penetration of fused metal is down in the parent metal about 1/32" and the depth of penetration is constant from one end of the weld to the other. Presence of porousness is an indication of too much heat. The bead should be centered in the V.

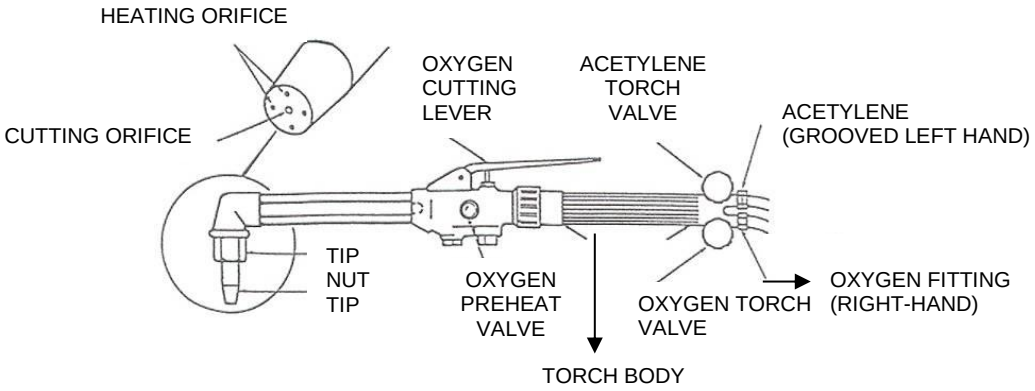
FIGURE 5



EXERCISE E: Cutting With the Cutting Torch

1. Secure a piece of 1/4" thick metal, 3" wide and 6" long. Mark line to be cut with soapstone.
2. Adjust the cutting torch as follows:
   a. See Table 1 for tip size and pressures. Adjust working pressures.
   b. See Figure 6 for name of parts of the cutting porch.
   c. Open acetylene valve 1/8" turn and light.
   d. Open acetylene regulator valve (on tank) slowly until a gap of 1/4" is made between base of flame and surface of tip. This is the correct pressure for the tip.
   e. Close the valve slowly until base of flame is seated on surface of tip.
   f. Open the oxygen torch valve wide open. (It is not used to adjust the cutting flame.)
   g. Open the preheat oxygen valve to produce a neutral flame.
   h. Press the cutting oxygen lever. (If the neutral flame changes to a carbonizing flame, keep the cutting oxygen lever on and adjust the preheat oxygen valve to produce a neutral flame.)

FIGURE 6



3. Use your left hand for a pivot to rest the torch to obtain steadiness. (Use gloves and goggles.)
4. Hold the flame 45 degrees to the direction of travel and let the tip of the blue one touch the metal.
5. When the metal begins to melt, press the cutting oxygen lever and proceed with steady speed.
6. If kerf fills up with molten metal, speed is too slow or a larger tip is needed or correct adjustment is needed.
7. If end of tip touches molten metal popping may occur and the tip may be plugged. A loosely fitted cutting tip will produce popping.
8. Keep check on gas openings and clean with tip cleaners if necessary. Make sure no bits of metal are inside the cutting tip. Remove from torch to check.
9. Turn the torch off as follows:
    a. Close acetylene torch valve.
    b. Close oxygen preheat valve.
    c. If cutting torch is to be removed from the mixing torch, close mixing torch acetylene valve.
    d. Close all other valves as in Agriculture I.
10. A good cutting job is without slag and it is clean and smooth.

EXERCISE F: Piercing a Hole

1. In one piece of the cut metal in Exercise E, pierce a hole 1/2" in diameter. Mark with soap stone.
2. Adjust flame as in Exercise E.
3. Hold flame so that the tip of blue cone touches center of hole to be pierced. Use left hand as pivot.
4. When metal begins to melt, press oxygen lever.
5. When the hole is pierced through, rotate the tip in a circular motion to obtain the 1/2" diameter.

MECHANICS TECHNOLOGY

AREA: TOOL MAINTENANCE

COMPETENCIES TO BE DEVELOPED:

1. Introduce student to the importance of maintaining shop tools and the relationship to the safety of using tools
2. Protecting tools from rust
3. Repair and replace wooden handles in tools
4. Fit or reshape screwdriver tips
5. Sharpen cold chisels
6. Sharpen twist drills
7. Sharpen lawn mower blades
8. Service bearings
9. Service belts

Time: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *Agricultural Mechanics Fundamentals and Applications, 3rd Edition* by Elmer Cooper (Delmar)
2. *Agriscience Mechanics* by Phipps, Miller (Interstate)

STUDY QUESTIONS

1. A solvent recommended to remove grease and light rust from tools is:
   a. water
   b. turpentine
   c. varsol
   d. gasoline

2. Rust occurs when steel is exposed to:
   a. moisture and air
   b. grease and air
   c. dirt and air
   e. gasoline and air

3. Wooden handles of tools should be treated with:
   a. paint
   b. shellac
   c. linseed oil
   d. all of these

4. Most wooden handles are secured in the heads of tools by:
   a. nails
   b. glue
   c. wedges
   d. paint

TOOL MAINTENANCE (Cont.)

5. Describe a tool that is mushroomed.

6. Define the crown of a cold chisel.

7. The following tools are equipped with a Ferrule and a Tang:
   a. rakes
   b. hoes
   c. forks
   d. all of the above

8. The reason for learning tool sharpening skills is that:
   a. better work is possible with sharp tools
   b. sharp tools are easier to use
   c. sharp tools are safer
   d. all of the above

9. Plain iron and wood chisels are sharpened:
   a. one side only to a 29° concave edge
   b. one side only to a 59° concave edge
   c. two sides to a 29° concave edge
   d. one side only to a 29° straight edge

10. Center punches are sharpened at:
    a. 60-75 degrees
    b. 29-59 degrees
    c. 79-89 degrees
    d. all of the above

11. Define convexed edge.

12. Define concaved edge.

13. Define hollow grounds.

14. Define gear.

15. Direct drives include:
    a. flexible hose
    b. flange
    c. flexible shaft
    d. all of the above

16. Horsepower is the force needed to lift:
    a. 33,000 pounds one foot in one minute
    b. 550 pounds in one second
    c. all of the above

17. Define pulley.

18. Define sprocket.

TOOL MAINTENANCE (cont.)

19. To increase the speed of a machine powered with an electrical motor the following must be done:
    a. increase the size of a motor pulley
    b. decrease the size of the machine pulley
    c. all of the above

20. The following are shapes of belts:
    a. V-belt
    b. multi-belt
    c. flat belt
    d. all of the above

21. The following part keeps a shaft of an electrical motor centered in the motor frame:
    a. ball bearing
    b. needle bearing
    c. bushing
    d. all of the above

22. Why are most motors equipped with slotted holes in their bases?

23. Name three (3) types of U-pulleys.

24. Most ball bearings must be lubricated with a small amount of oil at regular intervals.
    a. true
    b. false

TOOL MAINTENANCE

INFORMATION SHEET

Rust: occurs when steel is exposed to moisture and air. Air and moisture must be eliminated from steel to prevent rust. Applying a lubricating oil or paste wax protects unpainted steel edges and surfaces.

Ferrule and Tang: Hoes, rakes, and forks are driven into their handles. The handles are fitted with metal collars to prevent splitting of the handle. The metal collar is called a ferrule and the metal finger of the tool is called a tang.

Transmissions: is the case that holds gears, which is a wheel with teeth that mesh with teeth on another wheel to transfer power and speed.

Belts: permit motors to run at one speed and the machine to run at another speed. Belts are flexible and therefore are used on a number of motor drive systems. Belts come in different shapes such as V-belt, multi-belt and flat belt.

Bearings: The three kinds of bearings are 1) ball bearing 2) needle bearing and 3) bushing. Most ball bearings or needle bearings are sealed bearings (permanently lubricated), but bushings will require a small amount of oil from time to time.

Reasons for keeping tools sharp:

a. higher quality work
b. faster work
c. safety
d. length life of tool

Steps for adjusting grinder:

a. adjust light
b. adjust guard as near to the wheel as possible
c. adjust tool rest to within 1/8th of the grinding wheel

Safety practices while sharpening tools:

a. protect eyes with safety glasses
b. adjust guard and tool rest properly
c. check wheels for cracks
d. dress wheel frequently
e. apply tool slowly to grinding wheel
f. avoid using the flat side of the wheel for grinding
g. use proper size wheel
h. stand in safe location
i. shut off unattended machine
j. use proper size grit
k. rim speed should not exceed 420 rpm

EXERCISES

EXERCISE A: Adjust and Dress a Grinder

1) Secure a bench grinder, wheel dresser, goggles and try square.
2) Use safety goggles.
3) Adjust the tool rest 1/8" from the wheel.
4) Adjust the glass shield so as to be in line between the emery wheel and the eyes.
5) Adjust the light in a position to give light directly on the tool being sharpened without casting shadow on the work.
6) Place the wheel dresser firmly against the wheel while the grinder is on and move the dresser from side to side across the tool rest.
7) Continue this operation until the wheel is square.
8) Check the wheel to see if it is round by placing a piece of scrap metal on the tool rest and against the wheel to see if the wheel and scrap metal make smooth and continuous contact. (See Figure I.)
9) Reset the tool rest if necessary.
10) Always check grinding wheel for cracks.

FIGURE 1

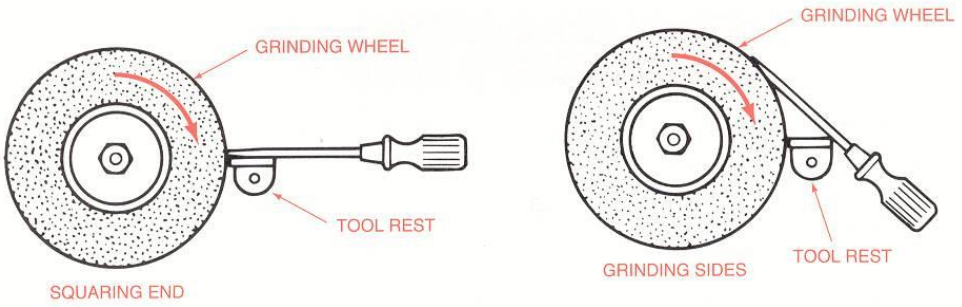
EXERCISE B: Sharpening and Balancing Rotary Mower Blade

1) Secure a used rotary mower blade from instructor.
2) Use a good clear set of safety goggles.
3) Use a good pair of leather gloves.
4) Inspect blade for nicks.
5) Using the bench grinder, remove all nicks from blade. Avoid overheating the blade.
6) Grind the blade at one end to a 45° angle.
7) Grind the other end of the blade to a 45° angle.
8) Check the balance of the blade with a blade balance. The heavier end will drop when placed on the blade balance.
9) Grind the heavy end again. Repeat until blade is balanced.

EXERCISE C: Fit a Common Screwdriver

1) Secure a screwdriver that needs reshaping.
2) Set tool rest 1/8" from wheel.
3) Grind point of screwdriver square.
4) Grind the two sides of the flat surfaces until they are straight and parallel near the tip. Leave blade thick enough to fit screw slot snuggly. (See Figure III.)

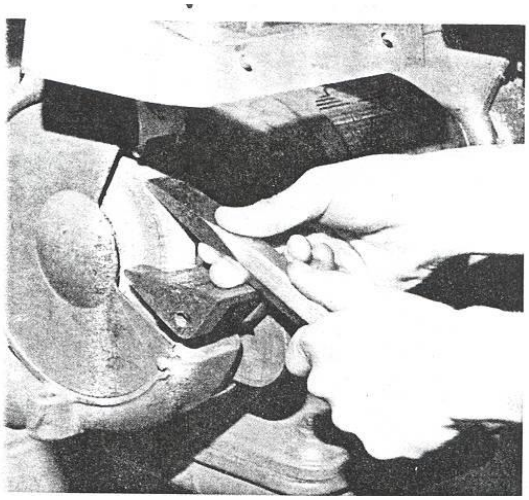
FIGURE III



EXERCISE D: Fit a Cold Chisel

1) Obtain a cold chisel in need of repair.
2) Set tool rest to give correct cutting angle (60°). (See Figure IV.)

FIGURE IV

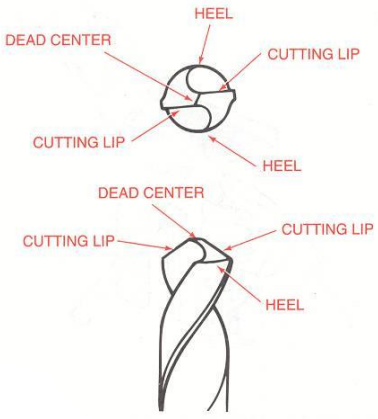


3) Press the chisel firmly against grinder wheel and move from side to side on tool rest until a single bevel forms a cutting edge. Repeat on other side of cutting edge.
4) Dip in water to keep cool.
5) Check correct angle gauge. (See Figure VII.)
6) Hand in completed cold chisel to instructor for credit.

EXERCISE E: Twist Drill Bit

To sharpen a twist drill bit requires knowledge of its design. The cutting tip of a drill consists of a dead center and two cutting lips. Before starting project, it would be helpful to compare bit to be sharpened with a new drill bit. (See Figure V.)

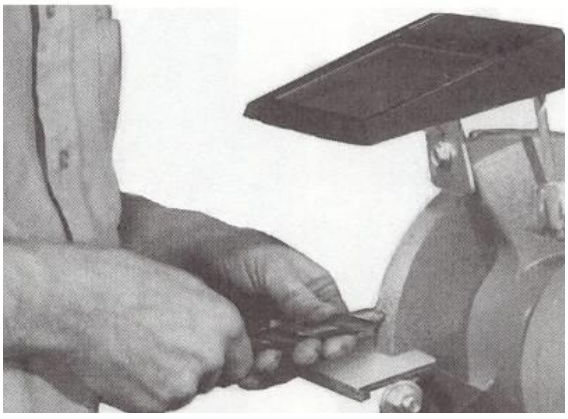
FIGURE V



The cutting tip of a twist drill.

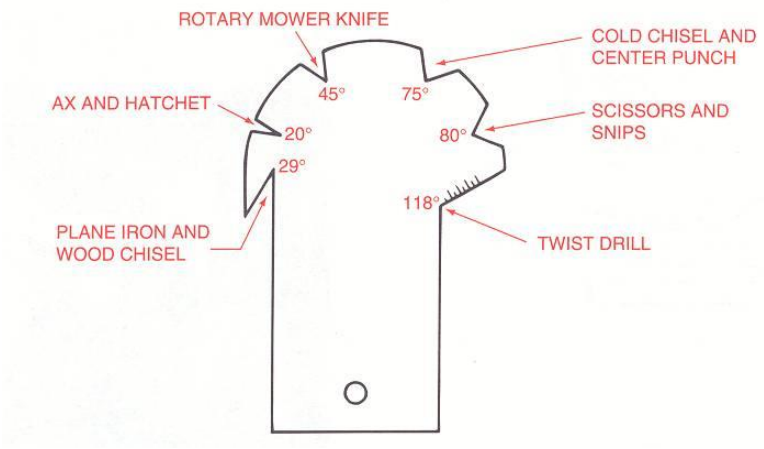
1) Obtain a twist bit that needs sharpening.
2) Set tool rest level and near the center of the grinding wheel.
3) Place bit on tool rest and press firmly against wheel. Hold the drill between your thumb and index finger with approximately 1“ of bit exposed. Place the back of your index finger on the tool rest with your thumbnail up and hold bit at 59°angle to the wheel surface and level with floor. (See Figure VI.)

FIGURE VI



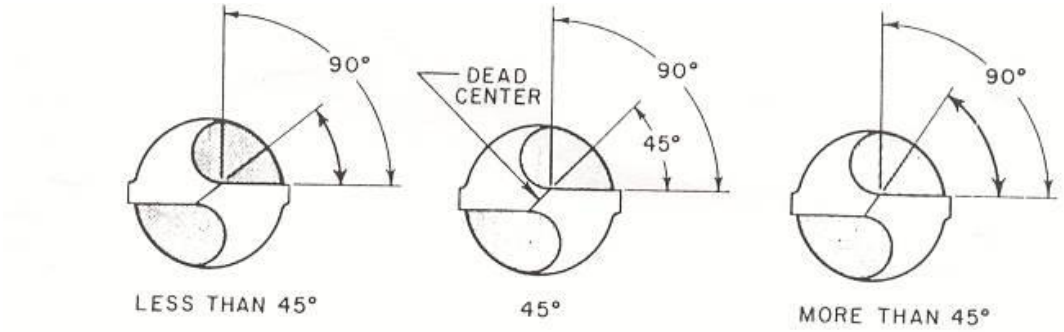
4) While giving a clockwise twist, grind one side to 59°. Rotate bit and grind other side exactly the same. To prevent overheating, frequently dip bit in cool water. After grinding, use tool-sharpening gauge to check the angle of lips, position of dead center, and clearance of resharpened drill bit. (See Figure VII and VIII.)

FIGURE VII



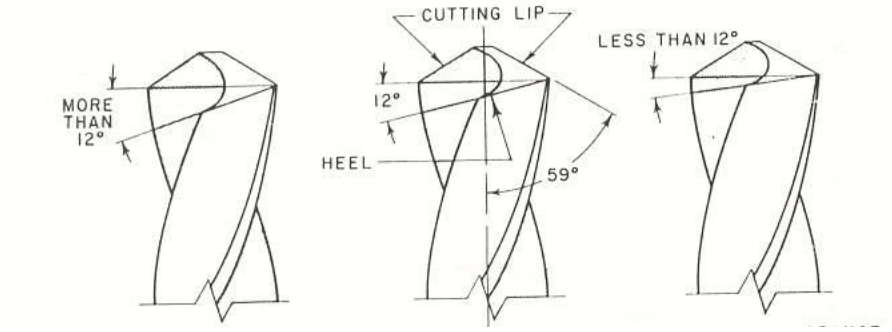
5) Place the cutting edge 59° to the wheel and 12° from wheel. Let heel touch. Use first finger as pivot; press heel and grind until cutting edge is touching wheel. (See Figure VIII.)

FIGURE VIII



Examples of correct and incorrect angles for sharpening twist drill. (See Figure IX.)

FIGURE IX



TOO MUCH CLEARANCE CORRECT CLEARANCE NOT ENOUGH CLEARANCE

6) Turn in to instructor for grade.

EXERCISE F: Fit a Hammer Handle

1) Use safety goggles.
2) Select a handle that is correct for the hammer.
3) Place the hammerhead in a metal vise.
4) Cut off the handle close to the hammerhead with a hacksaw.
5) Drill out the remaining handle with the largest metal twist drill that will go through the hammerhead eye.
6) Drive any remaining wood out with a punch and hammer.
7) Recondition the head if it is damaged or needs polishing.
8) Place the new handle in a vise and fit it by rasping.
9) Cut a slot in the handle with a ripsaw in the longest diameter of the top of the handle. If manufacturer cuts slit, skip this step.
10) Place the handle in the hammerhead, holding the handle in one hand and drive it into the head with a wooden or leather mallet. Always tap on the end of the handle with the head suspended.

MECHANICS TECHNOLOGY

AREA: POWER TOOLS

OBJECTIVES:
Introduce students to safe use of power tools

COMPETENCIES TO BE DEVELOPED:
1. Identify the different classes of power tools and give examples of each class.
2. Become acquainted with safety rules and precautions working with power tools. Learn how to safely use the following power tools: power grinder, circular power saw, drill, table saw, and band saw.
3. Identify parts of the following power tools: drill press, portable belt sander, portable grinder, portable circular saw, and table saw.

REFERENCES:
Agriscience Mechanics, by Lloyd J. Phillips and Glen M. Miller (Interstate)
Agriculture Mechanics Fundamentals and Applications, 3rd Edition by Elmer L. Cooper (Delmar)

STUDY QUESTIONS

1. Name four classes of power tools.
2. What determines the classification of power tools?
3. While using power tools, electrical shock hazards may be reduced by wearing:
   a. rubber-soled shoes
   b. coveralls
   c. gloves
   d. safety glasses
4. A router bit rotates at:
   a. 100 rpm
   b. 1000 rpm
   c. 20,000 rpm
   d. 200,000 rpm
5. A variable speed tool is one that will run:
   a. a long time without damage
   b. backwards as well as forward
   c. in hot locations
   d. at different speeds
6. When drilling metal with a power drill:
   a. use a center punch
   b. make a pilot hole
   c. use a cordless drill if appropriate
   d. all of these
7. What are the major safety considerations with power tools?
8. Describe the proper adjustments of the tool rest on a bench grinder.
9. What is a drill chuck?
10. When should you use a push stick on a table saw?
11. What is a GFCI?
12. What is the difference between a saber saw and a reciprocating saw?
13. Why should the location of a hole be marked with a center punch?
14. The portable power tool that has a retractable guard is the _____.
15. A tool used properly, but in poor condition, is _____.
16. Name eight (8) power tools.

INFORMATION

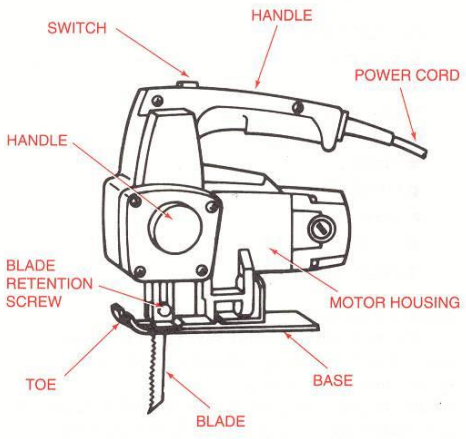
Safety is the utmost important factor when using a power tool. The operation manual that comes with each power tool will list the safety factors that apply to that tool. It will list such things as proper grounding to prevent electrical shock and the wearing of proper protection.

Examples are: safety glasses for eye protection, proper dress, proper service, and maintenance of the tool. Always disconnect power before making tool adjustments. Always use push sticks when required. Keep the shop area free of obstacles. Keep the area well ventilated. Slick floors around power tools must be avoided. Do not participate in horseplay while working with power tools.

All power tools will be of the following classes: Electric, Engine, Pneumatic and Hydraulic. The latest edition to the power tool list is the computer, which requires electricity to run. A number of larger power tools have built in micro-processors.

PORTABLE HAND JIGSAW

Jigsaws have extremely fine blades that make them great tools for doing delicate and intricate work, such as cutting out patterns or irregular shapes from wood or from thin soft metals. They are also one of the best tools for cutting circles.

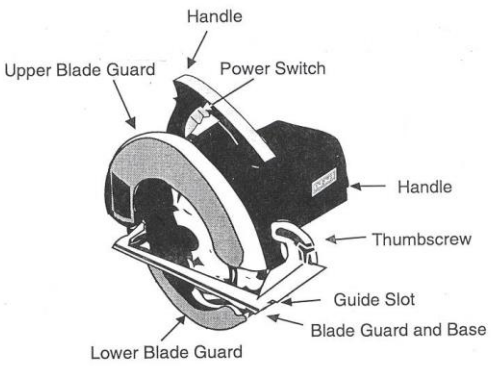


Description

Most jigsaws are capable of being operated at various blade speeds. Harder materials are best sawed at slower speeds. Though the tool is often thought of for use only in craft applications, the jigsaw can also work with fairly heavy blades and average maximum depth of cut turns to about 2". Thus, you can work with some fairly heavy work. With the correct blade and speed, the jigsaw can be used to cut hard and soft metals and other non-wood materials such as leather, plastics, laminate, and paper. The blade of this saw moves up and down.

CIRCULAR SAW

Many years ago a manufacturing company named "Skil" made power tool history by introducing the portable circular saw. Today there are dozens of models available made by different manufacturers, yet it is not unusual to hear a portable circular saw referred to as a "Skil-saw". Other names you might hear are "cutoff saw," "utility saw," and "builder's saw."

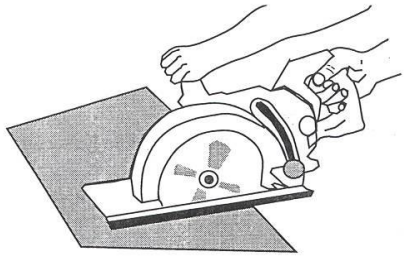


Description

Saw size is indicated by the diameter of the circular blade. Saw blade diameters are from 4-41/2" to 12", with the 7" to 8" size being the most popular. Blade speed is stated in rpm's when the blade is running free.

How to Use a Circular Saw

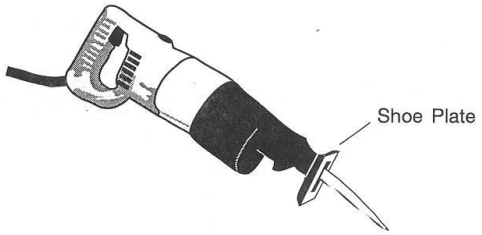
Step 1. Wear appropriate personal protective equipment.
Step 2. Properly secure the material to be cut. If the work isn't heavy enough to sit on its own without moving about, weight or clamp it down.
Step 3. Make your cut mark with a pencil or other marking tool.
Step 4. Place the front edge of the base plate on the work so the guide notch is in line with the cut mark.
Step 5. Grip the saw with two hands, as shown below.



Step 6. Start the saw. After the blade has revved up to full speed, move the tool forward to start the actual cutting. Note that the saw **kerf** has width, so the actual cut must be made on the waster side of the material.
Step 7. As you approach the end of the cut, the guide notch area of the base plate will be off the work. Use the blade as your guide.

RECRIPROCATING SAW

There is many times where a saber saw can be efficiently controlled with one hand. It will be a rare exception when you might be able to control a reciprocating saw with one hand. Usually, you will need to use both hands gripping it firmly.



Description

Like the saber saw, reciprocating saws come with various speed options including single speed, two speed and variable speed.

The reciprocating saw is capable of cutting at low and high speeds. The low-speed setting is best for metal work and the higher speed for sawing wood and other relatively soft materials.

The shoe or footplate may have a swiveling action or it may be fixed. Whatever the design, it is there to provide a brace-point for the sawing operation.

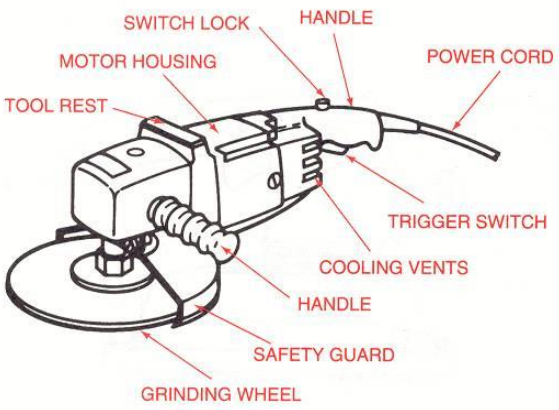
How to Use a Reciprocating Saw

Step 1. Wear appropriate personal protective equipment.
Step 2. If possible, to avoid vibration, clamp the work to a sturdy pair of saw horses or a vise.
Step 3. Set the saw to the desired speed range. (Speed selection made at the trigger on-off switch.)
Remember:
- Lower speeds for metal work
- Higher speeds for sawing wood and other relatively soft materials

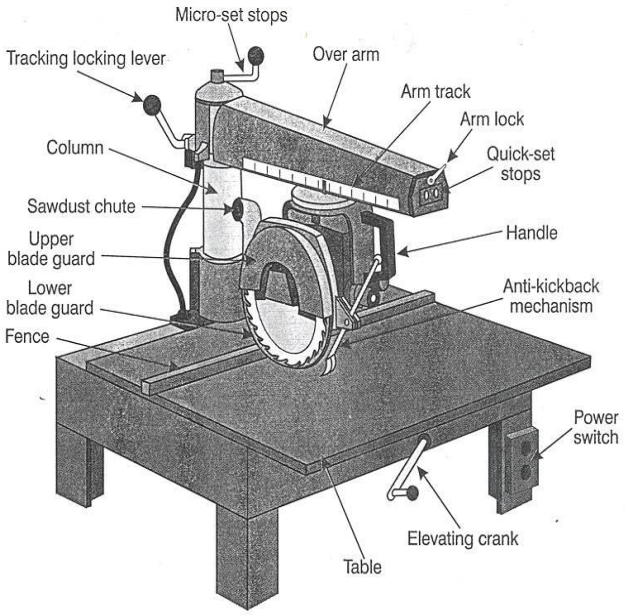
Step 4. Grip the saw with both hands. Place the foot plate firmly against the work piece.

GRINDERS

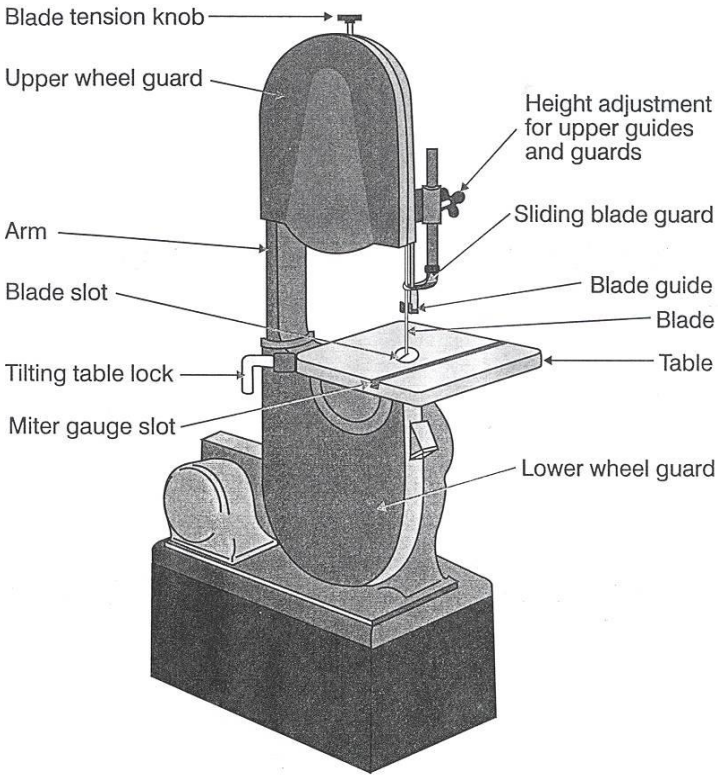
The angle grinder, also referred to as a side grinder, is used to grind away hard, heavy materials and for surface grinding such as pipe, plates, or welds.



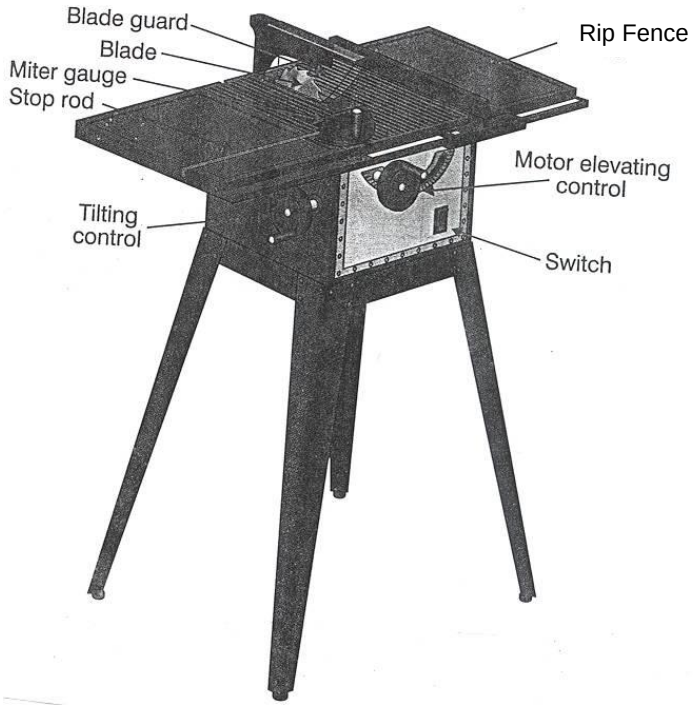
POWER SAWS



Major parts of a radial arm saw



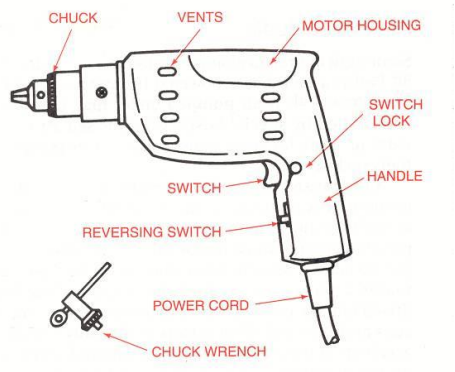
Major parts of a band saw



Major parts of a table circular saw

POWER DRILLS

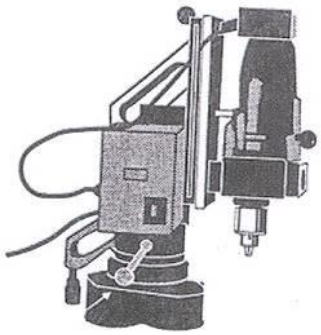
Most power drills have a pistol grip with a trigger switch for controlling power. The harder you pull on the trigger, the faster the speed.



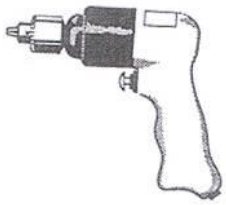
TYPES OF DRILLS

Cordless Drill

Electro-magnetic Drill

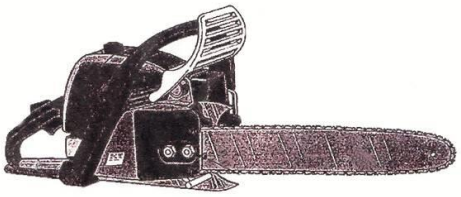


Hammer Drill

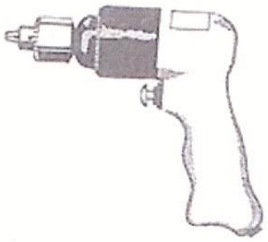


Pneumatic Drill

Examp



Chain Saw



Pneumatic Drill

EXERCISES

ALWAYS WEAR SAFETY GLASSES WHEN USING POWER TOOLS!

EXERCISE A: Rip a Board

1. Secure a piece of plywood 24" x 24".
2. Unplug the saw from power source.
3. Using a square, check the board and make sure one edge is straight.
4. Set the saw blade height so that it protrudes through the board no more than 1/4". Blade should be at a 90° angle with board.
5. Set the rip fence 5" from the saw blade and tighten the rip fence. Using a square check the rip fence for squareness.

*****Caution:** When ripping a board less than 3 inches wide or hands are close to blade, **always** use a push stick.

6. Place the straight edge of the board against the fence and feed the board through the saw.
7. Turn the saw off after ripping board.
8. Turn project in to instructor for credit.

EXERCISE B: Table Saw, Square a Board

1. Secure from the instructor a piece of lumber 1" x 6" x 24" long.
2. Unplug the saw from the power source.
3. Adjust the miter gauge until it is square (90°).
4. Using a square, draw a line across the board to be sawed, 1/2" from the end of the board.
5. Place board against the miter gauge with the squared line in line with the saw blade.
6. Adjust saw blade to be sure that it extends no more than 1/4" above the board to be sawed.
7. Put on safety glasses or eye protection.
8. Turn the machine on and feed the board into the saw. Be sure to saw on the waste side of the line.
9. Turn project in to instructor for credit.

EXERCISE C: Circular Power Saw, Square a Board

1. Secure a scrap piece of board measuring at least 1" x 4" x 12”.
2. Using a square, draw a line 3” from edge of board.
3. Place the saw blade on the edge of the board and use the guide on the saw to follow the line drawn on the board.
4. Turn in 3” piece of board in to instructor for credit.

MECHANICS TECHNOLOGY

AREA: SURVEYING

COMPETENCIES TO BE DEVELOPED:

1. Pacing
2. Use of odometer
3. Horizontal measurement
4. Set up a level and take a reading
5. Run a differential level
6. Identify surveying equipment

TIME: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *Forests and Forestry, 5th Edition,* by I.I. Hollarn, G.L. Rolfe (Delmar)
2. *Surveying: Theory and Practice, 6th Edition,* by R.E. Davis (McGraw-Hill Book Co.)

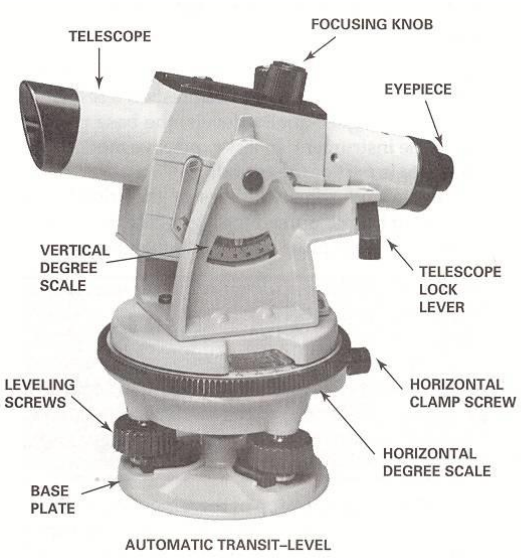
STUDY QUESTIONS

1. What is a chain?
2. What is an engineer's tape?
3. What are the two (2) basic units of linear land measurements?
4. One acre has _____square feet.
5. One acre has _____square chains.
6. Define pacing.
7. A pace has _____number of steps.
8. Define plane surveying.
9. What is an odometer?
10. What is slope chaining?
11. A compass is most accurate when mounted on a tripod, staff, or held by hand?
12. How is a right angle made using the 3-4-5 method?
13. How is the tripod level set up?
14. What is a bench mark?
15. What is back sight?
16. What is foresight?
17. What is a turning point?
18. How is the elevation figured?
19. Define plane surveying and geodetic surveying?
20. What is GPS or Global Positioning System?
21. What is GIS or Geographic Information System?
22. A plot of ground that is 10 chains wide by 10 chains long = _____acres.
23. How long is a chain?
24. What is the formula for figuring the area of a rectangle?
25. What is the formula for figuring the area of a triangle?
26. How many hundredths are in a foot?
27. How many tenths are in a foot?
28. What is meant by slope?
29. What is the Philadelphia or telescoping rod?

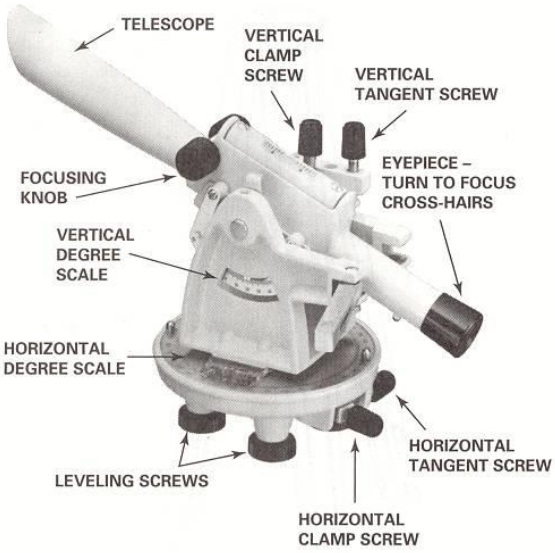
SURVEYING

INFORMATION SHEET

1. Examples of Levels
    a. Transit level – Consists of a mounted telescope which is capable of moving up and down in a 45-degree direction. Used for measuring vertical angles, setting points in a line, plumbing post, columns, walls and similar objects.
    b. Automatic transit level - Similar to the transit level except it has an internal compensator. This compensator uses gravity to maintain a true level of sight.
    c. Laser level – Energy is released in a narrow beam of light usually 3/8 inch in diameter. Beam can be detected at long distances by sensor attached to leveling rod. Allows one person to complete operation.

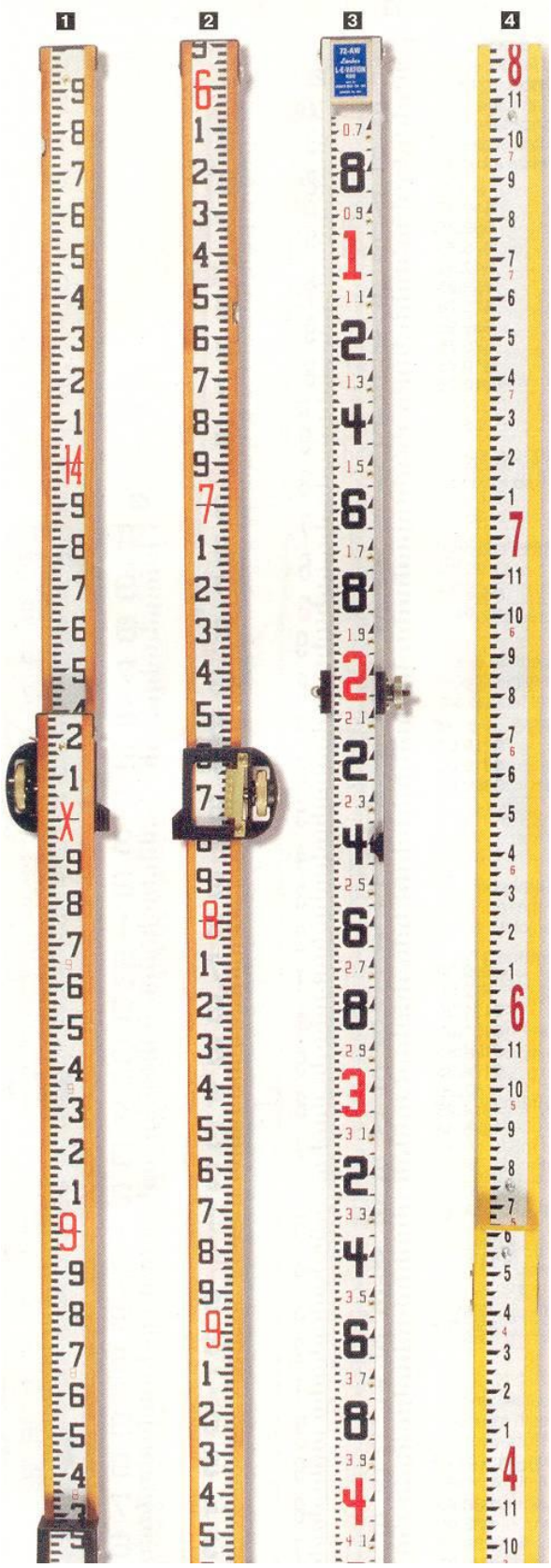


A. Automatic Transit Level



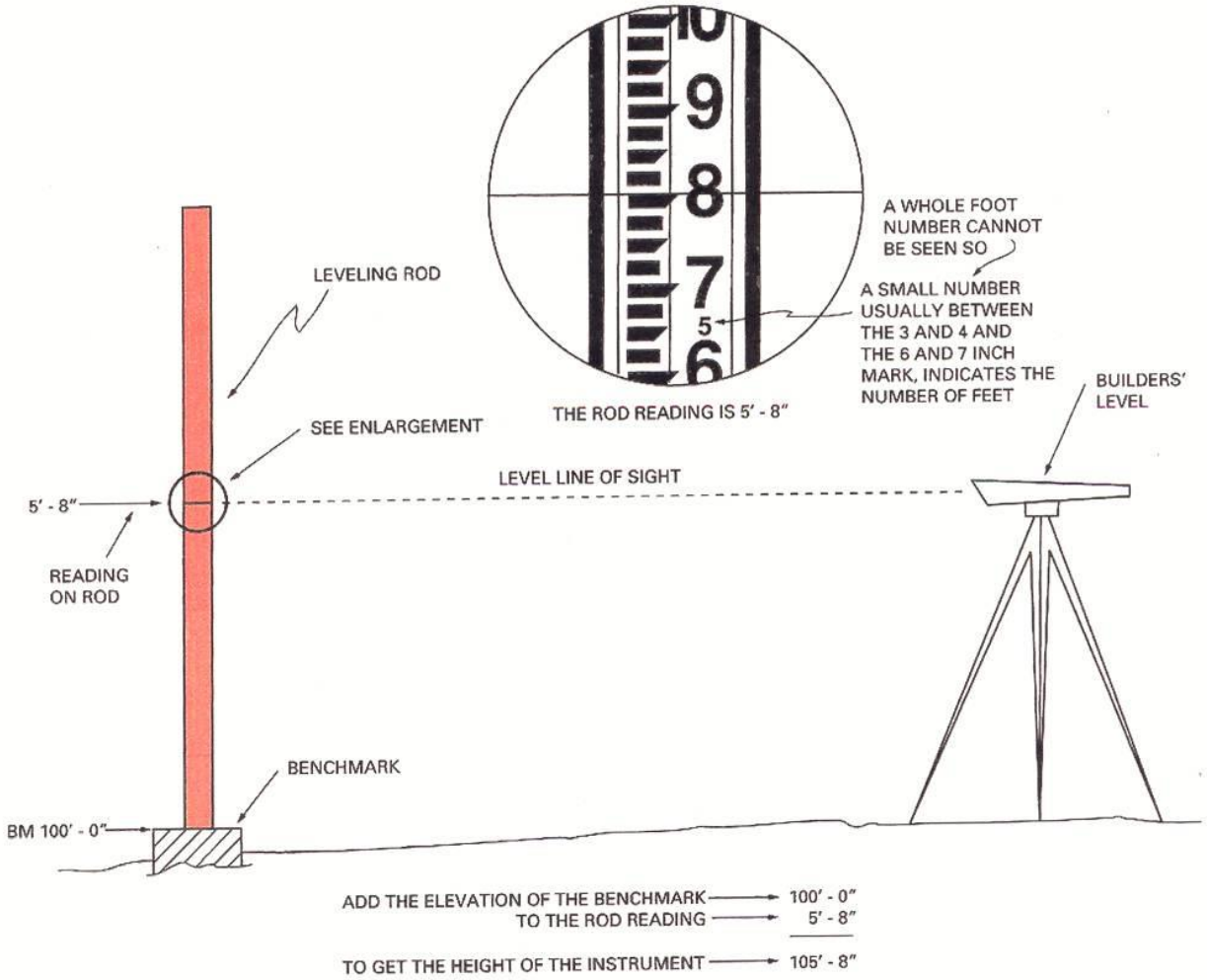
B. Transit Level

Examples of Telescoping Leveling Rods:



1. **Frisco Rod**
2. **Philadelphia Rod**
3. **Direct Reading L-E-Vation Rod**
4. **Leveling Rod for Builders and Engineers**

Reading A Telescoping Leveling Rod



SURVEYING

INFORMATION SHEET

1. ACRE: A unit of land measurement equal to 43,560 sq. ft. or 208.71 ft. square.

   ←208.71 ft.→

   43,560 sq. ft. ↑ 208.71 ft. ↓

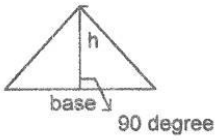
2. PACING: To step off a distance by walking and counting the number of steps. One pace equals 2 1/2 - 3 ft.

3. FORMULA FOR FIGURING THE AREA OF A RECTANGLE:

   Area (sq. ft.) = width (ft.) X
   Area = _____sq. ft.

4. FORMULA FOR FIGURING THE AREA OF A TRIANGLE:
   Area (sq. ft) = 1/2 B X H (height)
   Area = _____sq. ft.

5. FORMULA FOR CONVERTING SQUARE FEET TO ACRES:

   Acres = _____(sq. ft..) divided by 43,560 (sq. ft./acre)

6. CHAIN: A unit of land measurement equal to 66 ft. in length.

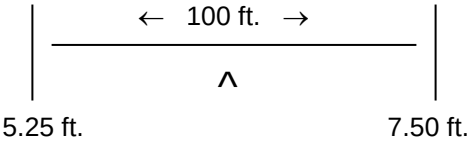
7. LEVELS: (Lasers or sight through types) Instruments used to get a horizontal plane.

8. TELESCOPING LEVELING ROD (Often referred to as a Philadelphia Rod): A measuring rod usual made of aluminum, fiberglass or wood, graduated in feet, tenths and hundredths of feet, inches and eighths of an inch or feet, inches and eighths of an inch.

9. 1 FOOT: 100 hundredths

10. 1 FOOT: 10 tenths

11. SLOPE: The difference in elevation between two points at a distance of 100 feet. The difference in feet is the percent slope.



Example: 7.50 - 5.25 ft. Difference in elevation = 2.25% slope

12. BENCHMARK: A point of predetermined elevation.

13. BACKSITE: A rod reading taken from a known elevation point.

14. FRONTSITE: A rod reading taken from an unknown elevation point.

15. LINEAR LAND MEASUREMENT: Done with chains (66') or in feet.

16. ENGINEER'S TAPE: Measured in feet, tenths and hundredths.

EXERCISES

EXERCISE A: Pacing to Determine an Approximate Distance

1. Consumable supplies needed:
    a. notepad
    b. pencil

2. Procedure
    a. Drive two wooden stakes exactly 100 feet apart. Use the tape to measure distance.
    b. Pace the distance between the two stakes using a normal consistent stride.
    c. Record the number of paces between the two stakes.
    d. Repeat steps b and c two more times. You will have three recordings on your paces per 100 feet.
    e. Average the three pacings by adding them and dividing by three.

    $$\frac{\text{Pacing \# 1 + Pacing \#2 + Pacing \#3}}{3} = \text{Your average pacing per 100 feet.}$$

    Pace a distance provided by your instructor and compute the distance using the following formula:

    $$\frac{\text{Your average pace}}{100'} = \frac{\text{Number of paces}}{\text{X (distance sought)}}$$

    $$\text{X (your average pace)} = 100 \text{ (number of paces)}$$

    $$\text{X} = \frac{100 \text{ (number of paces)}}{\text{Your average pace}}$$

    $$\text{X} = \text{Unknown distance}$$

3. Solution

    If your average pace is 2.85 feet long and it took you 34 paces to cover the unknown distance then the solution to the problem is:

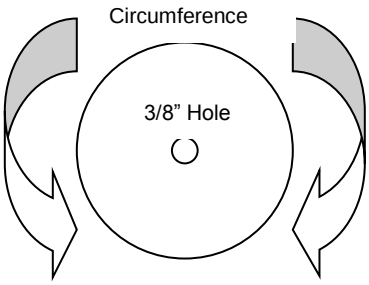
    $$\frac{2.85}{1.0} = \frac{34}{X}$$

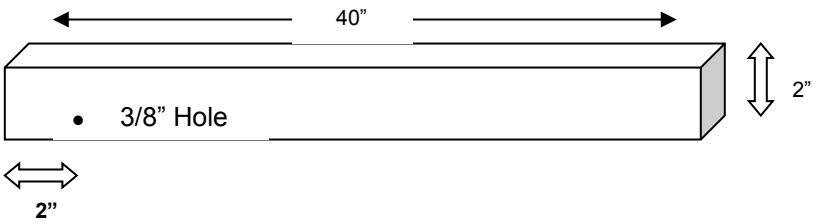
    $$X = \frac{100 \times 34}{2.85} = \frac{3400}{2.85} = 1193 \text{ ft.}$$

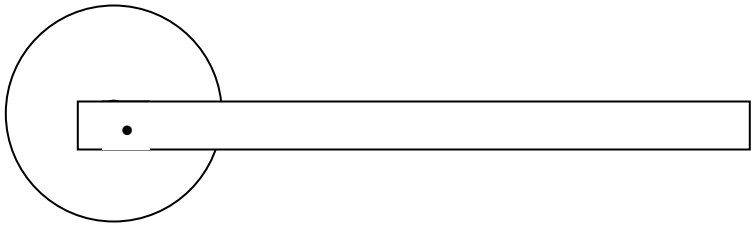
Turn this solution in to instructor for credit.

EXERCISE B: Build an Odometer

1. Secure a lid from a five-gallon bucket.
2. Secure a 2" x 2" x 40" of pine lumber.
3. Secure a 3/8 x 3" bolt.
4. Drill a 3/8" hole in the center of the lid.
5. Drill a 3/8" hole 2" from one end of the 2" x 2" board.
6. Fasten the board to the lid by inserting the bolt through the holes and put a tap to hold them together.
7. Measure the circumference of the lid. (See Figure I.)





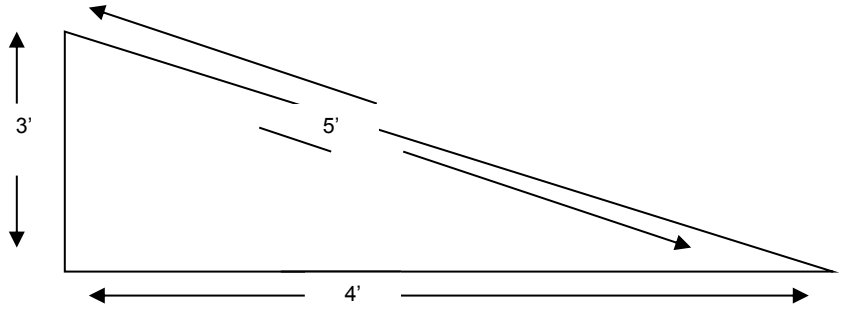


EXERCISE C:

1. Using the distance that was used in Exercise A and the odometer that you built in Exercise B, determine the length of the same course.

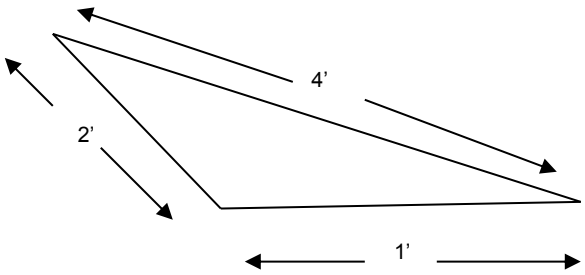
EXERCISE D:

1. Lay out a right angle using the 3-4-5 method. (See Figure II.)



EXERCISE E:

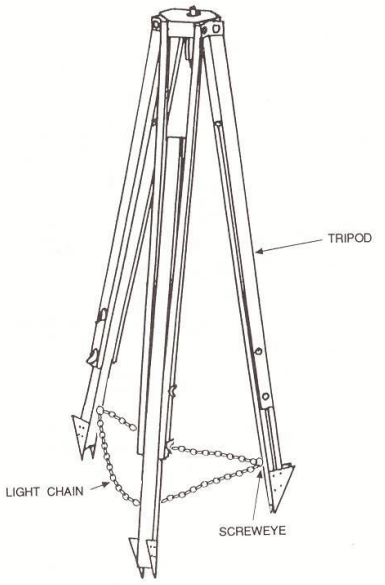
1. Lay out a 45° angle using the 2-1-4 method. (See Figure III.)



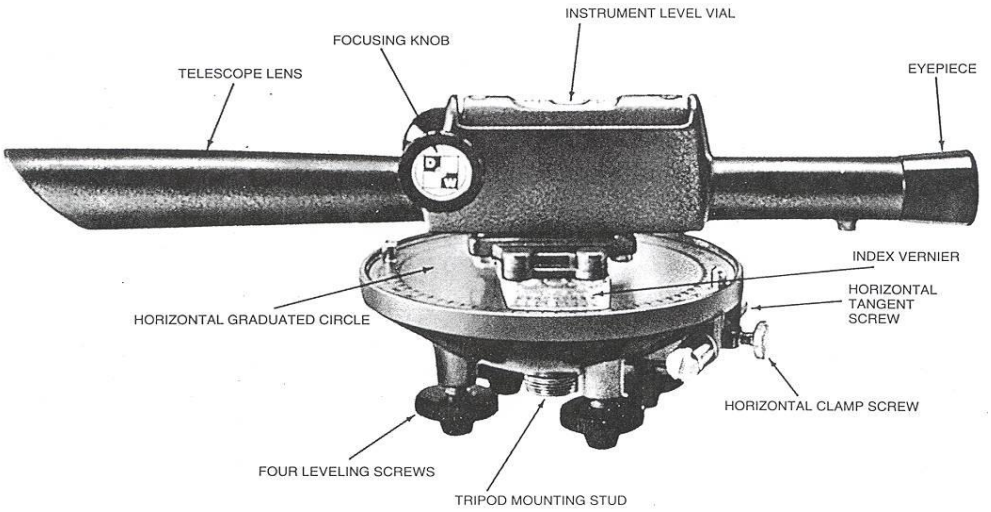
EXERCISE F: Set Up and Adjust the Instrument

1. Consumable supplies needed:
   a. none

2. Procedure:
   a. Grasp the two legs of the tripod nearest you and set the leg shoes in the ground about three feet apart.
   b. Swing the third leg out to complete the triangle.
   c. Check the tripod head to see if it is approximately level.
   d. Tighten the leg thumb screw.

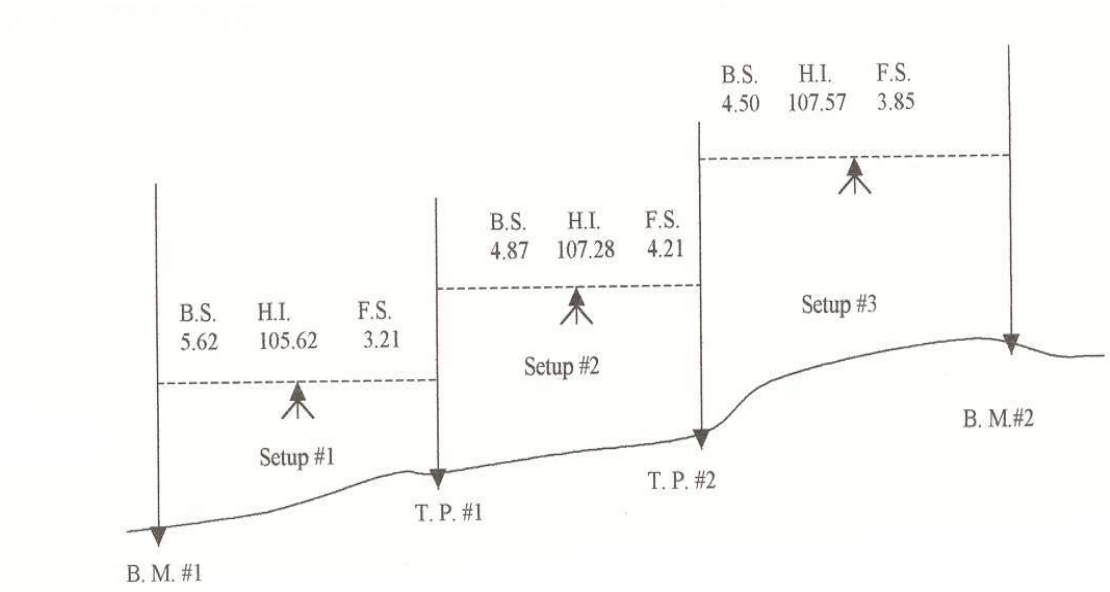


   e. Attach the instrument by screwing it down to the tripod head.
   f. Align the barrel of the telescope directly over two of the leveling screws.
   g. Rotate these two leveling screws towards or away from one another until the bubble is level.
   h. Turn the telescope 90 degrees to align it with the other two screws. Level hem in the same manner.
   i. Rotate the telescope to different positions over the two sets of leveling screws to make final adjustments. (NOTE: The instrument should now be level in all directions.)



EXERCISE G: Differential Leveling

1. Locate Benchmark #1 and set up the level in a convenient place where Benchmark #1 can be seen when the transit is leveled.
2. Set the rod on BM #1.
3. Reading through the level move the target on the rod till it and the crosshairs on the level are even.
4. This is a backsight reading and is added to the known elevation of BM #1 (100 feet) to obtain the height of instrument.
5. The rod man takes the rod moving in the direction of BM #2. The rod is set down where the instrument man can read it from the setup he is in (Setup #1).
6. The reading is taken on the rod and this is called the foresight reading. The foresight reading is subtracted from the height of instrument and this will give you the elevation of the point where the rod is called Turning Point #1.
7. The instrument is picked up and moved beyond the rod in the direction of BM #2 and the above procedure is repeated. First, a backsight on the known elevation TP #1, the height of instrument is figured, the rod is moved to a new turning point (Turning Point #2), a foresight taken and subtracted from the height of instrument to obtain the elevation.
8. These steps are repeated till you reach BM #2. A foresight is the last reading on the benchmark which gives you its elevation.
9. Repeat the above steps except go from BM #2 to BM #1 going back a different way.



DIFFERENTIAL LEVELING

STATION	BACKSIGHT	HEIGHT OF INSTRUMENT	FORESIGHT	ELEVATION
BM #1	5.62			100'
		105.62		
TP #1	4.87		3.21	102.41
		107.28		
TP #2	4.50		4.21	103.07
		107.57		
BM #2			3.85	103.72

MECHANICS TECHNOLOGY

AREA: PLUMBING

COMPETENCIES TO BE DEVELOPED:

1. Identify different kinds of pipe and their uses
2. Measuring and marking pipe
3. Cutting pipe with a hacksaw
4. Cutting pipe with a pipe cutter
5. Reaming pipe with a pipe reamer
6. Threading pipe
7. Assembling pipe and determining length

TIME: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *Agricultural Mechanics Fundamentals and Application, 3rd Edition* by Elmer C. Cooper (Delmar)
2. *Agriscience Mechanics* by Lloyd J. Phipps (Interstate)
3. *Modern Plumbing* by E. Keith Blankenbaker (GoodHeart/Wilcox)

STUDY QUESTIONS

1. List four (4) types of plumbing systems.
2. Describe the Pneumatic Plumbing System.
3. Describe the Hydraulic Plumbing System.
4. Describe the Supply Plumbing System.
5. Describe the Disposal Plumbing System.
6. List two ways that water plumbing is used besides supply and disposal.
7. Define a plumbing fitting.
8. Most pipes are sized based on _____.
9. Name five plumbing fixtures.
10. Define a valve.
11. Name three (3) different materials that are used to make pipe.
12. The pipe made of polyvinyl chloride is commonly called _____pipe.
13. The plastic pipe used on hot water is:
    a. CPVC
    b. PVC
    c. black plastic
14. What are pipe fittings used for?
15. What does O.D. and I.D. mean in plumbing?
16. Give the process in detail of soldering copper pipe.
17. What is a septic tank?
18. How is air pressure measured on a surface?
19. What does pneumatic refer to?
20. List three (3) grades of steel pipes.
21. Name three (3) ways to join copper to fittings.

PLUMBING

INFORMATION SHEET

Plumbing--Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste.

Four types of plumbing systems are:

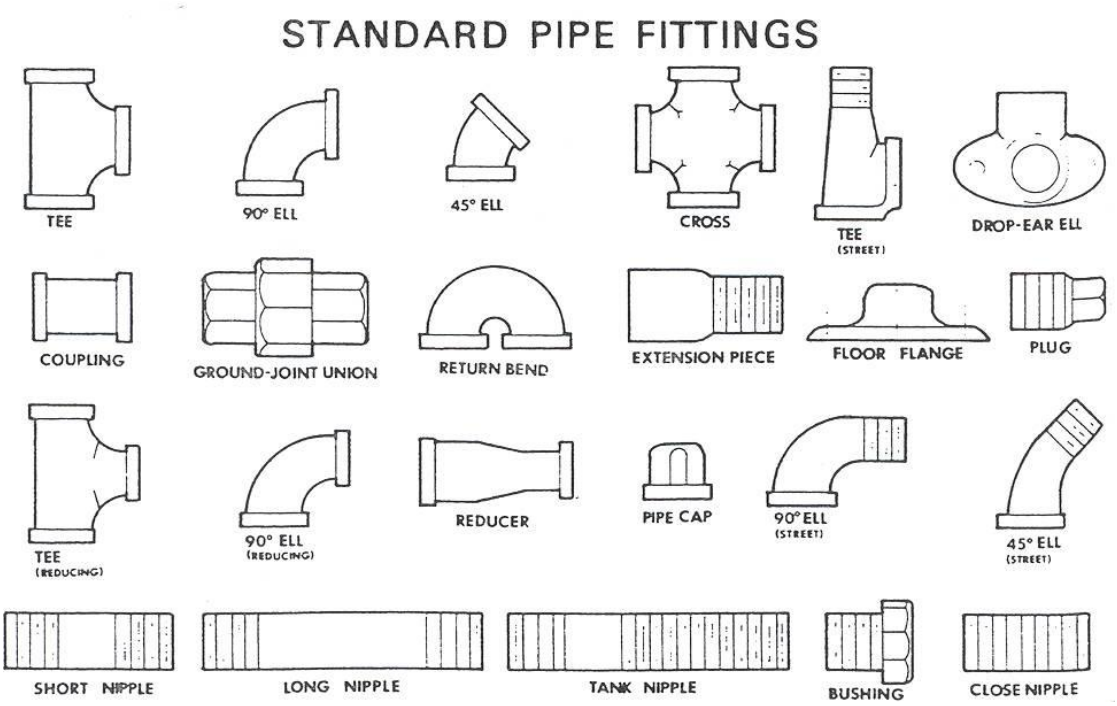
a. Pneumatic
b. Hydraulic
c. Supply--used to carry water into building for use by humans
d. Disposal--used to carry away waste from a building

Ways water plumbing is used besides supply and disposal.

Fitting--A piece used to join pipe, to provide an opening in pipe, to change the direction of pipe, or to close the end of pipe.

Common plumbing fixtures:

45° elbow	Bell reducer
90° elbow	Coupling
90° street elbow	Nipple
Tee	Union
Bushing	Plug
Cap	Floor flange
Straight cross	"Y"



Kinds of pipe and their uses:

a. black steel--used for natural gas, LP gas, oil, and air
b. galvanized--used for water lines
c. copper tubing--used for water, refrigeration, and waste systems
d. PVC--used for cold water and waste systems, and vent piping systems
e. CPVC--used for hot water where temperatures range as high as 180°
f. black plastic (PE) (polyethylene)--used for the underground installation of water systems for homes

O.D.--outside diameter of pipe. Used for pipe larger that 12".

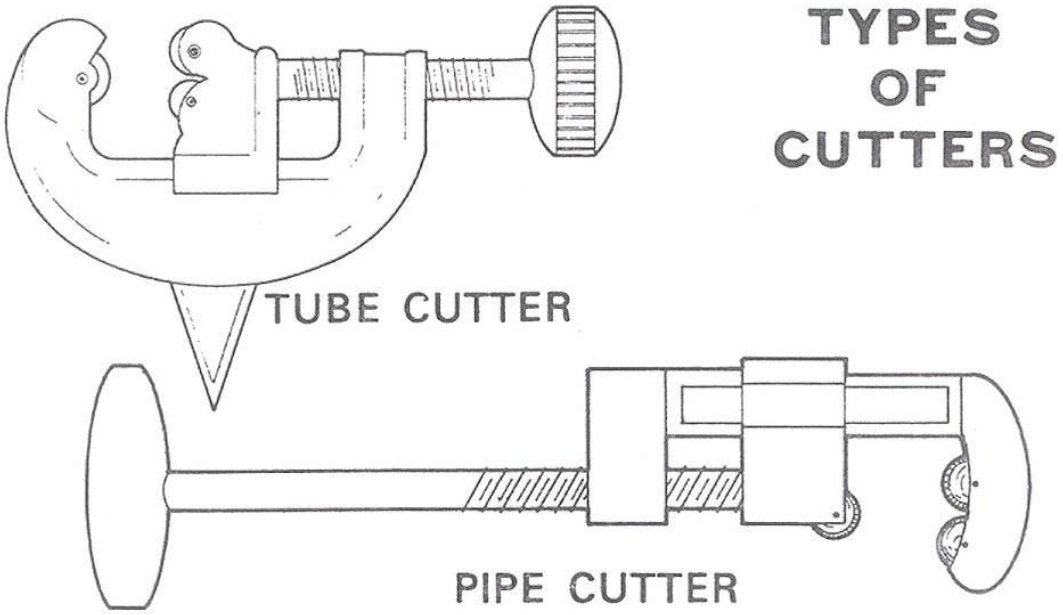
I.D.--inside diameter of pipe. Used for pipe 12" or less in diameter.

Three grades of steel pipe:

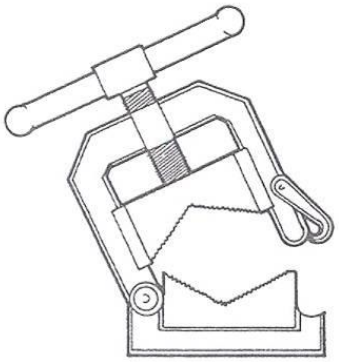
a. standard
b. extra heavy
c. double extra heavy weight

Ways to join copper tubing to fittings:

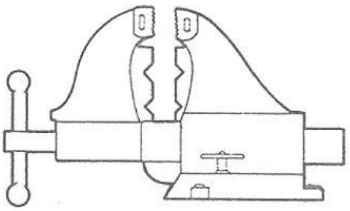
a. sweating or soldering
b. flare fittings
c. compression fittings



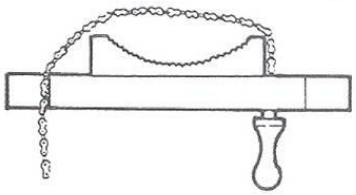
TYPES OF VISES



HINGED PIPE VISE



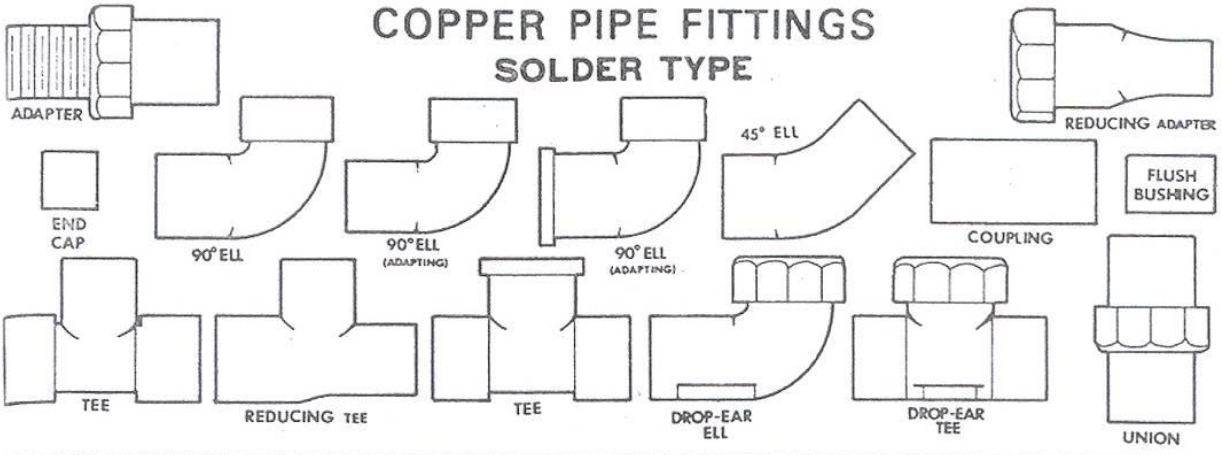
COMBINATION PIPE VISE



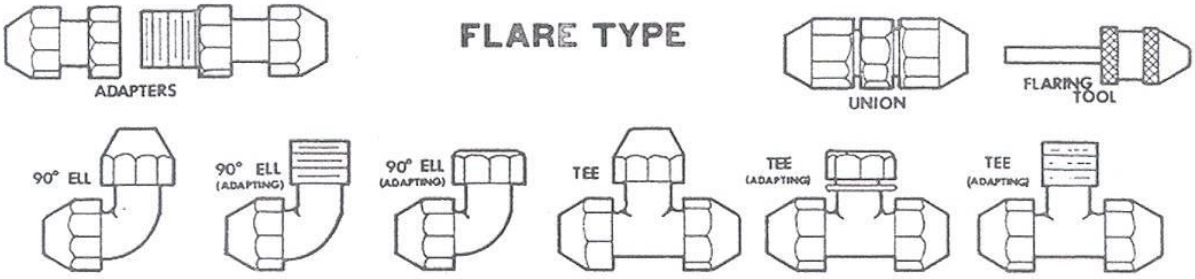
CHAIN PIPE VISE

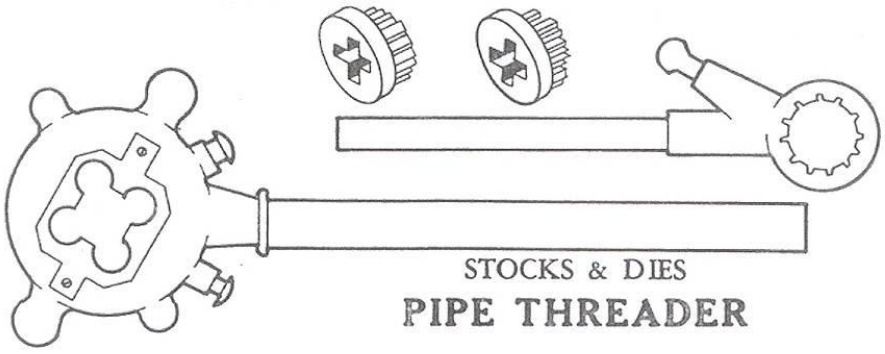
COPPER PIPE FITTINGS

SOLDER TYPE



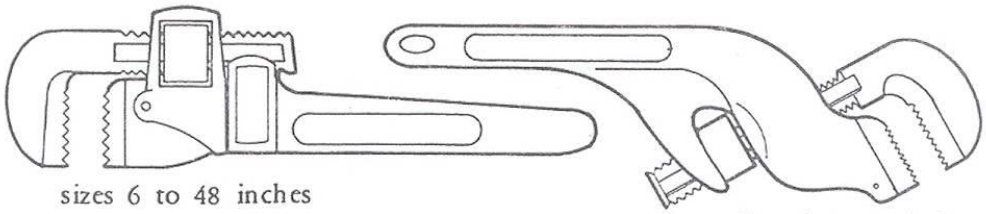
FLARE TYPE





STOCKS & DIES

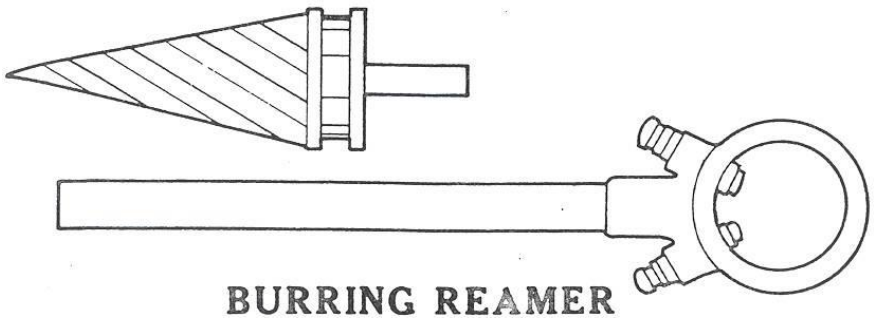
PIPE THREADER



sizes 6 to 48 inches

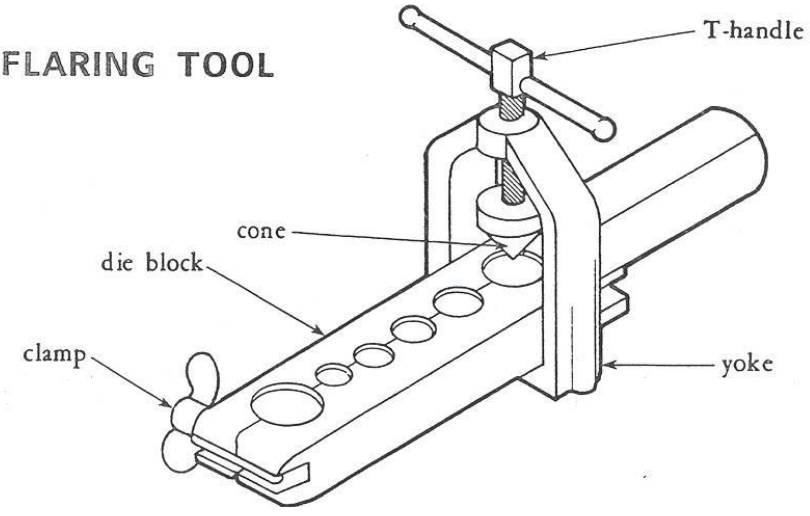
PIPE WRENCHES

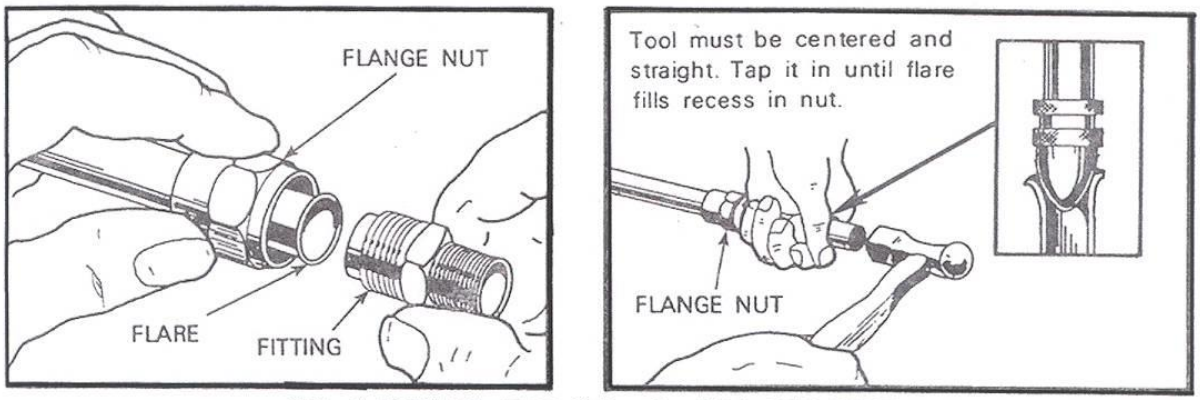
sizes 6 to 36 inches



BURRING REAMER

FLARING TOOL





FLARING TOOL & HAMMER

SOLDERING COPPER PIPE

Use the following steps in soldering copper pipe/tubing and fittings: (Note: Be sure to use safe practices in soldering. Protect the eyes and be careful with the hot flame.)

1) Use emery cloth or steel wool to clean the outside of the pipe/tubing a distance equal to the depth of the socket (or hub) in the fitting.
2) Use emery cloth, steel wool, or a special brush to clean inside the socket area of the fitting.
3) Apply flux to the area of the pipe/tubing that will go into the fitting. Also apply flux inside the fitting where the pipe will fit.
4) Insert the pipe/tubing in the fitting and rotate 1/4 turn to distribute the flux.
5) Heat the pipe/tubing until it will melt solder. A small acetylene torch or a propane torch is used for this.
6) Touch the solder to the pipe/tubing where it joins the fitting. The heating action will pull the molten solder into the joint. Only a small amount of solder is needed. Be careful not to overheat the fitting as overheating tarnishes the copper.

FITTING OR VALVE	TYPE OF CONNECTION		
	SCREWED	BELL AND SPIGOT	SOLDERED OF CEMENTED
ELBOW-90 DEGREES			
ELBOW-45 DEGREES			
ELBOW-TURNED UP			
ELBOW-TURNED DOWN			
ELBOW-LONG RADIUS			
ELBOW WITH SIDE INLET-OUTLET DOWN			
ELBOW WITH SIDE INLET-OUTLET UP			
REDUCING ELBOW			
SANITARY T			
T			
T-OUTLET UP			

FITTING OR VALVE	TYPE OF CONNECTION		
	SCREWED	BELL AND SPIGOT	SOLDERED OF CEMENTED
T-OUTLET DOWN			
CROSS			
REDUCER-COCENTRIC			
REDUCER-OFFSET			
CONNECTOR			
Y OR WYE			
VALVE-GATE			
VALVE-GLOBE			
UNION			
BUSHING			
INCREASER			

PIPE SYMBOLS FOR PLUMBING

DRAIN OR WASTE ABOVE GROUND

DRAIN OR WASTE BELOW GROUND

VENT

SD — STORM DRAIN

COLD WATER

SW — SOFT COLD WATER

HOT WATER

S — SPRINKLER MAIN

SPRIKNLER BRANCH AND HEAD

G — G — GAS

A — COMPRESSED AIR

PIPE SYMBOLS FOR HEATING

V — VACUUM

CI — SEWER-CAST IRON

CT — SEWER-CLAY TILE

S-P — SEWER-PLASTIC

HIGH-PRESSURE STEAM

MEDIUM-PRESSURE STEAM

LOW-PRESSURE STEAM

FOS — FUEL OIL SUPPLY

HW — HOT WATER HEATING SUPPLY

HWR — HOT WATER HEATING RETURN

PIPING SYMBOLS FOR AIR CONDITIONING

RL — REFRIGERANT LIQUID

RD — REFRIGERANT DISCHARGE

C — CONDENSER WATER SUP

CR — CONDENSER WATER RET

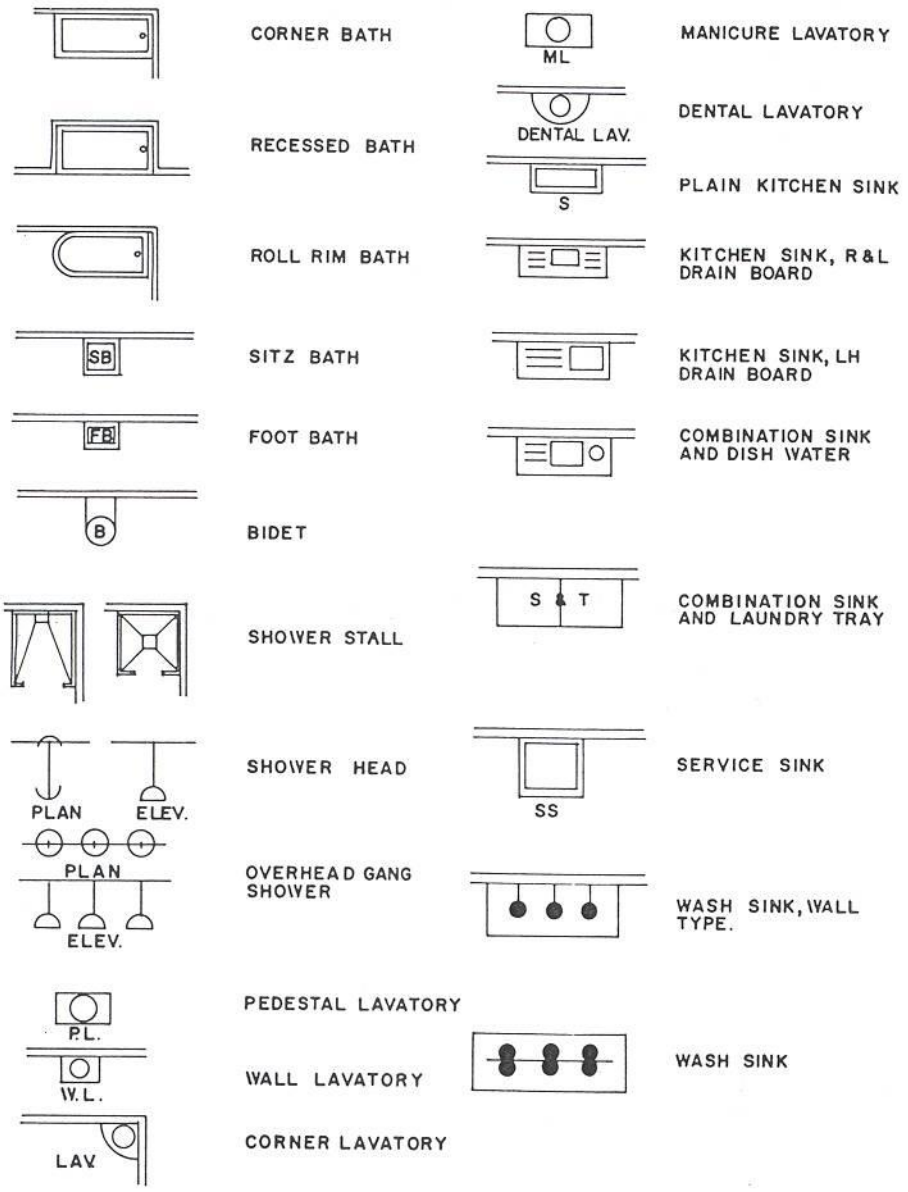
CH — CHILLED WATER SUPPLY

CHR — CHILLED WATER RETURN

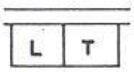
MAKE UP WATER

HUMIDIFICATION LINE

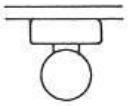
PLUMBING FIXTURES, APPLIANCES, AND MECHANICAL EQUIPMENT SYMBOLS



PLUMBING FIXTURES, APPLIANCES, AND MECHANICAL EQUIPMENT SYMBOLS (CONT.)



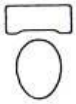
LAUNDRY TRAY


WATER CLOSET (LOW TANK)

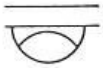

WATER CLOSET (LOW TANK)

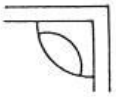

WATER CLOSET (NO TANK)


WATER CLOSET


WATER CLOSET


URINAL (PEDESTAL TYPE)


URINAL (WALL TYPE)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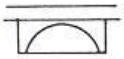
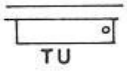
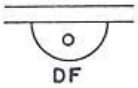

URINAL (STALL TYPE)

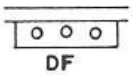


URINAL (TROUGH TYPE)

DRINKING FOUNTAIN (PEDESTAL TYPE)



DRINKING FOUNTAIN (WALL TYPE)



DRINKING FOUNTAIN (TROUGH TYPE)

HOT WATER TANK

WATER HEATER

METER

HOSE RACK

HOSE BIBB

GAS OUTLET


VACUUM OUTLET

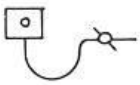
DRAIN

GREASE SEPARATOR


OIL SEPARATOR

CLEANOUT

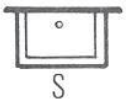

GARAGE DRAIN


FLOOR DRAIN WITH BACKWATER VALVE

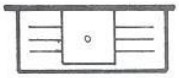

ROOF SUMP

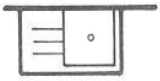
SINKS

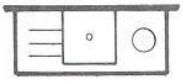
DISHWASHER



PLAIN KITCHEN

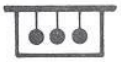

KITCHEN, R&L DRAIN BOARD


KITCHEN, L.H. DRAIN BOARD


COMBINED SINK & DISHWASHER

COMBINED SINK & LAUNDRY TRAY

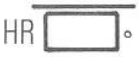
SERVICE


WASH (wall type)

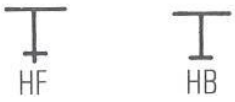

WASH (free-standing)

LAUNDRY TRAY

HOSE RACK



HOSE BIBS OR FAUCET



WASHING MACHINES

WRINGER

AUTOMATIC

DRYERS

CENTRIFUGAL

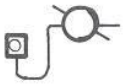
CABINET

RACK

DRAIN

DRAINS


GARAGE


FLOOR, WITH BACKWATER VALVE

DRAINAGE

LAMP HOLE DRAIN

LEADER DRAIN

DRY WELL

RECEIVING BASIN

YARD DRAIN INLET

CUTTING, THREADING, AND INSTALLING GALVANIZED PIPE

Cutting Galvanized Pipe:

Before you cut any pipe, make sure you have measured and marked the correct length exactly. Many plumbing supply stores will cut and thread lengths of galvanized pipe for you. If you're going to do it yourself, you'll need some special equipment: a pipe cutter or a hacksaw with a 24 or 32-tooth-per-inch blade, a pipe vise, a reamer, and a file.

It is important to cut perfectly straight so the pipe won't leak around the fitting. The easiest way to insure a square cut is to use a pipe cutter, a tool that fits onto the pipe end exactly and cuts true.

After the pipe is cut, you'll find some burrs both inside and outside. File off the outside burrs; use the tapered reamer to grind off the inside ones (left in they would restrict the flow of water). Clean the pipe end inside and out with a rag.

Threading Galvanized Pipe:

The threading die should have the same nominal diameter as the pipe--for example, a 1/2-inch die for a 1/2-inch pipe. Fit the die into the stock (the handle). Then slip the die over the end of the pipe. Exerting force inward toward the pipe, begin rotating the handle clockwise. When the die bites into the pipe, you can stop pushing and simply continue the clockwise rotation. (Once begun, the threads will pull the die along without your needing to exert any force.) Apply generous amount of cutting oil as you turn the threader. If the threader gets stuck, you probably have some metal chips in the way; back the tool off very slightly and blow the chips off. Continue threading until the pipe extends about one thread beyond the end of the threader. Finally remove the threader and clean off the threads with a stiff wire brush.

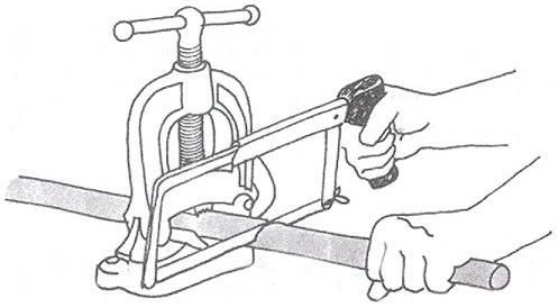
Installing Galvanized Pipe:

Once threaded, the pipe is ready to be installed with its fittings (galvanized pipe requires malleable iron fittings). Coat the threads of the pipe with pipe joint compound or wrap them with fluorocarbon tape. Do not coat the inside of the fitting. Screw the pipe and fitting together by hand as far as you can. Do this slowly--done too fast, joining creates heat which causes the pipe to expand; later, the pipe shrinks and the joint becomes loose.

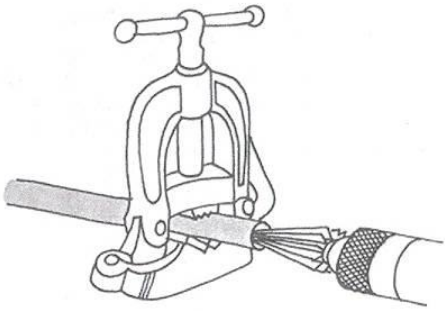
After you have tightened the pipe and fitting by hand as far as you can, finish with two pipe wrenches. Use one on the fitting and one on the pipe, turning in opposite directions. (Always turn pipe wrenches toward the opening of their jaws.)

(See following illustrations.)

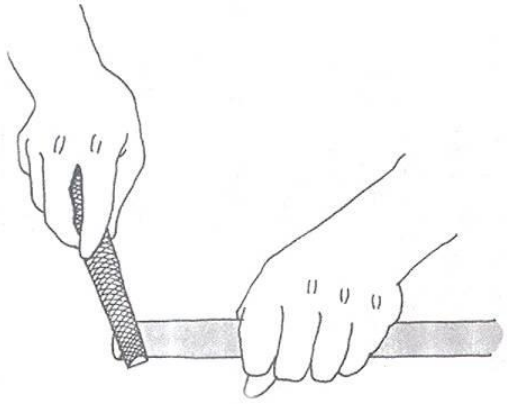
CUTTING, THREADING, AND INSTALLING GALVANIZED PIPE



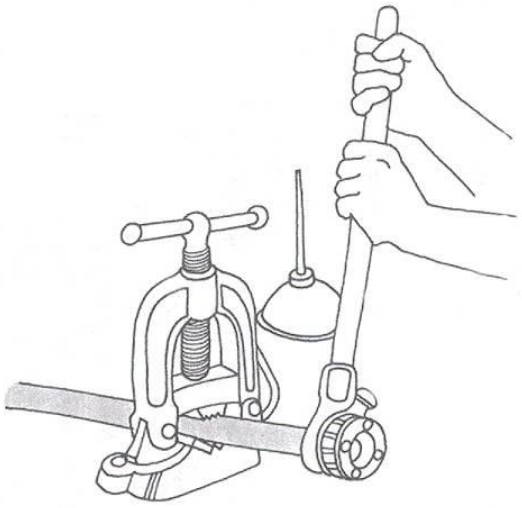
Step 1. *Fit pipe into the vise. (Some have pipe jaws under regular jaws.) Cut with hacksaw or a pipe cutter.*



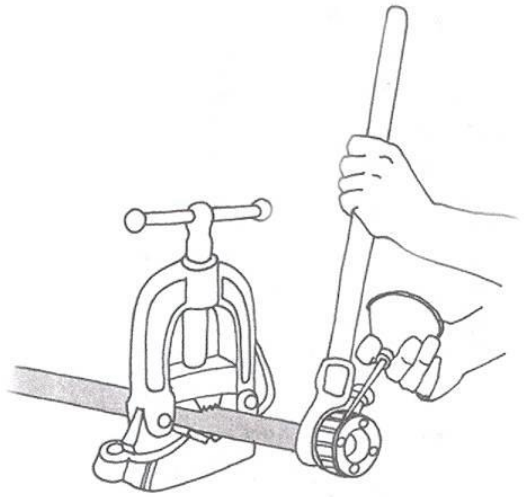
Step 3. *File off burrs on the inside of the pipe with a reamer. Vise holds pipe steady during the reaming process.*



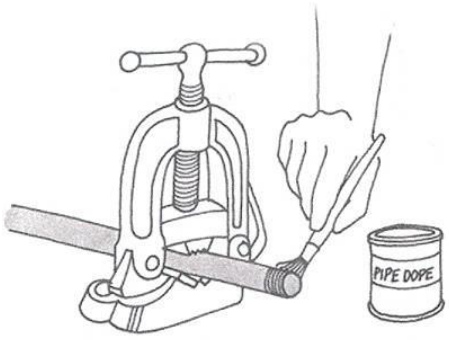
Step 2. *Cutting will leave burrs on both the inside and outside of the pipe. File off the outside burrs.*



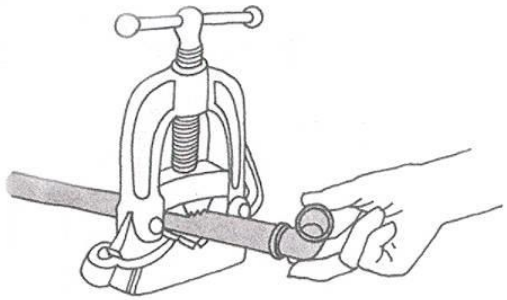
Step 4. *Fit pipe threader over pipe end and tighten it. Exert force at first while turning to start cutting action.*



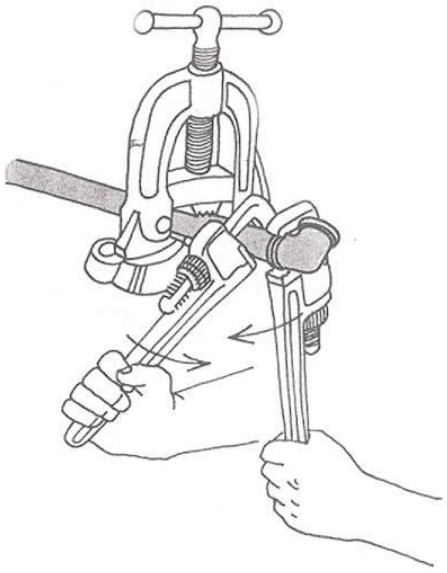
Step 5. *While cutting threads, use generous amounts of oil. Chips may stop threader. Back off, brush chips away.*



Step 6. *Threads cut, pipe end cleaned off, apply pipe joint compound to threads to help seal the completed joint.*



Step 7. *Clean out the threaded inside of fitting; then screw it onto the pipe end by hand as far as it will go.*



Step 8. *Use two wrenches to tighten joint—one on pipe, one on fitting. Turn slowly in opposite directions.*

COPPER TUBING

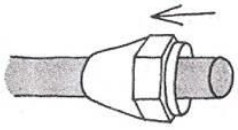
Flare and Compression Fittings:

Instead of soldered fittings on copper tubing, you can use flare and compression fittings. These are very easy to install and equally easy to take apart. They're expensive, though.

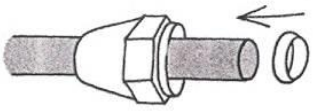
To assemble a flared joint, you'll need a flaring tool. One type simply fits into the end of the tube and is pounded with a hammer. A screw-down type clamps onto the pipe and the tapered point screws down to produce the flare.

Compression fittings are made without the flare. First, a flange nut fits over the end of the tube. Then a compression ring slides on. Next, the body of the fitting is placed against the end of the tube and the flange nut is screwed into it, compressing the ring very tightly between fitting and pipe.

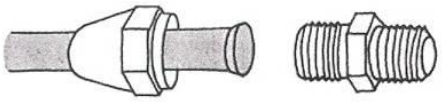
Assembling a Flare Fitting:



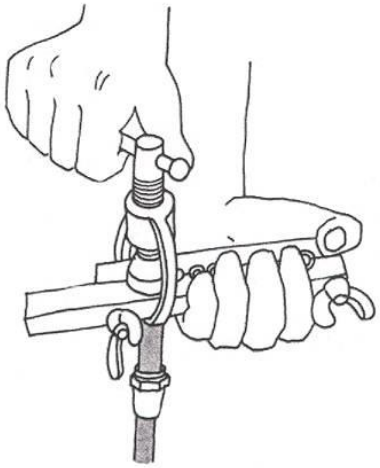
Flare fittings *for copper pipe are expensive but easy to assemble. First fit threaded fitting over pipe end.*



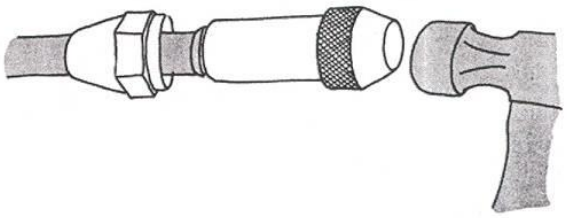
After the threaded fitting *is in place, slide the small metal gasket over pipe end next to the fitting.*



Once flare is made, *the end of this threaded fitting will fit snugly into it. Slip female end over it, screw down tight.*

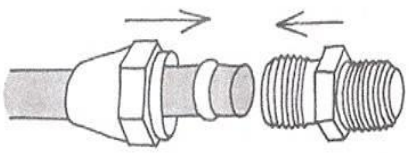


Special flaring tool *does precise job. Clamp it down over pipe end and screw tapered head into pipe, creating flare.*

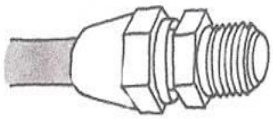


Tapered end *of flaring tool fits into end of pipe, is hammered in to make flare. Use vise for support.*

Assembling a Compression Fitting:



Compression fittings *use threaded male and female connections and compression ring, don't require initial flaring.*

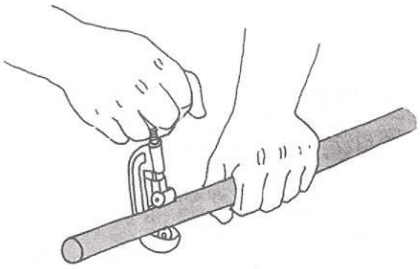


Once joined, *flare and compression fittings look the same. Disassembling is a simple task—unscrew the female ends.*

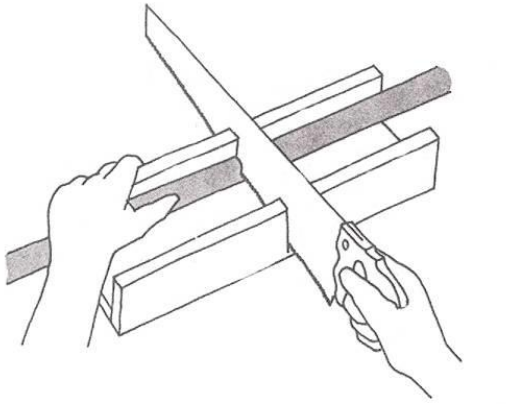
PLASTIC PIPE

Cutting Plastic Pipe:

You can cut rigid plastic pipe with a hacksaw (24 or 32-tooth blade), a fine tooth handsaw, or a fine-toothed power saw. With the handsaw, use a miter box to get a square cut. The power saw should have guides to insure a square cut. You can also use a pipe cutter with a special blade for plastic pipe.



Special pipe cutter *for plastic gives good, even cut. Blade on this cutter is narrow to prevent large burrs.*

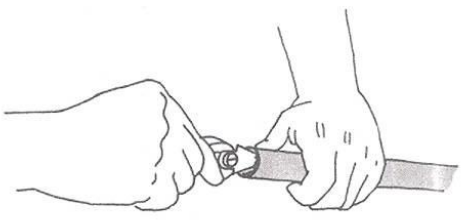


You can also cut plastic pipe *with a regular handsaw. To insure a square cut, place it in a miter box, hold securely.*

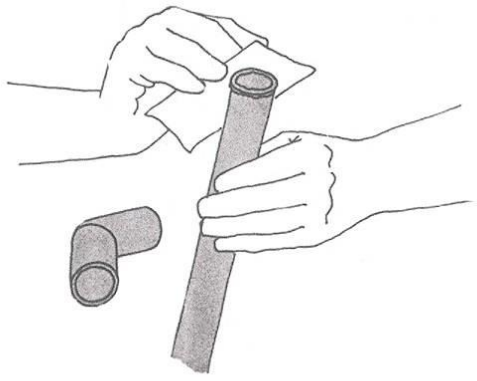
Fitting Plastic Pipe:

Cut off all burrs, inside and out, with a knife or a reamer. Clean the end of the pipe with a rag.

Do a trial fit of the pipe and fitting. If the pipe won't fit, file or sand it down. When the pipe and fitting go snugly together (not so loose that the fitting will fall off), remove the gloss on the outside of the pipe and on the inside of the fitting using fine sandpaper or a liquid cleaner made for the purpose.



After cutting plastic pipe *you'll find burrs, just as on metal. You can remove them with a sharp knife instead of a reamer.*



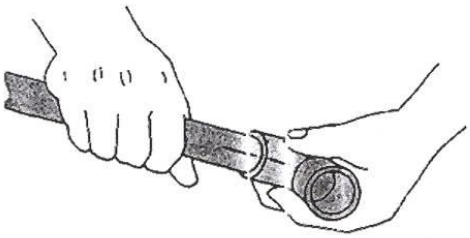
Once you've removed any burrs *from inside and outside the pipe end, clean it off very thoroughly with a dry cloth.*

For bonding the pipe and fitting, use special cement and a non-synthetic bristle brush. Some cement comes in a container with an applicator brush. For pipe 1/2 inch or smaller, you can use a 1/2-inch brush. Use a 1-inch brush for pipe up to 2 inches. For larger pipes, use a brush at least half the nominal pipe size. Be sure that you get the right type of cement for the kind of plastic you are using.

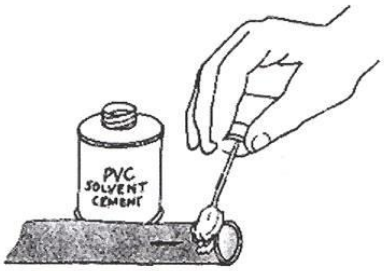
Before cementing the pipe and fitting, you should know exactly how the finished run will line up. It's a good idea to mark the pipe and the fitting beforehand and line up the two marks when cementing.

Brush a light coat of cement on the inside of the fitting. Apply a heavy coat to the pipe end. Put the two pieces together immediately. After you give them a quarter turn to spread the cement evenly, line them up precisely. Wipe the excess cement from around the lip of the fitting. (The bead of excess cement should be uniform all around the fitting. If there's a very heavy bead, there's probably too much cement in the fitting.) Check inside the fitting with your finger to make sure no cement is blocking it.

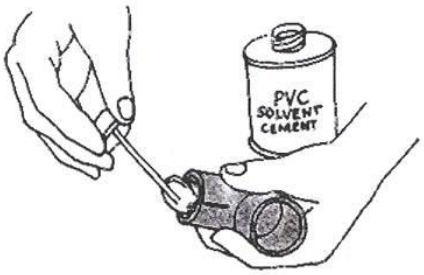
Hold the fitting and pipe together for about a minute. Then wait at least an hour before you put any water into the pipe. (If air temperature is between 20° and 40° F., wait at least 2 hours; between 0° and 20° F., wait at least 4 hours.)



Place fitting *over the end of the pipe (it should fit snugly) and mark both pipe and fitting to show exact placement.*



Apply a thick coat *of special plastic solvent cement to the outside of the pipe end. It dries fast so don't dawdle.*



Coat inside of fitting *with very light coat of solvent. Once you begin cementing, you have less than a minute to finish.*

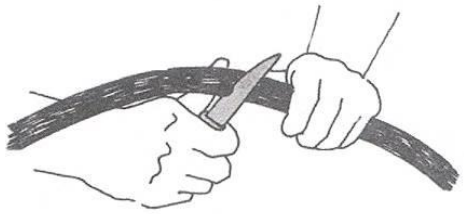
Polyethylene Tubing:

Polyethylene tubing is made for outdoor use--most often for wells and sprinkler systems. It isn't suitable for hot water. It comes in three grades, rated at 125 psi, 100 psi, and 80 psi. This last one is good for most residential underground watering systems.

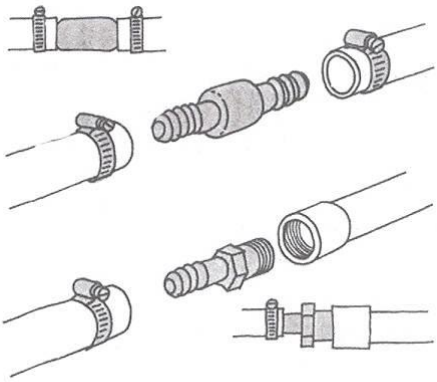
You can cut polyethylene tubing with a knife or a hacksaw. Making perfectly square cuts is not crucial.

Fittings for polyethylene are ridged plastic, held in place by screw clamps. Adapters can join polyethylene pipe to other kinds of pipe. (Sprinkler heads are most often steel.)

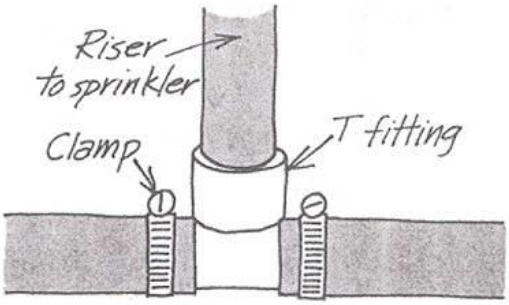
With polyethylene systems you can take apart and reassemble fittings as often as necessary. If you have difficulty getting a fitting to come apart, pour hot water over the end of the tubing to soften it.



Flexible polyethylene *plastic pipe is very easy to work with. You can cut it with a saw or, shown here, with a sharp knife.*



Top: *Ridged plastic fitting and clamps join two lengths of polyethylene pipe.* **Bottom:** *Adapter joins plastic, steel pipes.*



Special adapter T *joins polyethylene pipe with threaded galvanized steel pipe (called a "riser") for sprinklers.*

EXERCISES

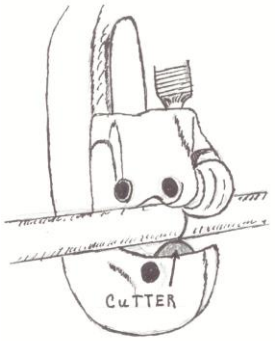
EXERCISE A: Measuring and Marking Steel Pipe

1) Obtain a piece of 3/4-inch steel pipe (galvanized or black).
2) Mark a piece that will fit two (2) fittings that are 30 inches apart center to center.
3) Place pipe in a vise or on the plumbing table.
4) Measure 30 inches of pipe.
5) Add 9/16-inch to each end of the pipe.
6) Mark with a file or hacksaw.

EXERCISE B: Cutting Steel Pipe (a) with a Hacksaw (b) with a Pipe Cutter

1) Place the marked piece of pipe from Exercise A in the pipe vise with 4 inches extending outside the vise.
2) Saw the pipe at the mark with the hacksaw.
   a. Check hacksaw for straightness of the blade and tightness of the blade.
   b. Teeth must point away from the saw handle.
   c. Keep blade at a 90° angle to the pipe.
3) Use a pipe cutter for the second cut.
   a. Place the pipe between the rollers and the cutter wheel as shown in Figure 1.
   b. Place the cutter wheel on the mark to be cut, tighten only slightly about 1/8" - 1/4" turn.
   c. Make a complete turn around the pipe then tighten again 1/8" - 1/4" turn, continue this procedure until the cut is made.

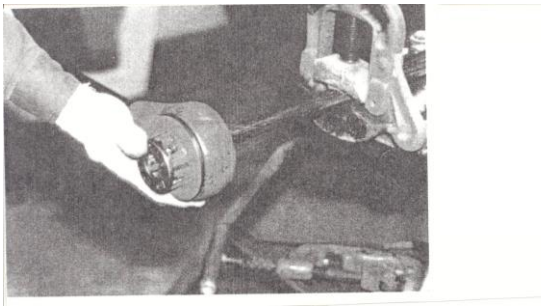
FIGURE I



EXERCISE C: Threading Steel Pipe with a Hand Threader

1) Use the pipe from Exercise B and clamp vise.
2) Select the correct size die for the pipe (3/4").
3) Use a small amount of cutting oil on the exterior of the pipe area to be threaded.
4) Push the die guide in the threader onto the end of the pipe squarely. (See Figure II.)
5) Make the rotation of the handle in a clockwise direction and at the same time push on the die stock hub to engage the die in the steel. Add a few drops of cutting oil during the threading process. Do not turn the die back and forth.
6) Keep turning the handle of the threader clockwise until the desired length of threads is on the pipe (9/16").
7) Back the die off by turning it counter clockwise.

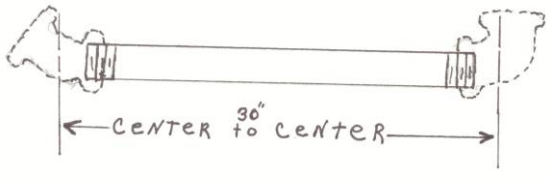
FIGURE II



EXERCISE D: Joining Steel with Fittings

1) Secure one steel 90° elbow, one 45° steel elbow along with the pipe from the previous exercise.
2) Clamp the pipe in the pipe vise to hold.
3) Coat the threads with a thin layer of sealer or wrap with a piece of Teflon® tape.
4) Insert one fitting onto the pipe and tighten by hand as much as possible.
5) Use a pipe wrench to finish tightening.
6) Insert the other fitting onto the other threaded end of the pipe and repeat step 4 and 5.
7) The pipe must be 30" from center of one fitting to center of the other fitting. (See Figure III.)

FIGURE III



EXERCISE E: Cutting and Flaring Copper Tubing

1) Obtain a piece of tubing from the instructor 24" long. Use 3/8" tubing.
2) Lay the tubing on the table and mark 1/4" from the end.
3) Hold the tubing in one hand and place the tubing cutter on the mark, making sure that the tubing is between the rollers and the cutters.
4) Make the first round with the cutter a light cut. Tighten the handle about 1/4 -1/2 turn and proceed to turn the cutter around the tube until the tube is cut.
5) Hold the tubing in the hand and use the reamer on the tubing cutter and ream the burr from the inside of the tubing.

EXERCISE F: Flaring Copper Tubing

1) Insert the tubing, which was cut in Exercise E, into the flaring tool vise extending 1/16" above the flat surface of the vise. Tighten with moderate pressure.
2) Place the flaring anvil on the flaring vise and insert it into the end of the tubing and slowly tighten until the flare is made.

EXERCISE G: Measure, Cut, and Assemble PVC Pipe

1) Obtain the following materials:
   a. one piece of PVC pipe, 24" long and 1/2" in size
   b. one 90° elbow
   c. one 45° elbow
   d. one can of cleaner
   e. one can of cement for PVC
2) Measure 20" on the pipe. Make a mark. In measuring, calculate pipe length to the depth of the hub in fittings. Usually hub depth is equal to the diameter of the PVC.
3) Cut the PVC with cutters or hacksaw.
4) Use PVC cleaning compound to clean both inside the fitting and outside the pipe.
5) Coat the inside of the fitting and length of pipe equal to the distance it will go inside the fitting with cement.
6) Insert the pipe completely into the fitting. Turn the pipe 1/4 turn.
7) Allow to dry.

MECHANICS TECHNOLOGY

AREA: CONCRETE AND MASONRY CONSTRUCTION

COMPETENCIES TO BE DEVELOPED:

1. Identify tools used for concrete work
2. Select materials for concrete
3. Make a workable masonry mix
4. Placing concrete
5. Finishing concrete
6. Calculate concrete
7. Make a silt test

TIME: The time allotment for instruction in this area is five (5) hours.

REFERENCES:
Agricultural Mechanics Fundamentals and Application, 3rd Edition, by Elmer Cooper (Delmar)
Agriscience Mechanics, by Phipps and Miller (Interstate)

STUDY QUESTIONS

1. What is concrete?
2. Concrete is a mixture of _____, _____ and _____.
3. What is a 1:2:3 mixture?
4. Define the following words:
   a. Masonry cement
   b. Portland cement
   c. mortar
   d. finishing lime
   e. ratio
   f. form
   g. moisture barrier
   h. control joint
   i. bull float
   j. screeding
5. List five (5) pieces of equipment used in concrete work.
6. What materials are used to construct forms?
7. What is trial mix?
8. Describe the steps for hand mixing concrete.
9. What is the chemical process that takes place between cement and water?
10. How is it determined when enough concrete has been placed in a form?
11. List four (4) ways that concrete might be dangerous.
12. What is the term used to level concrete with a straight edge after being placed in a form?
13. How is the surface of concrete kept level in a form?
14. Describe the method for curing concrete.
15. Concrete starts to harden about ____ minutes after it is mixed.
16. What is a masonry unit?
17. What is the name for different masonry units (blocks)?
18. A standard concrete block is what size: _____" long x _____" wide.
19. Why is the top of a concrete block (wider or narrower) than the bottom?
20. List the materials found in mixing mortar.
21. What is used to reinforce concrete?
22. Describe how to lay a straight course of blocks.
23. Define “ears” of a concrete unit?
24. What is a silt test?
25. What is a flush joint in block work?
26. Name the metal instrument similar to a wood float used to finish concrete.
27. What is a pointed metal instrument used to apply mortar to brick and/or concrete blocks?
28. What are the different types of concrete blocks?

EXERCISES

EXERCISE A: Estimate Amount of Concrete Needed

1. Study the following formulas and examples:
   a. Formula for cubic feet:

$$\text{Cubic feet} = \frac{\text{width (ft.)} \times \text{length (ft.)} \times \text{thickness (in.)}}{12}$$

   b. Formula for cubic yards:

$$\text{Cubic yards} = \frac{\text{cubic feet}}{27}$$

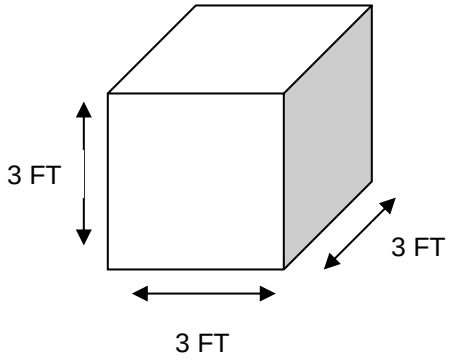
   Example: How much concrete would be required for a 4" floor in a 40' x 72' building?

$$\frac{\text{Cubic feet} = 40' \times 72' \times 4" = 960 \text{ cu ft}}{27}$$

EXERCISE B:

It is important to estimate the amount of concrete needed for a job. Concrete is figured and sold by the cubic yard. (27 cu ft = cu yd) (See Figure I.)

FIGURE I



1. Determine the cubic yards of concrete needed by multiplying the thickness by the width and length:

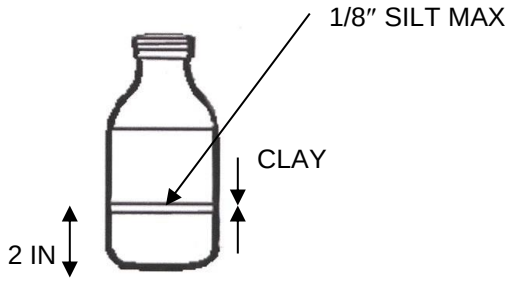
$$\text{cu yd} = \frac{T \times W \times L}{27}$$

2. How many cubic yards of concrete is needed to build a concrete floor 6 inches thick, 14 feet wide and 24 feet long?

EXERCISE C: Silt Test

1. Secure a 1-quart glass jar.
2. Fill the jar to a depth of 2 inches with sand. (See Figure II.)

FIGURE II



3. Fill the jar to 3/4 full of water.
4. Close the lid and shake the contents for 1 minute.
5. Shake the jar until the sand is level.
6. Let the jar set for 12 hours.
7. After 12 hours, measure the thickness of the silt and the thickness of the clay.
8. If the silt layer is more than 1/8 inch thick, the sand cannot be used in concrete.

EXERCISE D: Determine the Number of Block Needed

1. You have a wall that is 8 ft x 12 ft. Give the number of 8" x 16" blocks needed to build the walls.
2. Use this formula:

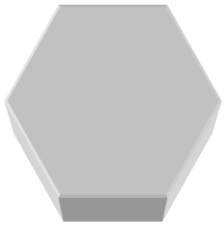
$$\frac{\text{Length of wall in feet x height of wall in feet}}{\text{Square feet of the block used}} = \text{the number of blocks required for the wall}$$

$$\frac{\text{Length of the block in inches x height of the block in inches}}{\text{144 square inches per square foot}}$$

You must multiply the number of blocks by 1.15 to give you 15 percent extra for errors and broken blocks.

EXERCISE E: Make a Hexagon Stepping Stone of Desired Size (See Figure III.)

FIGURE III



Consult the instructor about the project to be used for practice in making concrete. One of the following practices could be used:

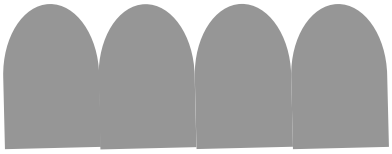
1. Consumable supplies needed:
   a. Portland cement
   b. sand
   c. gravel (pea gravel works best for this job)

2. Procedure:
   a. Oil the mold to prevent concrete from sticking.
   b. Place plywood under mold.
   c. Mix Portland cement, sand, and gravel together thoroughly with shovel. (Note: For the dry tamp mix, use one (1) part Portland cement to two (2) parts of moist sand and three (3) parts gravel. If the sand is very moist, very little moisture of water is needed.) (Note: A part is considered a shovel full, not heaping.)
   d. Pour mix into a wheelbarrow or mixing pan.
   e. Add enough water to mixture and mix until it is the consistency of mud. (Note: If mix is too dry, add moisture to it by putting water into the mix 1/2 cup at a time.)
   f. Shovel the cement out of the wheelbarrow and put into the mold. Tamp the sides to prevent a honeycomb.

g. Trowel the top off with a wooden float and finishing trowel.
h. Clean all tools with water and do not wash or pour wastewater into a sink.
i. Allow mixture to dry for 24-48 hours.
j. Take stepping stone out of mold after proper drying time and turn in to instructor for grade.

EXERCISE F: Make a Concrete Landscape Border (See Figure IV.)

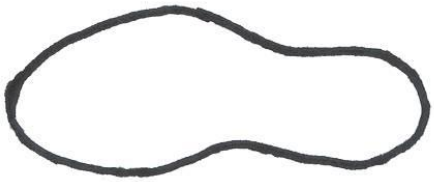
FIGURE IV



Follow the steps (A through J) in Exercise E, using a landscape mold.

EXERCISE G: Make a Concrete Footprint (See Figure V.)

FIGURE V

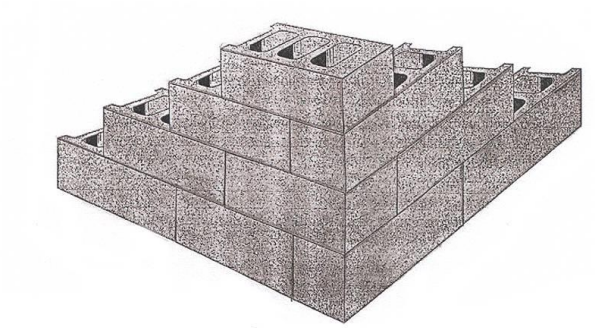


Follow the steps (A through J) in Exercise E.

EXERCISE H: Lay a Block Corner

1. Consumable supplies needed:
   a. sand
   b. lime
2. Procedure:
   a. Mix simulated mortar in a wheelbarrow with a shovel. (Note: Your ratio should be 1 part lime to 4 parts sand.)
   b. Draw a 90-degree corner on a flat surface using chalk and framing square.
   c. Spread and furrow a full mortar bed along the chalk line.
   d. Lay corner block first. (Note: All blocks should be laid with the thicker end of the face shell up, as this provides a larger mortar-bedding area.)
   e. Apply mortar only to the horizontal face shells of blocks, after the first course is laid.
   f. Apply mortar to the vertical face shells of block with trowel.
   g. Bring each block over its final position and push downward into mortar bed and against the previously laid block.
   h. Check blocks with a level. (Note: If the blocks are not aligned or plumb, tap into place with trowel handle.)
   i. Check each course of blocks for being level and being plumb. (Note: Mortar joints for concrete masonry should be 3/8".) (Note: Each course, in building corners, is stepped back a half block.) (See Figure VI.)
   j. Have instructor inspect for credit.

FIGURE VI



CONCRETE AND MASONRY CONSTRUCTION

INFORMATION SHEET

Concrete is a building material made up of Portland cement, fine aggregate (sand or fine stone), and course aggregate (gravel or crushed stone and water).

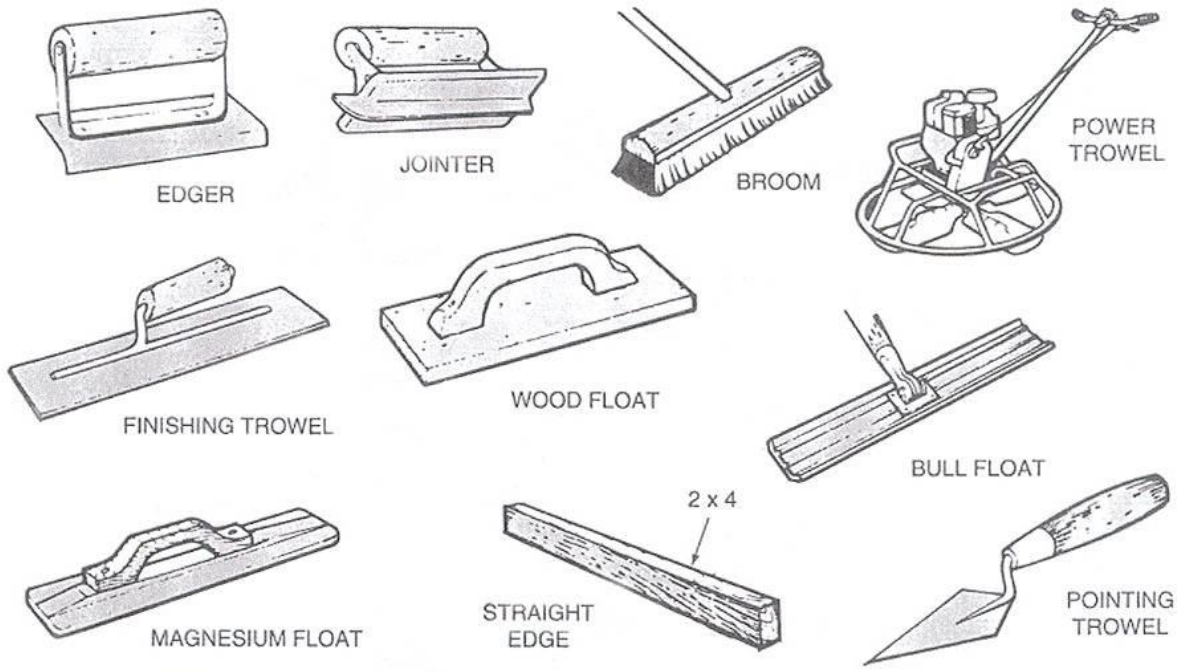
Masonry is a term used when referring to building materials including brick, stone, tile, or concrete units. Burning limestone and clay then grinding and mixing it produces a dry powder called Portland cement. Mixing Portland cement, sand, water, and finishing lime produces mortar. By grinding up treated limestone, you can produce finishing lime. The word "ratio" refers to the amount of cement to fine aggregate to course aggregate.

Concrete is a semi-liquid when freshly mixed and therefore, must be contained by a metal or wood form.

Moisture barrier must be used anytime that moisture must be prevented from passing through the concrete. When concrete is poured into a large area there will need to be control joints, which is a planned break that will permit the concrete to expand and contract without cracking.

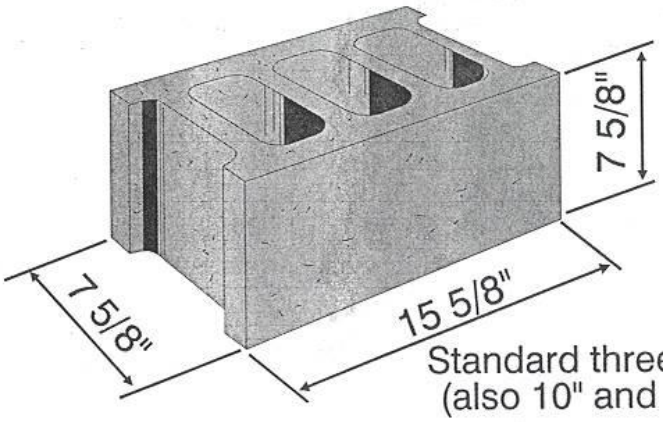
When making a concrete mix, it is sometimes good to make a trial mix before mixing a large quantity.

Concrete blocks or any units made from aggregates are called units.



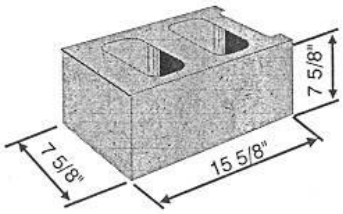
Tools for placing and finishing concrete.

Examples and dimensions of concrete blocks:

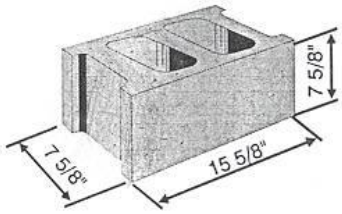


Standard three-core block
(also 10" and 12" widths)

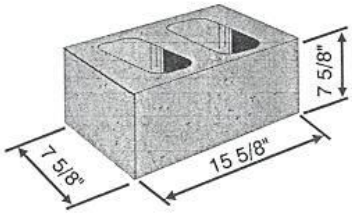
Examples of one-core and two-core block



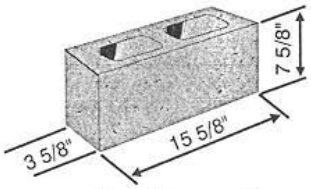
Corner unit



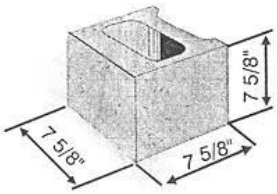
Stretcher unit
(wall-no corners)



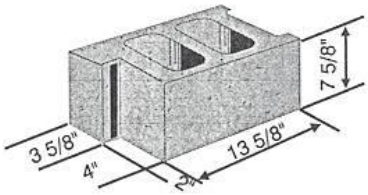
Pier or
double end unit



Partition unit



Half block



Jam or joist unit

MECHANICS TECHNOLOGY

AREA: WOODWORK - HAND TOOLS

OBJECTIVES:

1. Introduce students to the safe use of woodworking hand tools
2. Identify and properly use hand tools

COMPETENCIES TO BE DEVELOPED:

1. Identify hand tools used in woodworking
2. Read a tape measure
3. Calculate board feet
4. Demonstrate ability to do the following:
   a. drive nails with hammer
   b. use a nail set
   c. sawing - cross, rip, keyhole, coping, and back saw
   d. drilling - brace and bit
   e. use of chisel and mallet
   f. use of framing square
   g. use of the combination square
   h. use of the try-square
   i. use of the sliding T-bevel
   j. use of wood rasp
   k. use of hand plane
   l. screwdriver and screw sizes
   m. skill block

Time: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

1. *Agriculture Mechanics Fundamentals and Application, 3rd Edition* by Elmer L. Cooper (Delmar)

STUDY QUESTIONS

1. Name five (5) measuring tools.

2. What is the difference in cross and rip saw?

3. What determines the size of a handsaw?

4. What is the purpose of the set in a handsaw?

5. What is a backsaw and for what is it used?

6. What is the use of a compass saw?

7. At what angle should a handsaw be used?

8. How is the size of nails designated?

9. What are the parts of an auger bit?

10. How is the size of auger bits determined?
11. The No. 8 on an auger bit is how large?
12. What is the purpose of a ratchet?
13. Which screw would be used on a finished wood surface?
14. Name the types of hammer used in woodworking?
15. How are claw hammers held?
16. How are claw hammers specified to size?
17. What weight hammer would be used in framing a building?
18. Name the types of square and give their uses.
19. What is the use of the T-bevel square?
20. Which square would you use in framing out a building?
21. Name two parts of the framing square.
22. In what shapes and forms do rasps come in?
23. What is the formula for determining board feet?
24. What are the dimensions of a standard sheet of plywood?
25. What determines the coarseness of sandpaper?
26. What are four (4) common grits of sandpaper?

WOODWORK - HAND TOOLS

INFORMATION SHEET

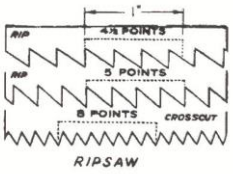
1. Safety practices:

a. wear safety glasses
b. make sure all tools are in good shape
c. keep work area clean
d. keep hand tools free of grease and oil while using them
e. when cutting wood, be sure it is secure
f. always work with the chisel blade pointed away from you
g. use tools only for the purpose for which they are intended

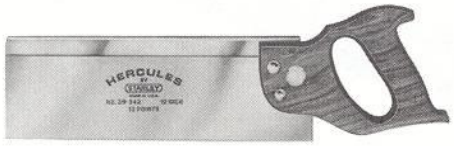
2. Identification of tools used in woodworking:

a. Cross cut saw: a handsaw used to cut across the grain of the board, usually 8-12 teeth per inch.
b. Rip saw: a handsaw used to cut along the length of the board, usually 5 teeth per inch.
c. Keyhole saw or compass saw: are saws designed for making cuts starting from a hole.
d. Back saw: is similar to a cross cut saw. It has very fine teeth and a stiff metal back. Used for accurate cuts.
e. Coping saw: is useful for cutting any kind of irregular, curved cuts in wood or other soft materials.
f. Tape measure: a flexible measuring device that rolls into a case.
g. Framing square: a flat square with tongue and body. The body is 24" and the tongue is 16" long.
h. Combination square: a tool that combines many tools in one.
i. Folding rule: a rigid rule 2 to 8 feet in length. It can be folded for handling and storage.
j. Try-square: a tool used to mark lines on boards in preparation for cutting.
k. Bit brace: a hand drill with a large crank-type handle with a ratchet drive.
l. Hand plane: a tool that shaves off small amounts of wood and leaves a smooth surface.
m. Hammer: a driving tool used for nails, relying on weight and speed to provide a force.
n. Mallet: a driving tool made with a leather head to be used on wood chisels.
o. Nail set: a punch used to drive nails below the wood surface.
p. Sliding T-bevel: a device used to lay out angles.
q. Wood chisel: is used for cutting both with and across the grain of wood. Use a wooden mallet for driving a chisel.
r. Wood rasp: a file that is good for making rough-cuts when a lot of material must be removed.
s. Screwdriver: There are two types, phillips and standard. There are a variety of sizes for different sizes of screws.

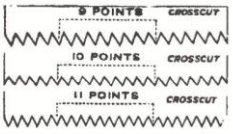
3. Picture of tools:



RIPSAW



BACK SAW



CROSSCUT SAW

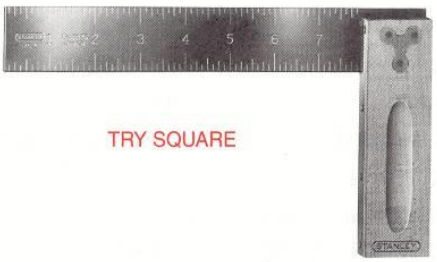

HANDSAW

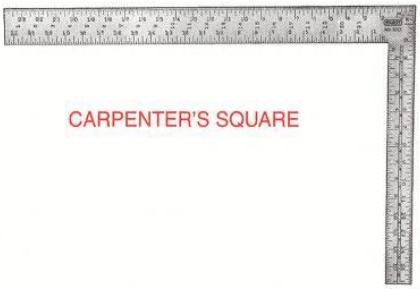

COPING SAW


COMPASS SAW

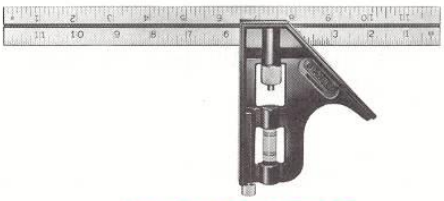

10. WOOD CHISEL

100-FT STEEL TAPE


TRY SQUARE


CARPENTER'S SQUARE

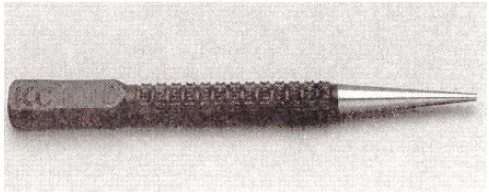
BEVEL


COMBINATION SQUARE

CURVED CLAW HAMMER

RUBBER MALLET

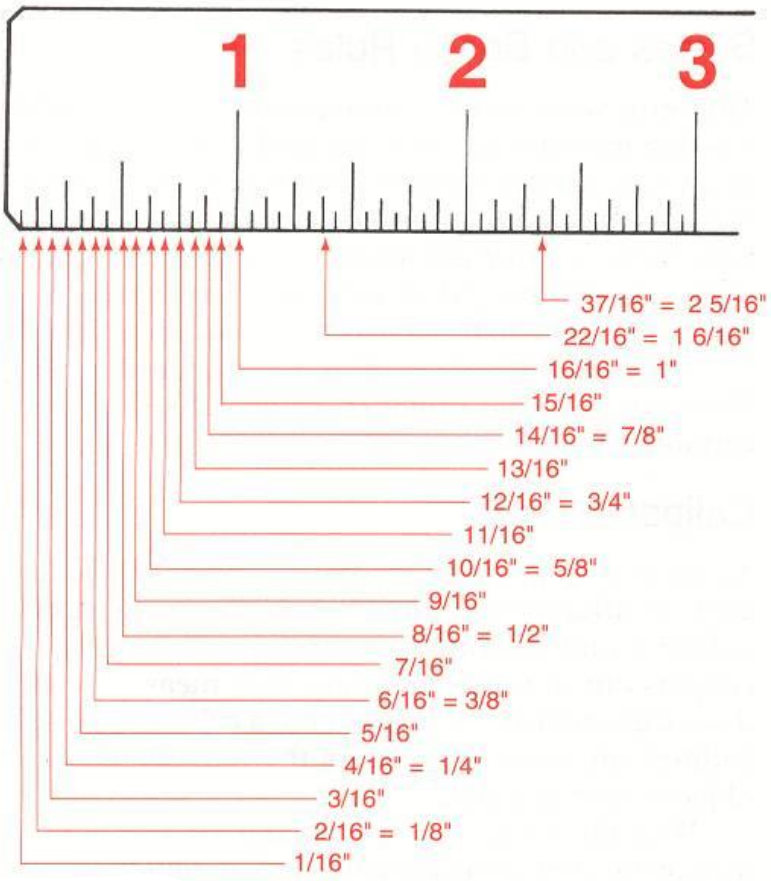
BIT BRACE



NAIL SET

4. Reading a measurement tool:

This tape has both U.S. Customary and metric units of measurement. The 1, 2, 3 values refer to inches. The 20, 30, 40 values refer to millimeters.



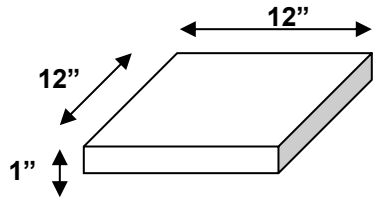
Rules, squares, and other measuring devices are divided into halves, quarters, eighths, and sixteenths of an inch. These divisions are frequently illustrated by lines of different lengths.

5. Calculate l

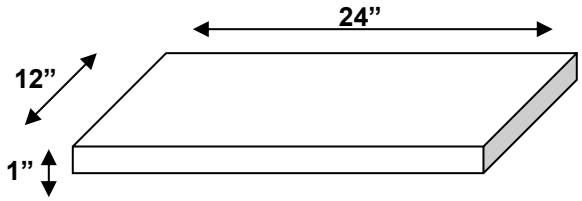
1. **A <u>board foot</u> is a <u>square foot</u> of lumber <u>1 inch thick</u>.**
2. **Lumber is sold by the <u>board foot</u>.**

Exceptions:

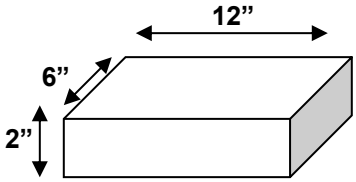
a. **Lumber less than 1 inch thick is figured as 1 inch thick.**
b. **Plywood, compo-board, etc., are sold by the square foot.**
c. **Moldings, dowels, etc., are sold by the lineal foot.**



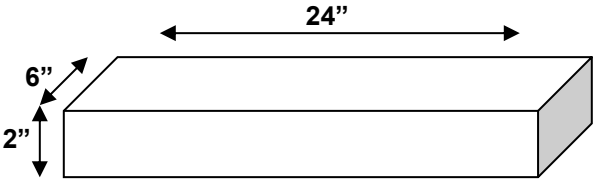
1 BOARD FOOT



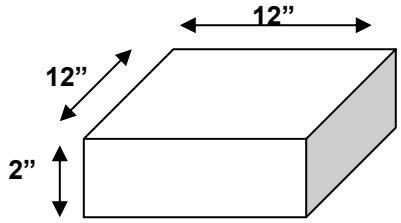
2 BOARD FEET



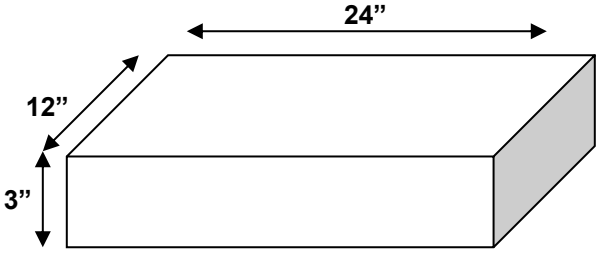
1 BOARD FOOT



2 BOARD FEET

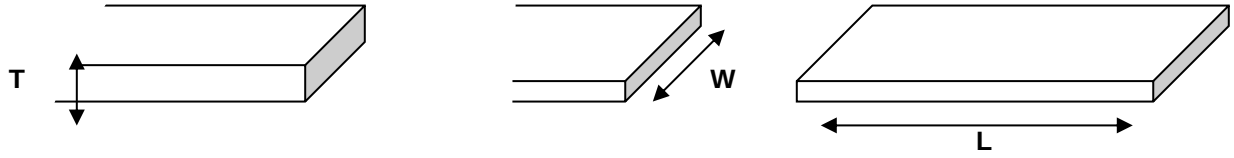


2 BOARD FEET



6 BOARD FEET

TO FIND THE NUMBER OF BOARD FEET, USE THIS GENERAL FORMULA:

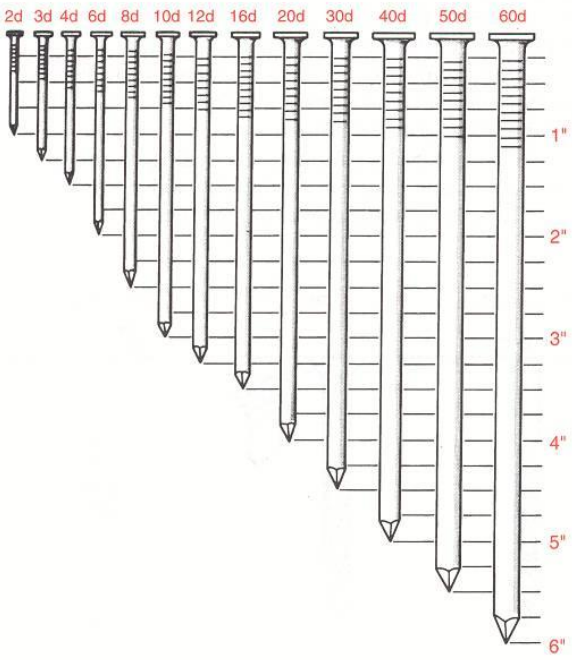


$$\frac{\text{THICKNESS (IN INCHES) X WIDTH (IN INCHES) X LENGTH (IN FEET)}}{12} = \text{BOARD FEET}$$

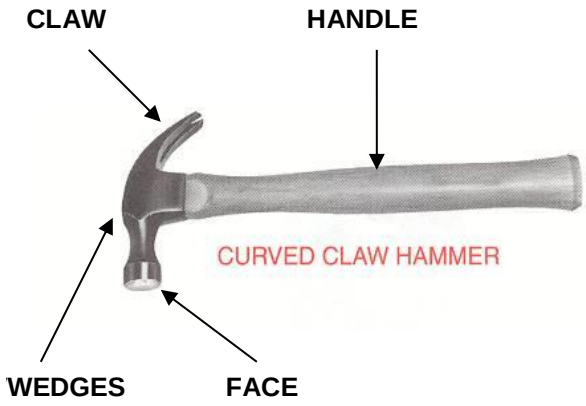
EXAMPLE:

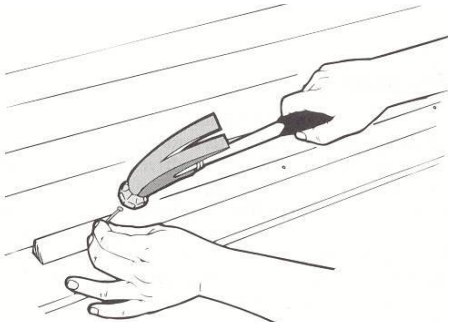
$$\text{1” X 6” X 6’} = \frac{\text{1 X 6 X 16}}{12} = \text{8 BOARD FEET}$$

6. **Hammer nails, size of hammer, and nail description:**

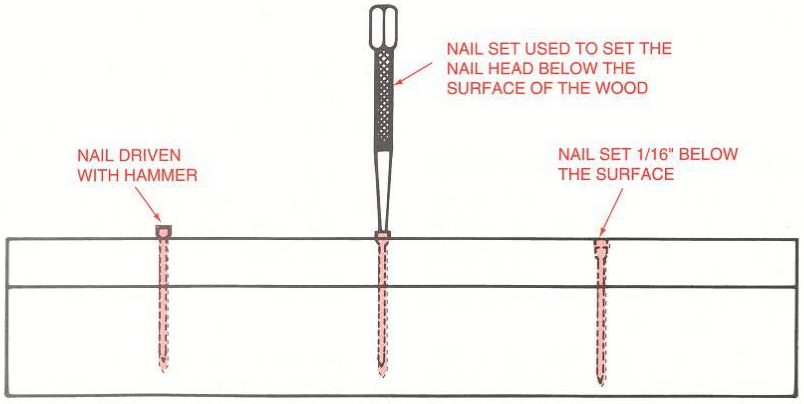


Length of nails by penny size.

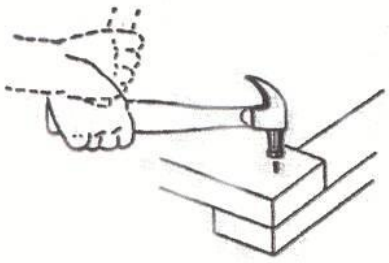




Proper procedure for grasping hammer: Grasp hammer firmly near the end.

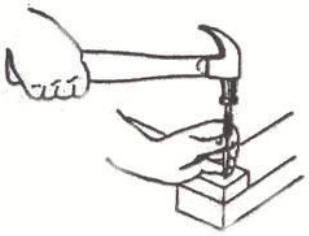


Use of nail set.



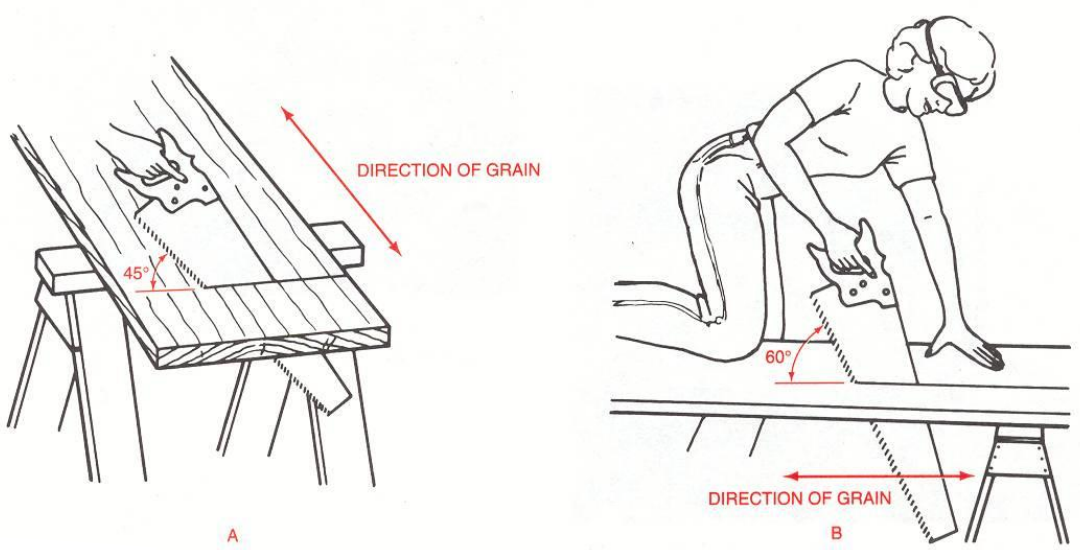
The hammer stroke in driving a nail.

Strike nail squarely to avoid bending nail and denting the wood.

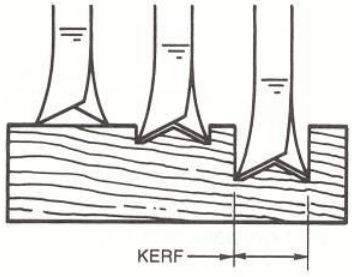


Set nail head below the surface of the wood.

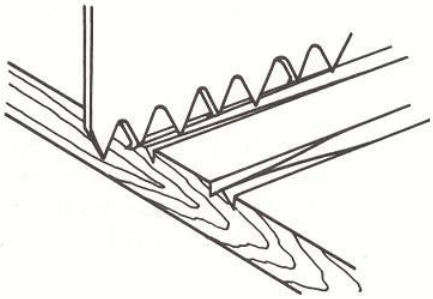
7. Sawing:



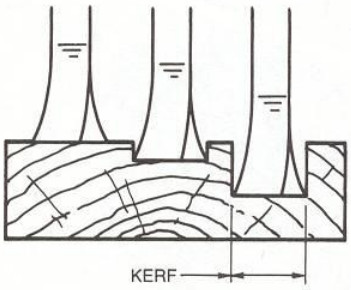
When using a crosscut saw, hold the saw at a 45 degree angle. When using a rip saw, hold the saw at a 60 degree angle. Start all cuts with short strokes, then use full, even strokes for good cuts. The saw kerf should be on the waste side of the line.



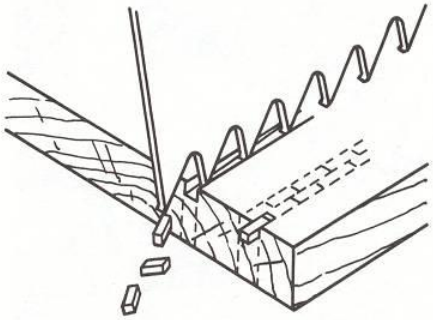
CROSS SECTION OF CROSSCUT TEETH



HOW A CROSSCUT SAW CUTS

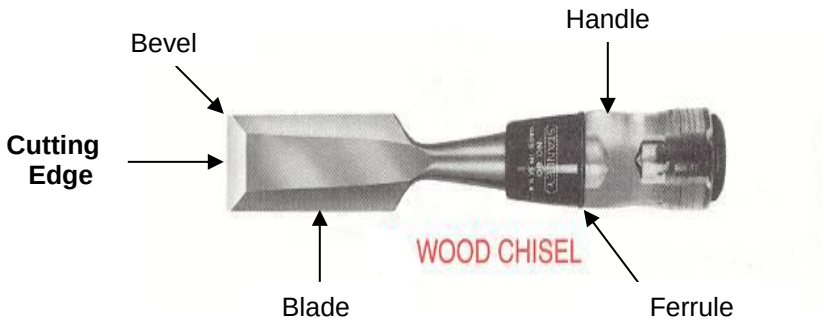


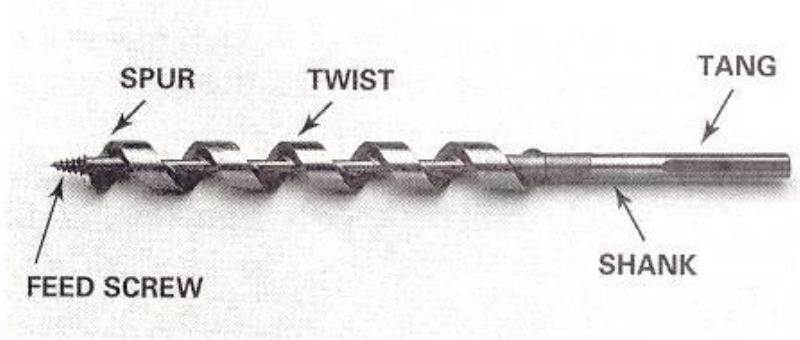
CROSS SECTION OF RIP TEETH



HOW A RIP SAW CUTS

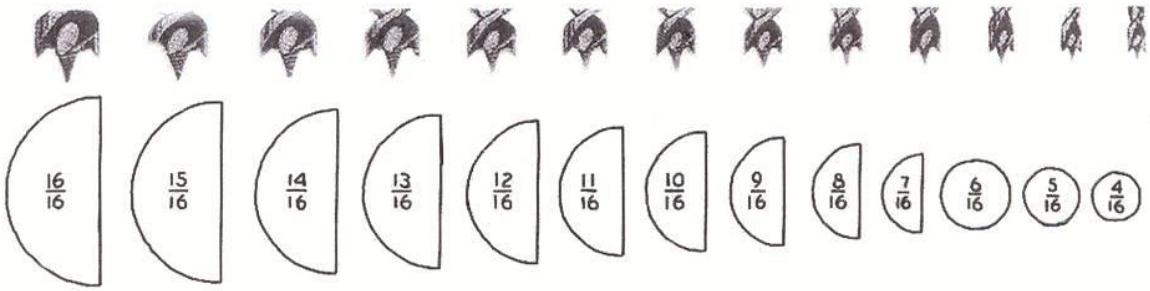
8. Wood chisel:





9. Brace and Bit:

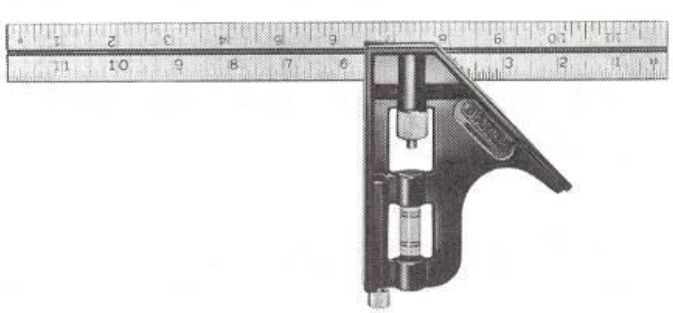
DENOMINATOR OF FRACTION USED IN MARKING SIZES OF AUGER BITS IS 16



1 IN 7/8 3/4 5/8 1/2 3/8 1/4

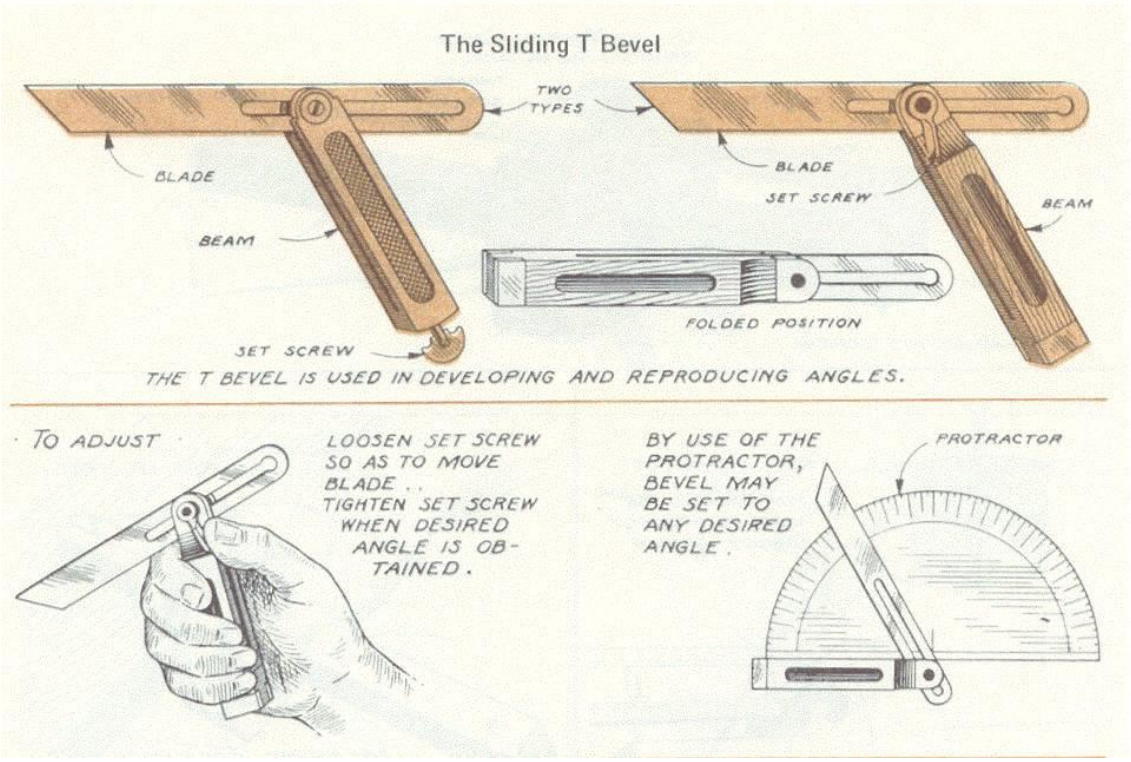
ACTUAL SIZE OF HOLES

10. Combination square:

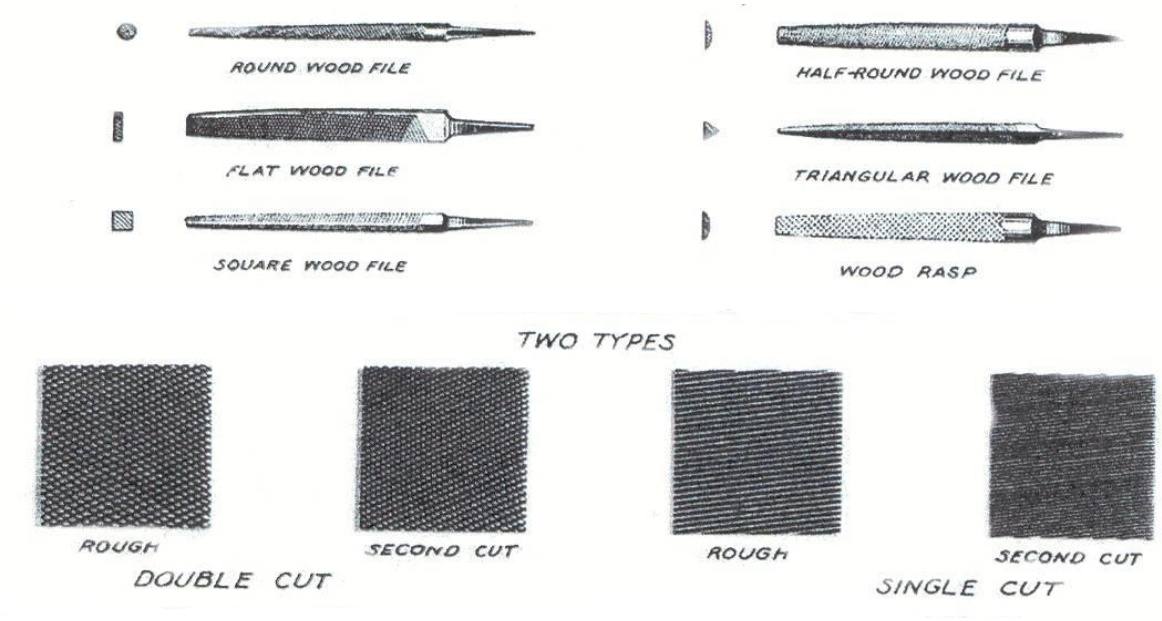


COMBINATION SQUARE

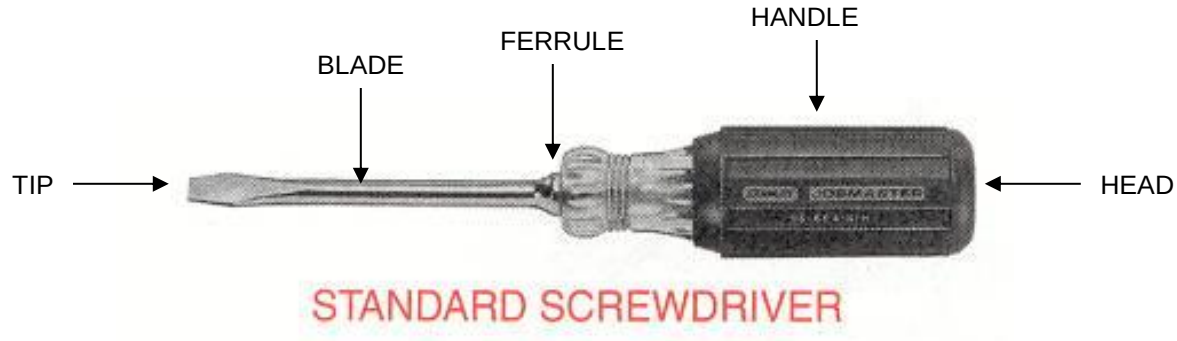
11. Sliding T-bevel:

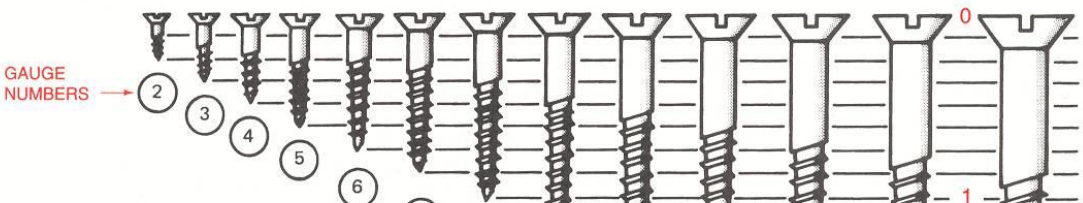


12. Wood rasp:

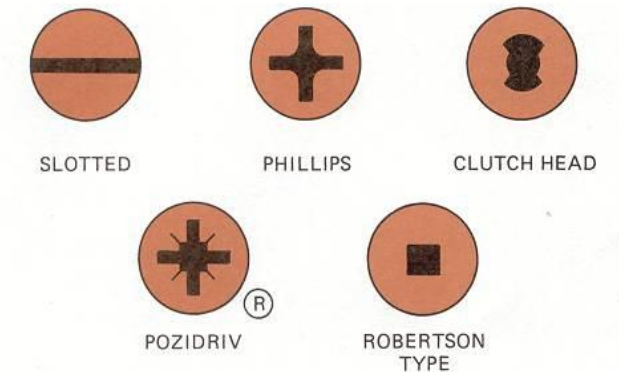


13. Screwdriver and screw sizes:





COMMON TYPES OF SCREW HEADS



14. Sandpaper:

SANDPAPER

Sandpaper is sold in many grades and sizes, and it is made from various abrasive materials. The abrasives in sandpaper are small particles from very hard materials. Each tiny particle has small, sharp edges that make smooth cuts. Sandpaper is used to smooth and prepare the surfaces of the wood for the application of the finishes. Sanding removes the defects and improves the appearance of the finished wood products.

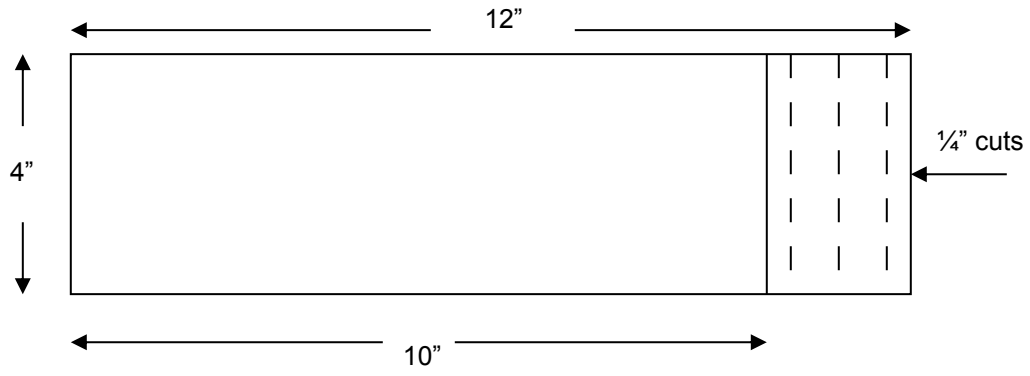
Class	Grit Size		Use	Available in
	Screen	Number		
Extra Coarse	24 30 35	3 2 1/2 2	Sanding texture, paint removal, etc.	Flint, garnet, emery, silicon carbide, and aluminum oxide
Coarse	40 50	1 1/2 1	Final texture sanding, removing defect removing old finishes	All the above
Medium	60 80 100	1/2 0 2/0	Removing rough spots, sanding to size	All the above
Fine	120 150 180	3/0 4/0 5/0	1st pre-finish sanding	All the above
Extra Fine	220 240 280	6/0 7/0 8/0	Final pre-finish sanding	Not available in emery
Ultra Fine	320 400 500 600	9/0 10/0 --- ---	Sanding between coats	1. Not available in flint 3. Garnet no finer than #400 4. 500 and 600 only in silicon carbide and aluminum oxide

EXERCISES

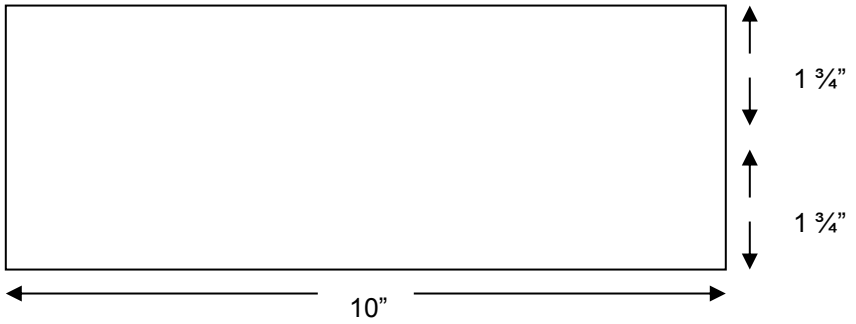
EXERCISE A: Complete Skill Block

1. Equipment, material and tools needed:
   a. (1) 2" x 4" x 12" block of wood
   b. (4) 6 penny nails
   c. (1) 3 penny nail
   d. handsaw (rip and crosscut)
   e. steel tape
   f. block plane
   g. wood chisel
   h. combination square
   i. carpenter's brace
   j. auger bit
   k. claw hammer
   l. coping saw
   m. wood rasp
   n. nail set

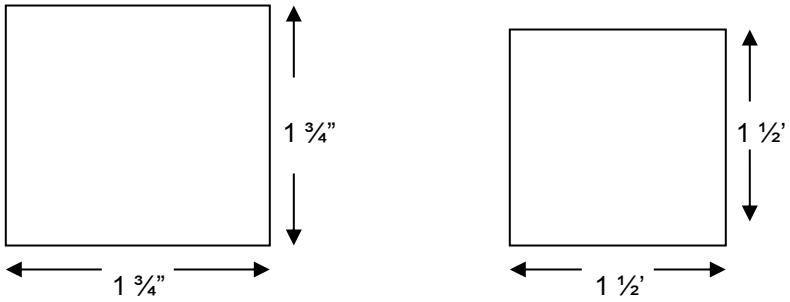
2. Procedure:
   a. Practice cutting a board square by cutting approximately 1/4" per cut until the 2" x 4" x 12" board is 10" long.



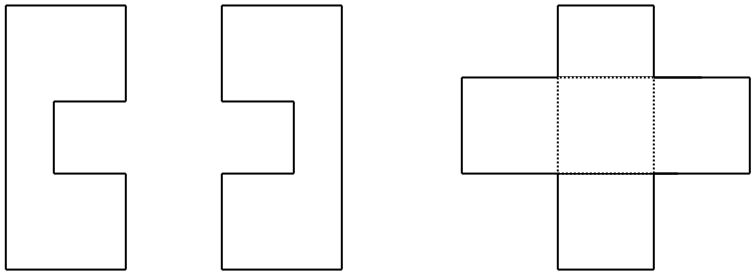
   b. Rip the 2" x 4" x 10" board down the center and check for square cut.



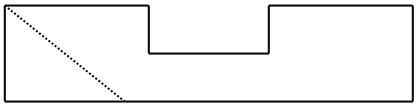
c. Using a block plane cut the 1 3/4" pieces of wood to 1 1/2" x 1 1/2" x 10".



d. Using the two pieces of wood make a cross-lap joint.
   1. Cross one piece on the other in the middle forming a 90-degree angle.
   2. Mark with a pencil along side of each piece where they cross.
   3. Using a combination square, mark half way down the sides of the boards at the lines.
   4. Saw across the boards to the depth of the lines.
   5. Use wood chisel, with bevel down, to remove the wood between the cuts.

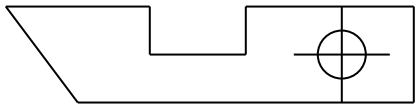


e. Using a combination square and hand saw, cut a 45-degree angle on the end of one of the remaining blocks as illustrated below.

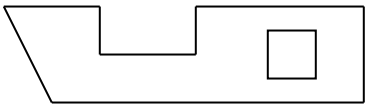


45° angle

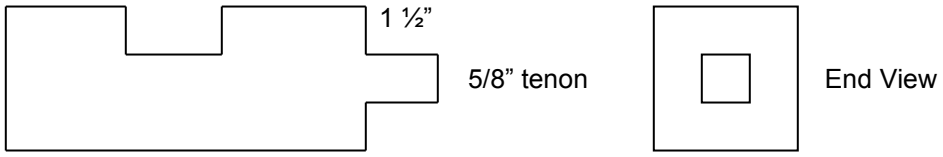
f. Make mortise and tenon joints.
   1. Drill 5/8" hole in center of one of the blocks as illustrated below.



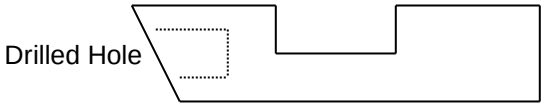
   2. Using a coping saw, cut out corners of the hole to make it square.



3. Using the remaining block of wood, make a 5/8" tenon as illustrated below.



g. Drill a hole 1/2" in diameter 2" deep using a brace and bit.



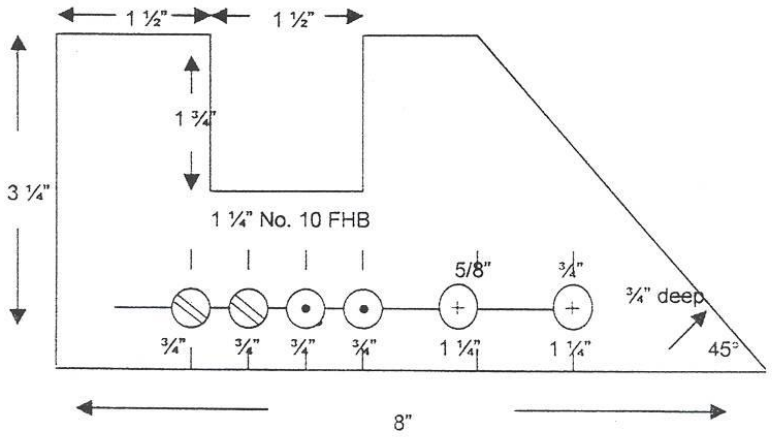
h. After all parts have been graded, nail the blocks together using (3) 6 penny nails and (2) 3 penny finishing nails, and set the heads of the 3 penny finishing nails using a nail set.

i. Turn finished work in to instructor for final grade.

EXERCISE B:

1. Consumable supplies needed:
   a. 2" x 4" stock
   b. (2) 1 1/4" screws - No.10 FHB

2. Procedure:
   a. Mark off an 8" piece of stock, using the combination square.
   b. Cut the board with the crosscut handsaw.
      (Note: Be sure to allow for the width of the kerf.)
   c. Plane surfaces to 1 1/4" thick and 3 1/4" wide.
   d. Mark and cut slot.



      1. Mark slot with combination square according to dimensions.
      2. Cut the slot to depth on each side, using a back saw.
      3. Finish the slot with a wood chisel.

   e. Drill holes for screw.
      1. Lay out (4) screw holes and mark centers.
      2. Drill holes using proper size bits for shank and anchor holes.
      3. Countersink to the proper depth.
         (Note: Do not drill completely through project.)
   f. Bore large holes.
      1. Lay out centers of large holes to be bored with brace and bit.
      2. Select proper size bit.
      3. Bore holes to the proper depth.
         (Note: Be careful not to split out the project on the backside.)
   g. Drive the 2 screws in two of the holes prepared for them.
   h. Do not burr the screw slot.
      (Note: Make sure the screw heads are flush with the surface of the project.)
   i. Hand in completed skill block to instructor for credit.

MECHANICS TECHNOLOGY

AREA: AGRICULTURE GRAPHICS

OBJECTIVE:

Students will learn to use drawing techniques to create plans for projects

COMPETENCIES TO BE DEVELOPED:

1. Learn to identify drawing equipment
2. Learn definitions of drawing symbols
3. Learn to identify the three main types of drawings
4. Given dimensions, the student will create drawings of isometric, oblique, and orthographic view of a simple object
5. Student will demonstrate ability to generate an orthographic view

TIME: The time allotment for instruction in this area is five (5) hours.

REFERENCES:

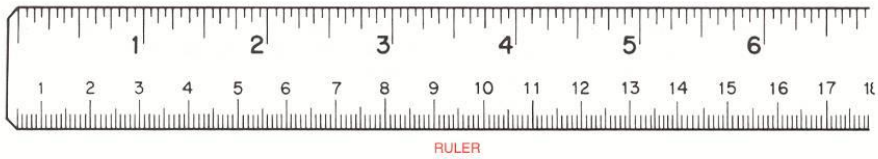
1. *Agricultural Mechanics Fundamentals and Applications, 3rd Edition* by Elmer C. Cooper (Delmar)
2. *Mechanical Technology in Agriculture* by Donald M. Johnson; Joe Harper; David E. Lawver; and Phillip Buriak (Interstate Publishers)
3. *Engineering Drawing and Design,2nd Edition* by David Madsen; Terrence Shumaker; J. Lee Turpin; and Catherine Stark (Delmar)

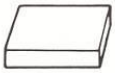
STUDY QUESTIONS

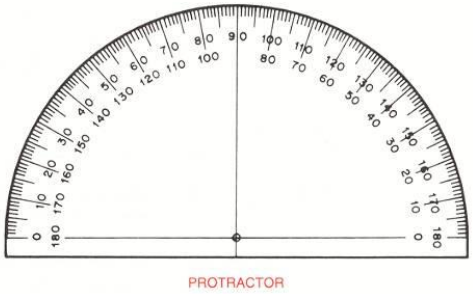
1. What is a sketch?
2. What is a mechanical drawing?
3. What is CADD?
4. Name two (2) advantages of CADD over hand drawing.
5. What is meant by making a drawing to scale?
6. What is the size of a drawing board?
7. What is a T-square?
8. List two (2) types of triangles.
9. What are triangles used for?
10. Denote grades of hardness of drawing pencils most used in Sketching and Drawing.
11. What is a protractor used for?
12. What instruments are used for drawing circles and curves?
13. What is LETTERING?
14. What is the difference between LETTERING and PRINTING?
15. What types of LETTERING are used for DRAWING?
16. What is meant by capital letters and lower case letters?
17. Why should guidelines be used for LETTERING?
18. What are the three (3) main types of drawings?
19. How many views are used for orthographic drawings?
20. What is a dimension line?
21. What is a hidden line?
22. What is an Architects Scale used for?
23. What instrument should be used to make horizontal lines on a drawing?
24. What are input devices?
25. Define a title block.

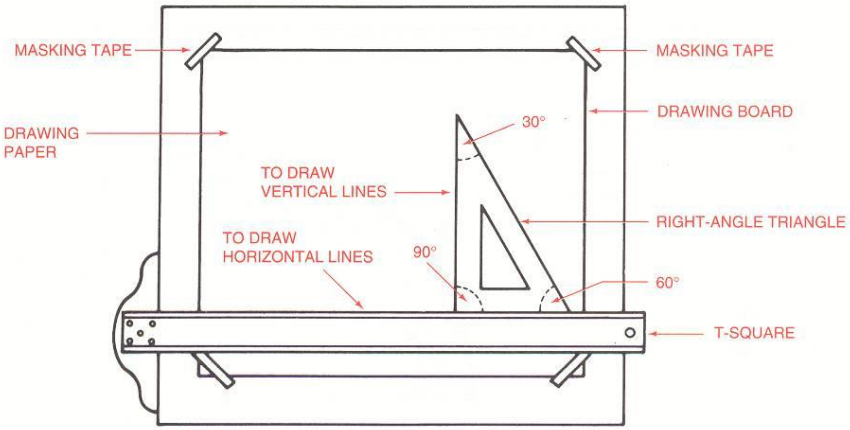
AG-GRAPHICS

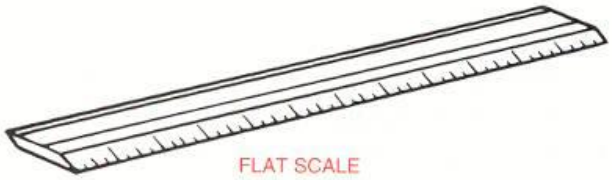
INFORMATION SHEET











AG-GRAPHICS

INFORMATION SHEET

DEFINITIONS:

Border – a heavy line all around and close to the outer edges of the paper

Dimension – the measurement of length, width, or thickness

Drawing – a picture or likeness made with a pencil, pen, chalk, crayon, or other instrument

Scale – the size of a plan or drawing as compared to that of the object it represents

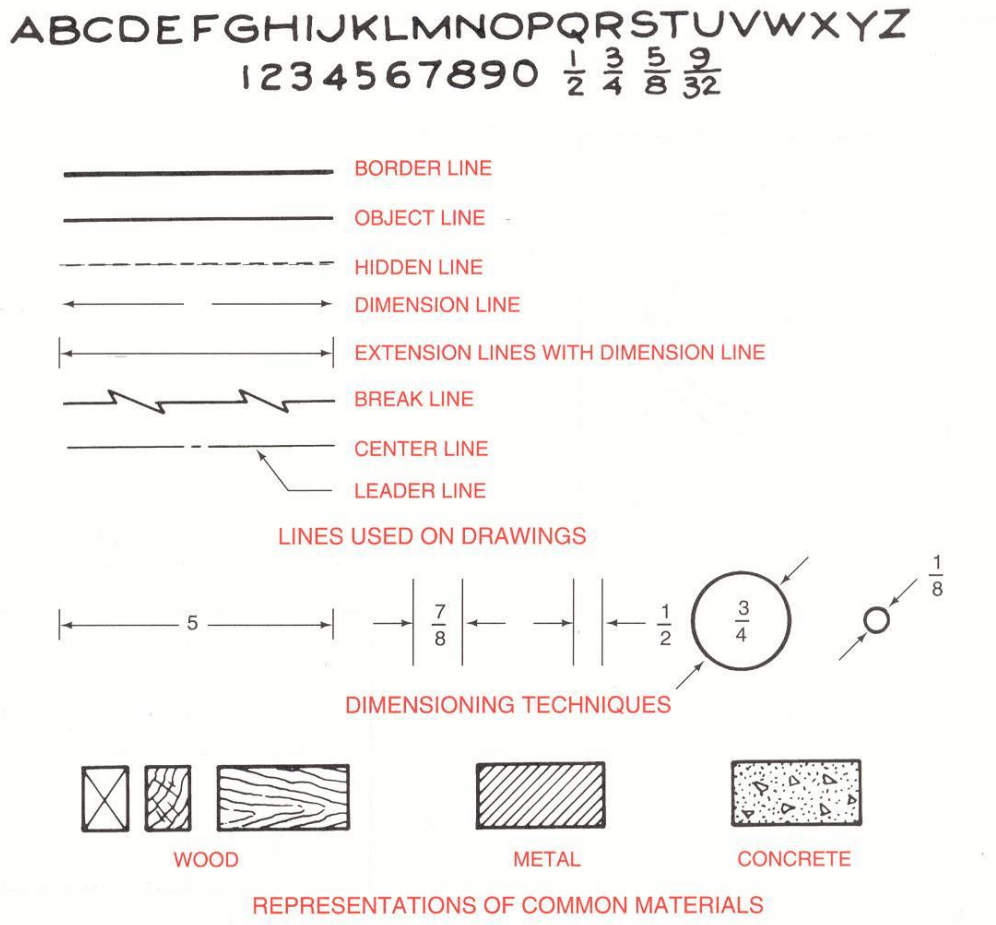
Sketch - a rough drawing of an idea, object, or procedure

Title block – the section of a drawing reserved for information about the drawing in general. Information includes the following:

- **The name of the person who prepared the drawing**
- **The date when the drawing was completed**
- **The name of the drawing**
- **The scale of the drawing**

AG-GRAPHICS

INFORMATION SHEET



TYPES OF LINES

Border line – a heavy, solid line drawn parallel t o the edges of the drawing paper

Object line – a solid line showing visible edges and form of an object

Hidden line – a series of dashes that indicates the presence of unseen edges

Dimension line – a solid line with arrowheads at the ends to indicate the length, width, or height of an object or part

Extension line – a solid line showing the exact area specified by a dimension

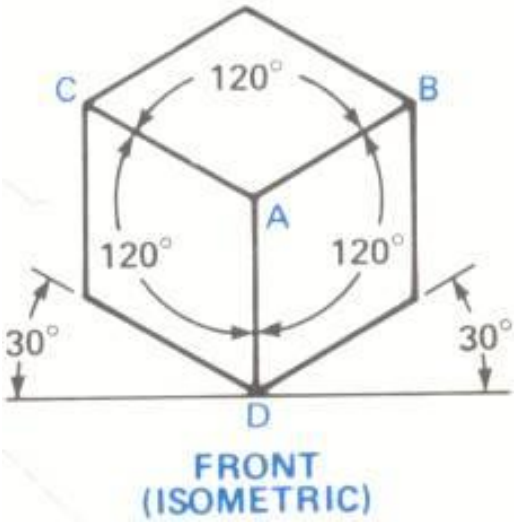
Break line – a solid, zigzag line used to show the illustration stops but the object does not

Center line – a long-short-long line used to indicate the center of a round object

Leader line – a solid line with an arrow used with an explanatory note to point to a specific feature of an object.

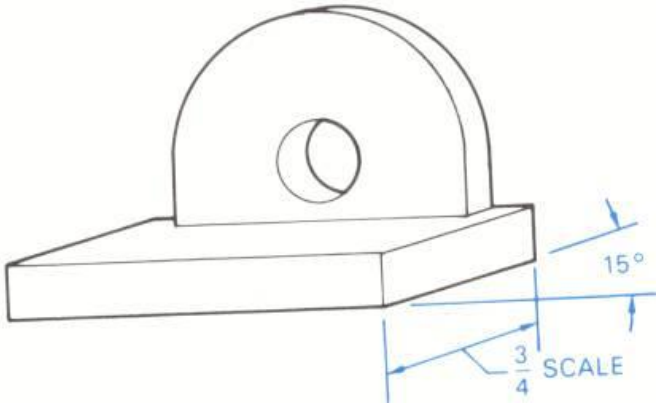
TYPES OF PICTORIAL DRAWINGS

ISOMETRIC DRAWING



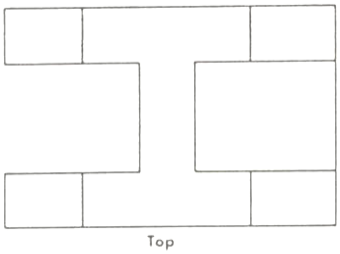
The word isometric means equal (iso) measure (metric). Isometric drawing is a form of pictorial drawing in which the receding axes are drawn at 30° from the horizontal as shown.

OBLIQUE DRAWING

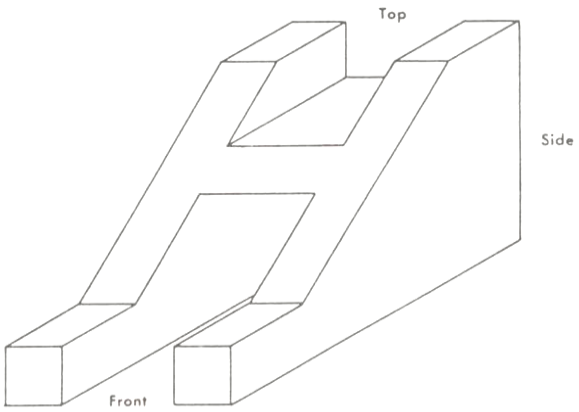


Oblique drawing is a form of pictorial drawing in which the plane of projection is parallel to the front surface of the object. The lines of sight are at an angle to the plane of projection and are parallel to each other. This allows the viewer to see three faces of the object. The front face and any surface parallel to it, is shown in true shape and size, while the other two faces are distorted in relation to the angle and scale used.

ORTHOGRAPHIC DRAWING



THREE-VIEW ORTHOGRAPHIC DRAWING



An orthographic drawing (otherwise known as a perspective drawing) is a pictorial drawing in which three sides are shown in one view: front, top and end or side. It is more natural in appearance in either the oblique or isometric drawing. The receiving lines tend to meet on the horizon rather than remain parallel as in the other pictorial drawings.

WHAT IS CADD?

The term computer-aided design and drafting (CADD) refers to the entire spectrum of drawing with the aid of a computer, from straight lines to color animation. An immense range of artistic capabilities resides under the heading of CADD, and drafting is just one of them. Three-dimensional industrial modeling and analysis is one of the specialized areas that has developed as a result of CADD.

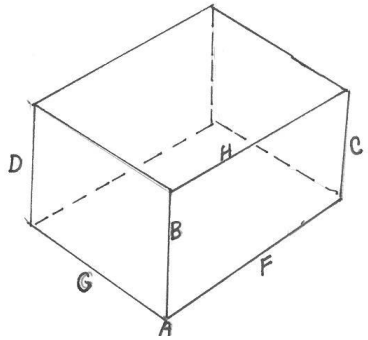
EXERCISES

Exercise A: Using Drawing Equipment to Make Lines Needed for Drawing an Object

1. Secure materials: 8 1/2" x 11" paper, T-square, Architects Scale, sharp pencil (2H), Triangle (30°, 60°, 90°), masking tape, drawing board, and eraser.
2. Square the paper on the drawing board, using the T-square for squaring it, and secure paper with masking tape.
3. Draw the following object by making vertical, and horizontal lines, and 30° lines. (See Figure I.)

Note: Lines B, C, D, and E are vertical lines
Lines F, G, and H are 30° lines
Lines H, I, and J are horizontal lines
Locate other vertical, horizontal, and 30° lines
This is an Isometric drawing

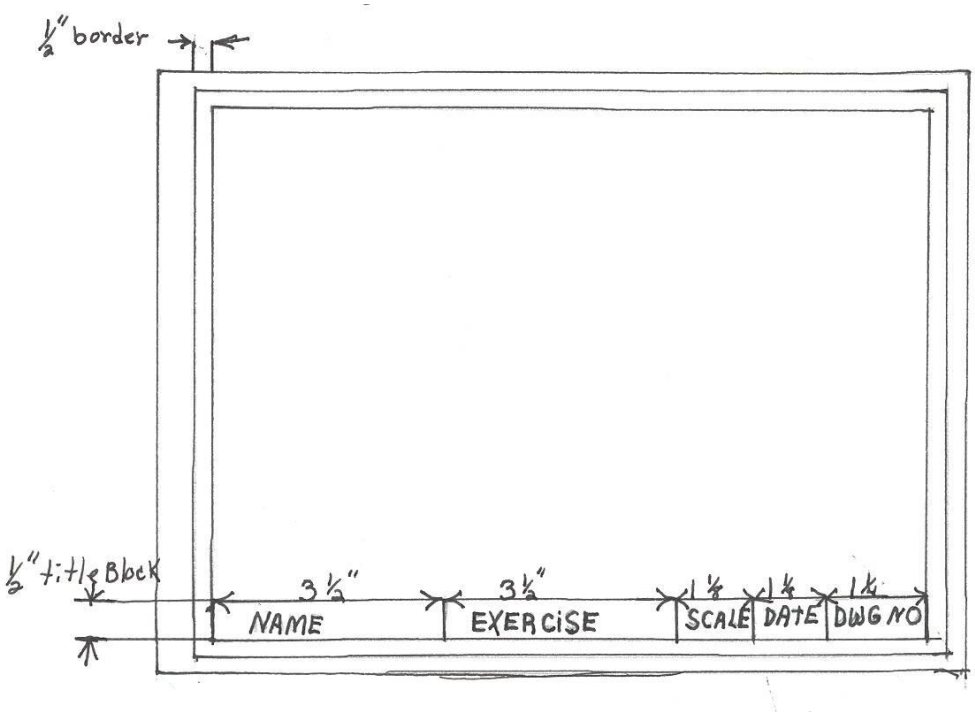
FIGURE I



Exercise B:

1. Secure a piece of drawing paper 8 1/2" x 11".
2. Turn the paper lengthwise. (See Figure II.)
3. Draw a 1/2" border around the paper.
4. Add a 1/2" title block.
5. In the title block, letter your name and the date, for the name of the project, print "Show Box" for scale, 1" =1' (See Figure II.)
6. Make a light mark 1" from the left margin and draw a very light line through it from top to bottom and parallel to the left border. This is your object line for the left side of the top and front views.
7. Make a light mark 1" up from the title block and draw a very light line through it from border to border and parallel to the title block, this is your bottom object line.
8. The length of the box if four (4) feet. The scale is 1" =12" or 1" = 1'. Measure across 4" from the left object line and draw a very light line from top to bottom. This is your object line for the right side of the top and front views.

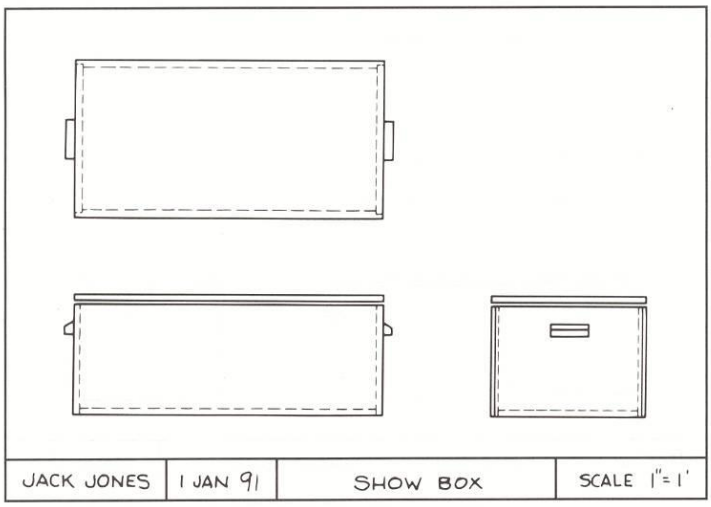
FIGURE II



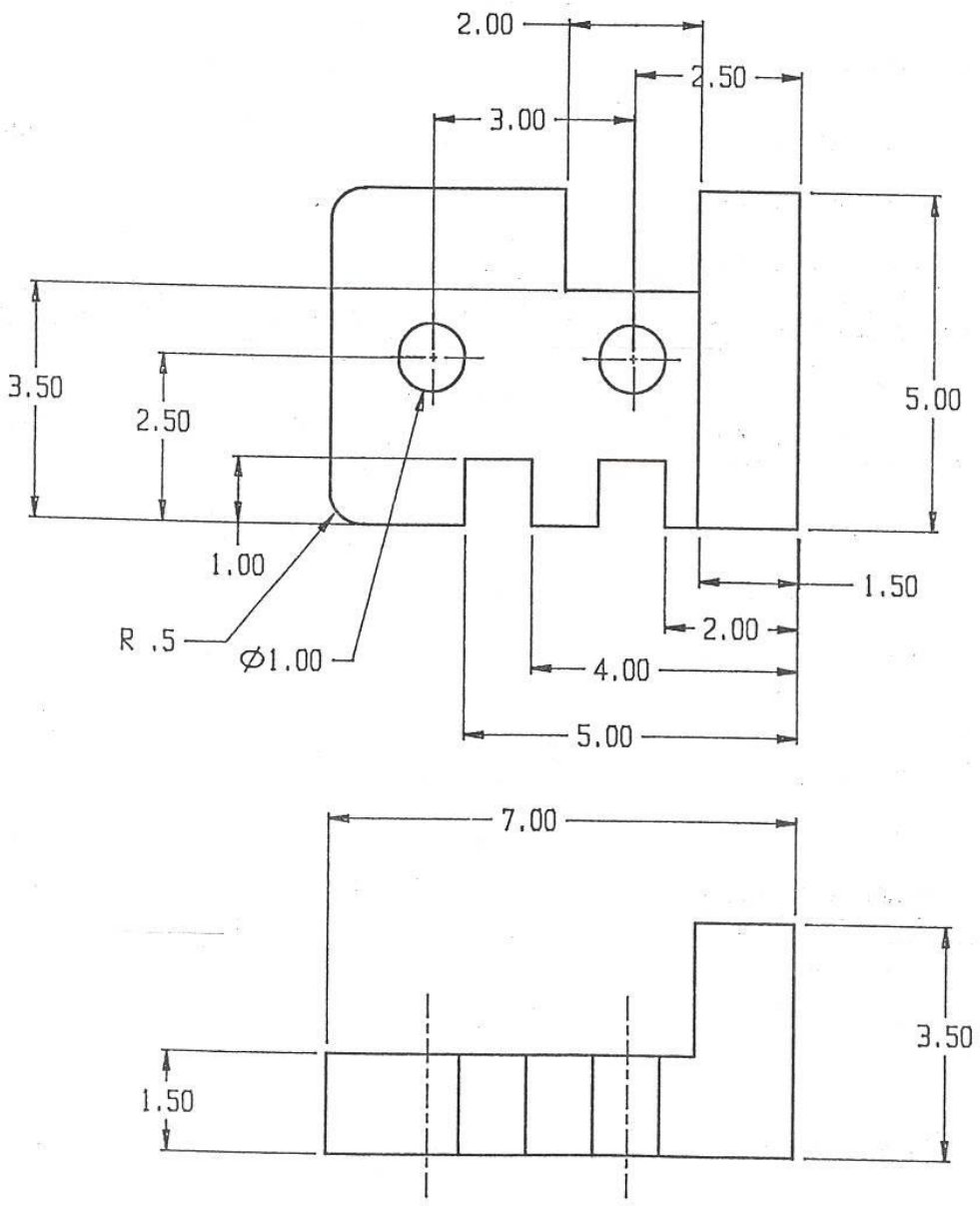
9. Measure 1" to the right and draw a very light vertical line from top to bottom. This becomes the right side of the end view.
10. Measure another 2" to the right and draw another very light vertical line. This is your right side of the end view.
11. The show box is 1 1/2" high, so start at the bottom object line and measure up 1 1/2". Draw a very light line to form the top object line of the front and end views. Measure up 1" from the top object line and draw a light line to form the bottom object line of the top view.
12. The show box is 2" wide, so measure up another 2" and draw a light line to form the upper object line of the top view.
13. All three views are blocked in and drawn to scale. Erase excess lines that extend beyond the views. (See Figure III.)

FIGURE III

Exercise C:



Carefully draw the mechanical drawing below, and then evaluate the drawing for each of the areas listed in the evaluation form that follows.



Assignment Sheet - Evaluate a Mechanical Drawing

1. Accuracy_____

_____

2. Linework _____

_____

3. Lettering _____

_____

4. Overall Appearance _____

_____

5. Dimensioning _____

_____

6. Reproducibility_____

_____

7. Spelling and Use of Abbreviations_____

_____

MECHANICAL DRAFTING WITH CADD

TOOLS, EQUIPMENT AND MATERIALS LIST

Basic Drafting Instruments
Compass
Drafting Pencils
Eraser
Scales
T-square or Drafting Machine
Triangles

Hardware
Computer
Keyboard
Monitor
Input Device: Mouse, Joystick, Graphics Tablet, Voice Input, or Other
Plotter
Printer

Software
Elementary Software
Utility software as available
CADD software: AutoCADD, CADDkey, Microstation, Design CADD, VersaCADD, CADDUM, or as selected Windows for DOS and utility software as needed