Using Metal Cutting Processes and Techniques

Unit A. Mechanical Systems and Technology

Problem Area 5. Metal Fabrication

Lesson 5. Using Metal Cutting Processes and Techniques

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: **VII:** Develop skills required to use construction/fabrication equipment and tools.

Benchmark: **VII-A:** Use tools in the workplace to demonstrate safe and proper skills with construction/fabrication hand tools.

Performance Standard: **1.** Demonstrate proper use of measurement and layout tools. **3.** Demonstrate safe and proper techniques in using hand and power tools in construction/fabrication.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Identify the equipment used when cutting cold metal.
2. Describe the processes and techniques used when cutting cold metal.
3. Identify the equipment used when cutting hot metal.
4. Describe the processes and techniques used when cutting hot metal.
5. Identify safety practices that should be observed when cutting cold and hot metal.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Burke, Stanley R. and T.J. Wakeman. *Modern Agricultural Mechanics*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook, Chapters 4 and 5)

Cooper, Elmer L. *Agricultural Mechanics Fundamentals and Applications*. Albany, New York: Delmar Publishers, Inc., 1987.

Phipps, Lloyd J., et al. *Introduction to Agricultural Mechanics,* Second Edition. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2004. (Textbook, Chapters 4, 5, and 13)

Phipps, Lloyd J., and Carl Reynolds. *Mechanics in Agriculture*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook, Chapter 15)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Cold and hot metal cutting tools
Pieces of steel

Terms. The following terms are presented in this lesson (shown in bold italics):

Cape chisels
Diamond point chisels
Double cut file
File
Flat chisels
Hacksaw
Rasp
Round nose chisels
Single cut file
Snips or shears

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Display pieces of steel. Ask students to identify ways that the materials can be cut or what tools could be used to cut them. Direct the discussion into cold and hot cutting techniques and tools.

Summary of Content and Teaching Strategies

Objective 1: Identify the equipment used when cutting cold metal.

Anticipated Problem: What equipment is used when cutting cold metal?

I. Cold metal may be cut with a hacksaw, cut-off saw, band saw, bolt cutter, file, snips or shears, or a cold chisel. Cold metal cutting tools are divided into categories depending on their power source, either hand or power. The operator provides the power for operating the hand tools, while power tools rely on a source other than the operator for power.

A. The tool most often used for cutting metal is the hacksaw. A ***hacksaw*** is a saw with a frame and a blade designed for cutting metal. They are designed so new blades can be installed easily. Select the proper blade for the job to be completed. Hacksaw blades vary in type and size.

1. All-hard blades are hardened throughout and are used for sawing heavy work, tool steel, cast iron, and brass.
2. Only the teeth are hardened on the flexible blades. They are used for sawing light and hollow materials.
3. Hand hacksaw blades are made in 8 inch, 10 inch and 12 inch lengths, with 14, 18, 24, or 32 teeth per inch.
4. Hack-saw blades can be purchased with an undulated (wavy), alternate, or raker tooth arrangement pattern. Lower quality blades have undulated teeth arrangement.

B. Bolt cutters provide a fast and efficient method of cutting bolts, rods, and other small metals. The capacity of the bolt cutter is stamped on the handle and ranges from $^{3}/_{16}$ inch to ¾ inch.

C. A ***file*** is made of hardened high-carbon steel, with flat or rounded surfaces that are made rough with teeth or grit. They are used for smoothing surfaces or sharpening metal objects. Files come in various shapes and sizes and in various sizes of cuts (chisel teeth).

1. A file with straight teeth all going in the same direction is a ***single cut file***.
2. A file with teeth in two directions is known as a ***double cut file***.
3. A file with sharp pointed teeth is known as a ***rasp***.
4. Both single cut and double cut files are made in different degrees of coarseness.
   a. Rough, middle, bastard, second cut, and smooth are examples of coarseness.
   b. The coarseness also varies with the length of the file.
5. Common files are flat, rasp, half round, round bastard, and taper triangular.
   a. Flat files are used for smoothing both wood and metal.
   b. Rasp cut files are used for smoothing coarse wood work.
   c. Half round files are used for both metal and wood.
   d. Round bastard files are used for enlarging and smoothing holes.
   e. Taper triangular files are used for filing saws or cleaning threads.

D. ***Snips*** or ***shears*** are large scissor-like tools for cutting sheet metal and fabrics, and are divided into regular, or compound aviation.
   1. Regular snips or shears are used for light cutting, while compound or aviation are used for heavy cutting.
   2. Snips or shears are used for cutting straight, left-hand, or right-hand curves.

E. When using a cold chisel to cut cold metal, the chisel must be harder than the metal it is intended to cut. The four standard shapes for cutting edges for cold chisels are flat, cape, diamond-point, and half-round nose.
   1. ***Flat chisels*** are used for chipping, removing metal from a flat surface, and cutting sheet metal.
   2. ***Cape chisels*** are used for cutting narrow, flat grooves and slots.
   3. ***Round nose chisels*** are used to cut concave grooves.
   4. ***Diamond point chisels*** are used to cut v-shaped grooves.

F. Metal cutting power tools are reciprocating hacksaws, band saws, cut-off saws, and shears.
   1. The power hacksaw has a reciprocating movement which operates similar to the hand hacksaw, however it cuts much faster. The frame holds a rigid blade which is ¾ inch to 1 inch wide and 12 inches to 18 inches long. Blades are available with fine to coarse teeth.
   2. Horizontal band saws have a blade that travels on wheels and moves through rollers and guides, and saws parallel to the ground. Blade movement is forward at all times, so it cuts continuously, which results in faster cutting than the power hacksaw.
   3. Metal cut-off saws, also known as chop saws, use a circular blade lowered into the material that is being cut. The cutting blade is an abrasive disc that provides a straight clean cut.
   4. The power shear can cut flat, angle, and other structural steel faster and cleaner than by hand or by power saw.

Use TM: A5–5A, A5–5B and A5–5C to provide examples of cold metal cutting equipment. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 5 in Modern Agricultural Mechanics, Chapter 16 in Mechanics in Agriculture, Chapter 4 and 5 in Introduction to Agricultural Mechanics and Unit 12 and 16 in Agricultural Mechanics are recommended.

Objective 2: Describe the processes and techniques used when cutting cold metal.

Anticipated Problem: What processes and techniques are used when cutting cold metal?

II. Proper procedures must be followed to properly cut cold metal.
   A. Hacksaws are made to cut metal.
      1. Be sure safety glasses are worn.

2. Select a blade with enough teeth per inch so that two or three teeth are in contact with the metal at all times. There must be few enough teeth to the inch to allow the gullets to carry off the chips without clogging.
3. Fasten the blade into the hacksaw frame with the teeth pointing away from the handle of the saw. Make sure the blade is fastened securely so that it will not twist and break.
4. Mark the stock at the point at which it is to be cut.
5. Place the stock in the vise, with the mark about ½ inch from the jaws. Sawing close to the jaws of the vice makes the sawing easier because the piece is held firmly and does not spring back and forth.
6. Place the saw on the mark and then pull it toward you using little pressure to start the kerf. To help get the saw started in the proper place, a notch can be cut at the mark with a file.
7. Apply slight pressure on the forward strokes of the hacksaw, and release the pressure on the return strokes to insure proper cutting and to lessen the danger of breaking the blade of the saw.
8. Run the saw evenly, using long strokes, with all the teeth cutting to prevent wear on a small portion of the blade, thus shortening the life of the blade.
9. Thin metal can be cut more easily with a hacksaw if a thin piece of wood is clamped on each side of the metal. Saw through the metal and wood pieces simultaneously.
10. Similar procedures should be followed when using a horizontal band saw.

B. ***Chisels*** are made to cut cold metal. These will usually cut any metal which can be filed.
1. Be sure safety glasses are worn.
2. Mark the material to be chiseled.
3. Select the correct chisel for the job. Make sure the edge is in good condition.
4. Place the stock in a vise or clamp it to the table. Watch the edge of the chisel as you work.
5. Sharp, quick blows are best. Reset the chisel after each blow.
6. The angle of the cutting edge of a chisel should be approximately 65 degrees with the cutting edge slightly rounded.
7. In removing metal, hold the chisel at an angle that will keep the surface of the work and the lower bevel of the chisel parallel.
8. When cutting heavy, round stock, cut halfway through, then turn the stock and make the rest of the cut from the opposite side.

C. Small amounts of metal may be removed where needed with a file.
1. Be sure safety glasses are worn.
2. Mark the material to be filed.
3. Place the stock in a vise or clamp it to the table.
4. Select the correct file for the job to be done.

5. File teeth usually slant toward the point of the file and therefore cut only on the forward stroke.
6. A handle should be placed on the tang of the file.
7. Hold the handle of the file against the palm of the hand, with the thumb on the top of the handle.
8. Hold the point of the file with the thumb and index finger of the other hand.
9. Use pressure on the forward stroke only, and use only enough pressure to make the file cut evenly. Do not bear down hard on a new file, or the teeth will be ruined. A new file should be broken in by using it first on brass or bronze.
10. Lift the file on the return stroke.
11. Do not take more than 30 to 40 strokes a minute. Excessive speeds will ruin both the file and the work.
12. Rubbing chalk on a file before it is used will help to prevent it from becoming clogged. If a file becomes clogged, it may be cleaned with a file card, pick, and brush.
13. Do not use a file on material harder than the file.
14. Store files in separate holders to prevent their rubbing together or knocking against other tools. The teeth are brittle and thus are easily dulled or broken.

D. Snips or shears are used for cutting sheet metal and fabrics.
1. Be sure safety glasses are worn.
2. Mark the material to be filed.
3. Place the stock in a vise or clamp it to the table.
4. It is advisable to wear gloves when handling and working with sheet metal.
5. Select the correct shears for the job to be done. Select a pair of shears that are sharp and free of nicks.
6. A piece of scrap should be cut first to be sure the shears are heavy enough.
7. Shears are used like scissors. For them to work well, the metal must curl or lift up and out of the shear as the cut progresses.

E. Cutoff saws are being used more and more in agricultural mechanics due to the speed and accuracy of cutting.
1. Be sure safety glasses are worn. Hearing protection may also be needed.
2. Mark the material to be cut.
3. Be sure the saw is properly adjusted and the blade in the machine is designed to cut the kind of material to be cut.
4. Place the stock on the table of the saw and use the vise or clamp to hold it securely.
5. Hold the handle with one hand and turn the switch on.
6. Lower the saw into and through the material to be cut using a slow deliberate motion.
7. After the cut is made, let the saw rise, and turn off the switch.
8. After the saw has stopped turning, release the handle and remove the material.

F. The power hacksaw is very useful in the agricultural mechanics shop.

1. Be sure safety glasses are worn.
2. Mark the material to be filed.
3. Be sure the saw is properly adjusted and the blade in the machine is designed to cut the kind of material to be cut.
4. Place the frame in the raised position.
5. Adjust the vise on the machine to hold the metal at the desired angle.
6. Position the metal in the vise on the machine and tighten securely.
7. Turn on the machine.
8. Lower the frame slowly and carefully until the blade is on the stock and starting to cut.
9. If equipped with coolant, turn it on.
10. Stay near the machine while it is cutting.
11. Switch off the machine when the cut is finished if it does not turn off automatically.
12. Remove all scrap metal and clean up all metal dust and coolant.

Use TM: A5–5D and A5–E illustrate using a hacksaw and file. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 5 in Modern Agricultural Mechanics, Chapter 16 in Mechanics in Agriculture, Chapter 4 and 5 in Introduction to Agricultural Mechanics and Unit 12 and 16 in Agricultural Mechanics are recommended.

Objective 3: Identify the equipment used when cutting hot metal.

Anticipated Problem: What equipment is used when cutting hot metal?

III. Hot metal can be cut with a hardy or a hot cutter, fuel gas equipment, arc welder, or plasma cutter.

A. Metal is measured and marked before it is heated. Use a center punch to mark the location. Pencil or chalk marks will burn off.

1. Using the hardy or a hot cutter to cut hot metal is a very delicate process that may require the help of another person.
2. Fuel gas welding equipment with a cutting attachment is a very useful and popular way to cut metal.
3. When oxygen strikes a preheated metal surface, it causes the metal to burn or oxidize. The oxygen combines with the heated iron to form a molten metal and slag which flows or is blown away, exposing more metal to the oxygen jet.
4. The tip of a cutting blowpipe has several small holes located around a larger hole in the center of the tip.

a. The small holes permit the oxyacetylene mixture to pass through them. They provide flames to preheat the metal before it is cut.

b. The large hole in the middle of the tip supplies a jet of oxygen under high pressure that does the actual cutting after the metal is preheated to a red heat.

B. The arc welding electrode can be used for cutting metal.

1. An electrode is useful for cutting cast iron, for cutting in inaccessible places, and for cutting small jobs.
2. The use of an arc is usually considered to be the best method of cutting cast iron, because cast iron does not oxidize with heat.
   a. To be cut, cast iron must be melted and the electric arc melts metal as a means of cutting it.
   b. Cutting metal with an electrode is fast, but the cut is not smooth.
   c. Steel melts at approximately 2,600°F, while the heat generated by the electric arc is 6,500°F.

C. Plasma arc cutters work by sending an electric arc through a gas that is passing through a constricted opening. The gas can be shop air, nitrogen, argon, oxygen, etc. This elevates the temperature of the gas to the point it enters a fourth state of matter, plasma.

1. As the metal being cut is part of the circuit, the electrical conductivity of the plasma causes the arc to transfer to the work.
2. The restricted opening or nozzle the gas passes through causes it to squeeze by at a high speed.
   a. The high speed gas cuts through the molten metal.
   b. The gas is also directed around the perimeter of the cutting area to shield the cut.
3. Plasma cutters are ideal for cutting mild and stainless steel, aluminum, brass and copper. Virtually no heat spread is given. This means almost no distortion or discoloration occurs to the material being cut.
4. Computer numerically controlled (CNC) plasma cutters fully automate the shape production process. These machines can be relatively inexpensive units that operate by personal computers. While those used with expensive, limited production computers made specifically for running the burning machines may cost as much as $100,000.

Use text material to strengthen student understanding of concepts. Chapter 4 in Modern Agricultural Mechanics, Chapter 16 in Mechanics in Agriculture, Chapter 13 in Introduction to Agricultural Mechanics and Unit 23 and 26 in Agricultural Mechanics are recommended.

Objective 4: Describe the processes and techniques used when cutting hot metal.

Anticipated Problem: What processes and techniques are used when cutting hot metal?

IV. Hot metal cutting processes and techniques vary with the tool used. Tools used to cut are a hardy, a hot cutter, or a combination of the two, fuel gas equipment arc welder or plasma cutter.

A. Follow the procedure listed when using the hardy to cut metal, be sure safety glasses and gauntlet or welding gloves are worn.

1. Place the hot metal over the hardy in line with the cut.
2. Strike the metal directly over the hardy until the cut is almost through.
3. Finish the cut by striking the metal just beyond the cutting edge of the hardy.
4. When finishing the cut, be careful not to strike the cutting edge of the hardy with the hammer.

B. The procedure for using a hot cutter is as follows:

1. Be sure safety glasses and gauntlet or welding gloves are worn.
2. Place the hot metal flat on the anvil and set the cutting edge of the handled hot cutter at the mark.
3. Strike the head of the hot cutter with a hammer until the metal is cut almost through.
4. Cool the hot cutter frequently in water to prevent drawing its temper.
5. Slide the metal over until the cut is just past the edge of the anvil. Finish the cut with light blows of the hammer. Be careful not to let the cutting edge of the hot cutter come in contact with the face of the anvil. The anvil face is made of hardened steel and will dull or break the cutter.
6. To help prevent flattening the end of round stock, use a combination of the hardy and hot cutter.

C. The following procedure is suggested for cutting ordinary steel with the fuel gas cutting equipment.

1. Mark a line with a center punch about 1 inch from the edge of the piece of steel. Make several marks along the line or use a scriber to make a line.
2. Place the piece of steel on the welding table so that the mark clears the edge of the table by at least one inch. A piece of metal clamped to the metal to be cut may be used as a guide.
3. Be sure safety glasses are worn. Put on a gas welding face shield or goggles, and gloves.
4. Light the cutting blowpipe.
5. Follow the same procedures for lighting, adjusting, and shutting down the blowpipe that were given in the previous lesson.
   a. An addition to the lighting procedure is to depress the cutting-oxygen valve lever and check to see that a neutral flame is present. If necessary, adjust the preheat-oxygen valve until a neutral flame is maintained when the cutting-oxygen valve is open.
   b. Hold the blowpipe with the nozzle perpendicular to the surface of the metal and with the inner cones of the preheating flames at the edge of the piece of steel and about $^{1}/_{16}$ inch above the chalk line.

c. Hold the blowpipe steady at this spot until the steel becomes a bright red, then slowly press down the cutting-oxygen valve lever. A bright red color indicates that the steel is near the melting point.

d. Move the blowpipe slowly along the cut-off line, cutting completely through the metal as the cutting proceeds.

D. Cutting with the arc welding electrode requires the use of 30 percent more amperage than would be used for welding.

1. Be sure safety glasses are worn.
2. Put on a electric welding face shield and gloves.
3. When cutting flat metal which is thicker than the electrode, the metal to be cut is placed in a flat or horizontal position.
4. Strike the arc where the cut is to be made, and allow the heat of the arc to form a crater of molten metal.
5. Move the electrode back and forth to force the molten metal from the cut or kerf.
6. A downward pushing motion coupled with a quick upward motion helps to force the molten metal from the cut. Since arc cutting is done by melting the metal, the motion of the electrode and the position of the work should assist the molten metal to fall out of the cut.

E. When cutting round stock, start at an outer edge of the stock so that the molten metal can escape.

1. Follow the same procedures as when cutting flat stock.
2. When the cut reaches the center of round stock, a new cut is made from the opposite side.
3. In cutting holes, burn a hole by pushing the electrode through the metal.
4. Use a short arc and push the tip of the electrode into the crater of molten metal.
5. If a larger hole is needed than the hole burned by the electrode, move the electrode around the edge of the hole in a widening circle until a hole of the desired size is obtained.

F. A plasma cutter is operated very similar to the oxyacetylene torch in that the tip does not touch the workpiece.

1. Be sure safety glasses are worn.
2. Turn the machine on and set it to manufacturer's recommendations.
3. Put on an electric welding face shield and gloves.
4. Hold the plasma arc gun with the contact tip perpendicular to the surface of the metal at the edge of the piece of steel and no closer than $^{1}/_{16}$ inch above the cut-off line.
5. Depress the trigger on the gun and move slowly along the cut-off line, cutting completely through the metal as the cutting proceeds.
6. When the cut is complete let loose of the trigger to extinguish the arc.

Use TM: A5–5F, A5–5G and A5–5H to reinforce hot metal cutting techniques and equipment. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 4 in Modern Agricultural Mechanics, Chapter 16 in Mechanics in Agriculture, Chapter 13 in Introduction to Agricultural Mechanics and Unit 23 and 26 in Agricultural Mechanics are recommended.

Objective 5: Identify safety practices that should be observed when cutting cold and hot metal.

Anticipated Problem: What safety practices are observed when cutting cold and hot metal?

V. When cutting cold and hot metal, observe the following safety practices. Obtain the instructor's permission before using any tool or machine. Follow these guidelines:

A. Keep the work area and tools clean. Dirty, greasy, and oily tools and floors can cause accidents. Clean and put away all unneeded tools and materials. Clean up oil spills and scrap metal from the floor and equipment. Keep paths to exits clear.

B. Wear industrial quality eye protection to protect eyes from sparks and metal chips.

C. To protect against burns, wear clothing such as coveralls, high-top shoes, leather aprons, and leather gloves. Remove all paper from pockets, and wear cuffless pants.

D. Protect hair and scalp by restraining long hair and wearing a cap.

E. Loud talking as well as pushing, running, and scuffling while working with hot metal can cause serious accidents. Keep your mind on your work.

F. In the event of an emergency, all students involved in or observing the emergency should call for help immediately. You should know the location of fire extinguishers and fire blankets and how to use them. You should also know the approved procedure for exiting the laboratory.

G. Report all injuries or accidents to the instructor immediately, no matter how slight.

H. Always use the right size tool and only for its intended purpose.

I. Be certain that stock to be worked is securely fastened in a vise or by clamps to prevent tools from slipping.

J. Mount vises, anvils, and clamps securely for metalwork.

K. Work in a well-ventilated area. Fumes and intense heat are a part of hot metalwork and require that work be done outdoors or in a forced-ventilated area.

L. When lifting heavy objects, obtain help. Lift with the legs and not the back. Straining to lift heavy objects can cause serious injury.

M. To avoid the possibility of accidental burns, keep hot metal in a safe place until it cools. Test metal with moistened finger tips before actually touching it. Use tongs or pliers for handling hot metal.

N. Before leaving the laboratory or work station, make certain the heat source is shut off and cool.

O. Do not perform hot metalwork on wood floors or near flammable materials. Never work on containers that have been used for storage of combustible material.

P. Keep cables and hoses from coming in contact with hot metal and sharp objects. Never point a flame at cables or hoses.

Use text material to strengthen student understanding of concepts. Chapter 4, 5, 6, 7 and 8 in Modern Agricultural Mechanics and Chapter 2, 4, 13, 14, 15, 16, and 17 in Mechanics in Agriculture are recommended.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle.

Application. The following lab activities will be helpful to students in applying the content of this lesson.

LS: A5–5A—Cutting Metal with a Cold Chisel
LS: A5–5B—Cutting with the Arc Welder
LS: A5–5C—Piercing with the Arc Welder
LS: A5–5D—Cutting with the Oxyacetylene Torch

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance, on the application activity. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1 = b, 2 = d, 3 = e, 4 = a, 5 = f, 6 = c

Part Two: Completion

1. bright red
2. bolt cutter
3. harder
4. center punch
5. arc electrode
6. Snips, shears
7. hacksaw
8. chalk
9. Plasma cutters
10. flexible

Part Three: Short Answer

The power hacksaw has a reciprocating movement; horizontal band saw blade movement is forward at all times, so it cuts continuously which results in faster cutting than the power hacksaw.

Sample Test Name _____

Test

Lesson A5–5: Using Metal Cutting Processes and Techniques

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. CNC	c. hacksaw	e. rasp
b. double cut	d. plasma	f. single cut

_____ 1. File with teeth in two directions.

_____ 2. Fourth state of matter.

_____ 3. File with sharp, pointed teeth.

_____ 4. Computer numerically controlled plasma cutter fully automated the shape production process.

_____ 5. File with straight teeth, all going in the same direction.

_____ 6. Saw with a frame and blade designed for cutting metal.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. A _____ _____ color indicates that the steel is near melting point.
2. A _____ _____ provides a fast, efficient method of cutting bolts, rods, and other small metals.
3. When cutting cold metal, a chisel must be _____ than the metal it is to cut.
4. Metal is measured and marked before it is heated using a _____ _____.
5. The best method of cutting cast iron is the _____ _____.
6. _____ or _____ are large scissor-like tools for cutting sheet metal and fabrics.
7. The most often used tool for cutting metal is the _____.
8. Rubbing _____ on a file before it is used will help to prevent it from becoming clogged.

9. _____ _____ are ideal for cutting mild and stainless steel, aluminum, brass and copper.
10. Only the teeth are hardened on _____ blades.

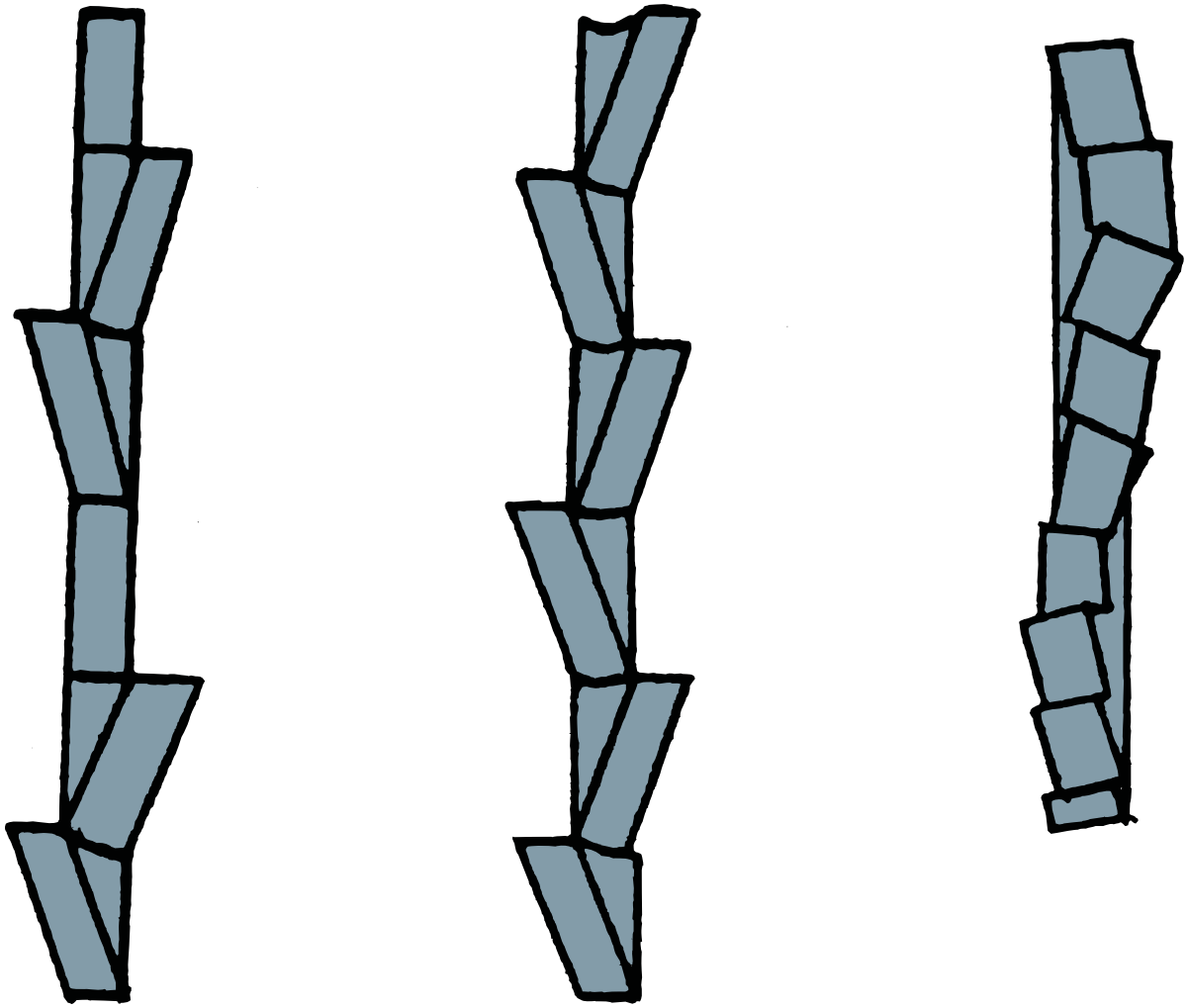
Part Three: Short Answer

Instructions. Provide information to answer the following question. Use complete sentences.

Explain the difference between a power hacksaw and a horizontal band saw.

TM: A5–5A

HACKSAW TEETH PATTERNS

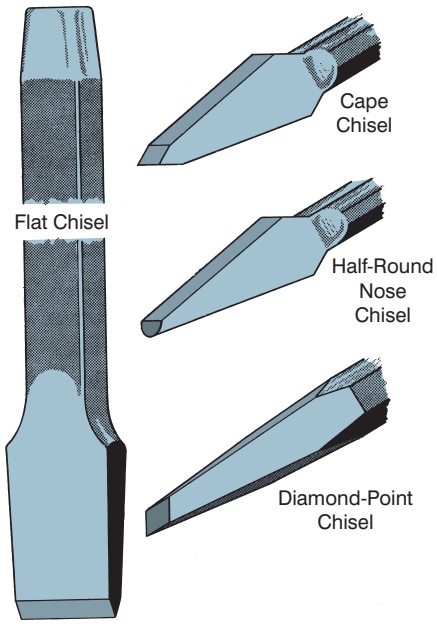


Raker **Alternate** **Undulated or Wavey**

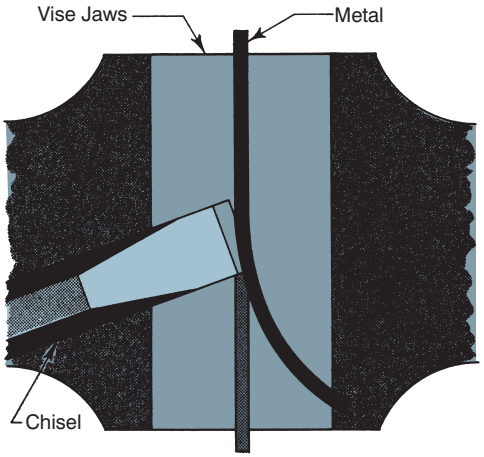
(Courtesy, Interstate Publishers, Inc.)

TM: A5–5B

COLD CHISEL SHAPES AND SHEARING METHOD



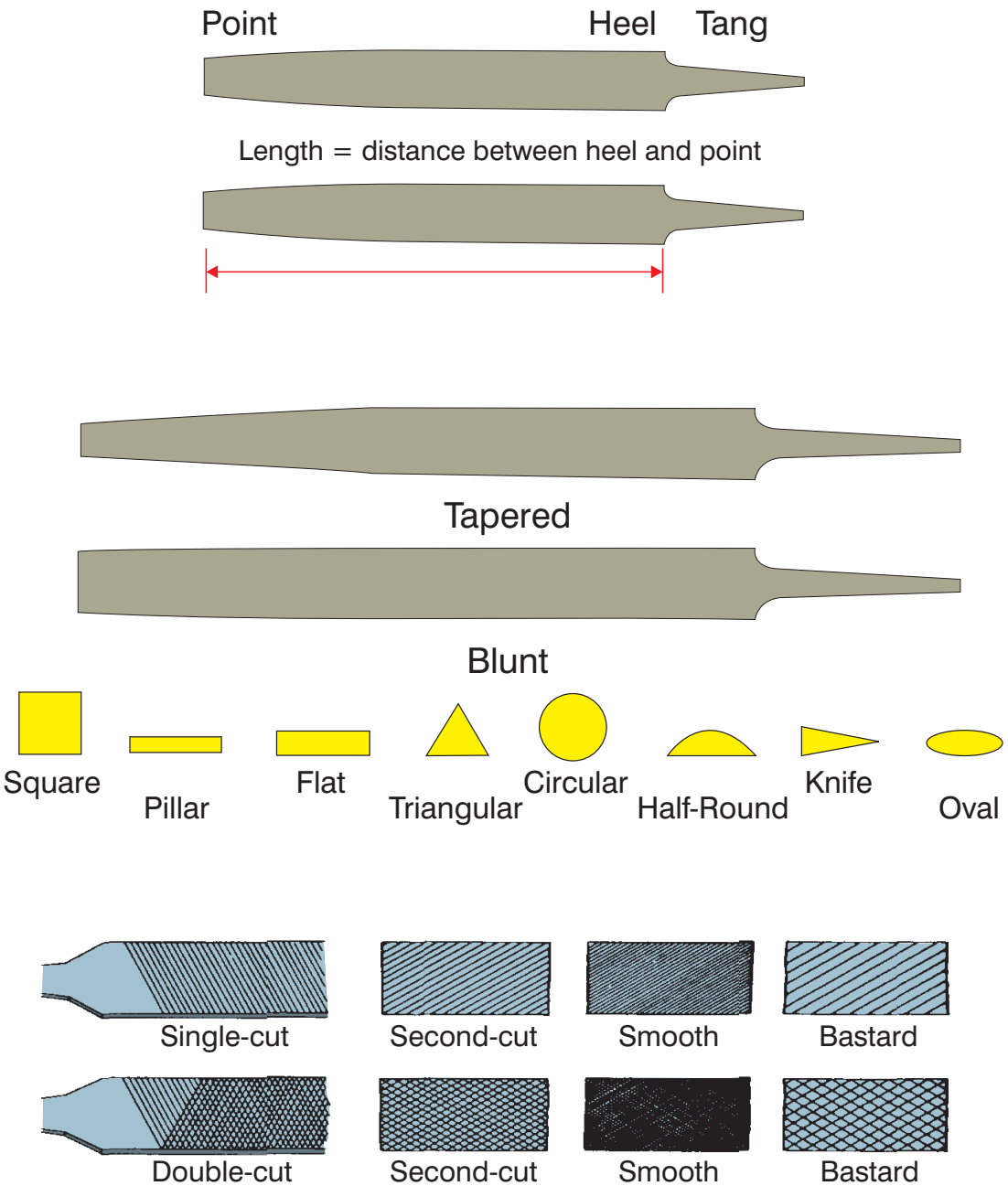
Shapes of cold chisel cutting points.



Shearing metal in a vise with a chisel.

(Courtesy, Interstate Publishers, Inc.)

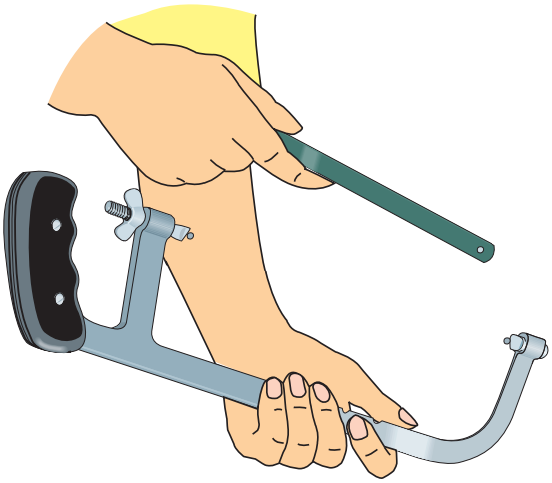
PARTS, SHAPES AND CUTS OF FILES



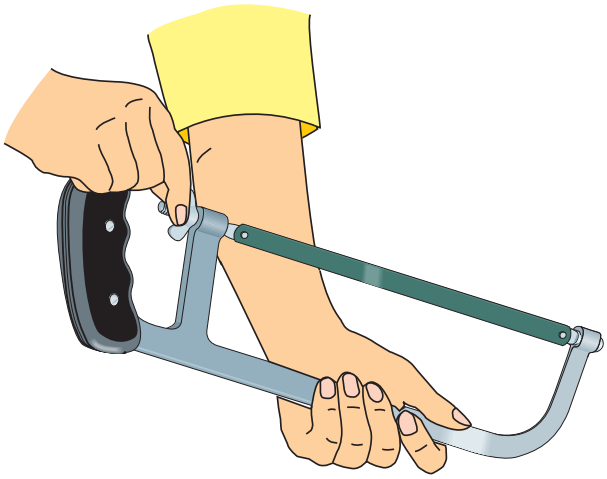
(Courtesy, Interstate Publishers, Inc.)

TM: A5–5D

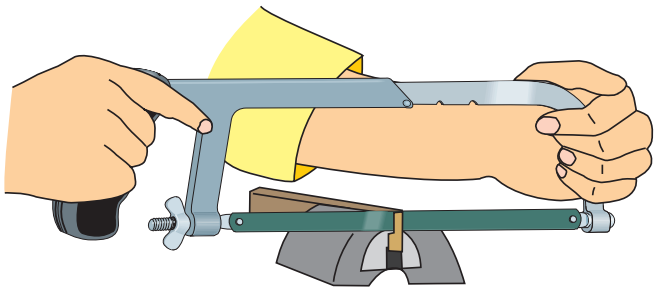
INSTALLING A BLADE AND PROPER HOLDING OF THE HACKSAW



First, make certain teeth are pointing away from handle, and place holes in blade over both pins.



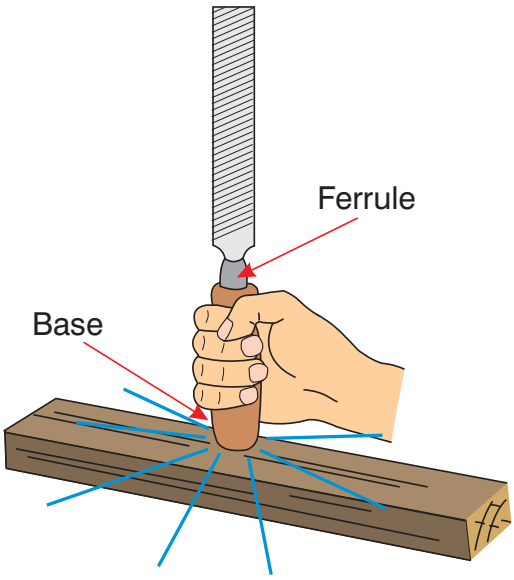
Then, tension blade.



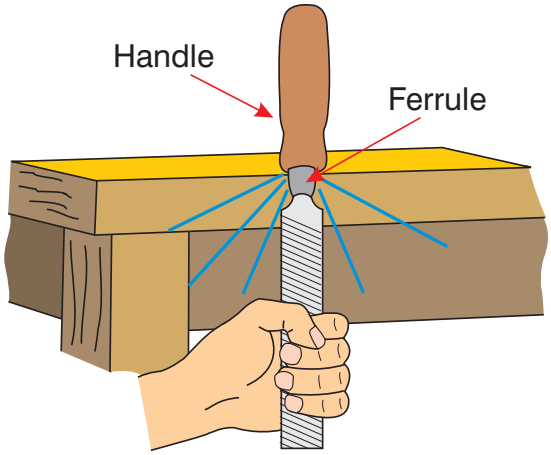
Hold hacksaw blade this way when sawing.

(Courtesy, Interstate Publishers, Inc.)

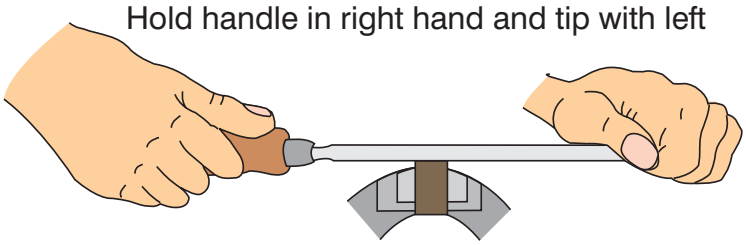
CARE AND USE OF THE FILE



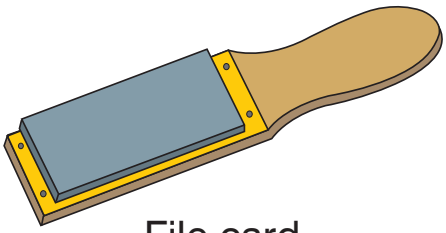
Setting a file handle



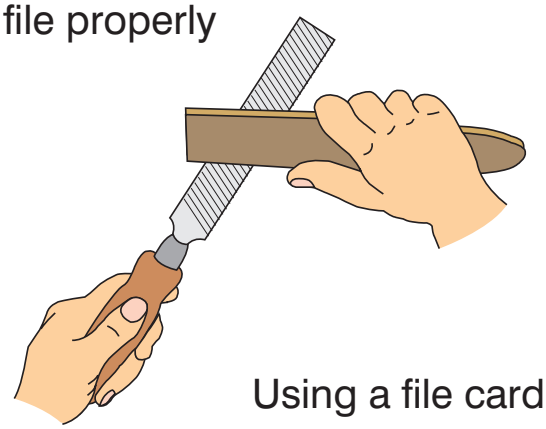
Removing a file handle



Holding a file properly



File card

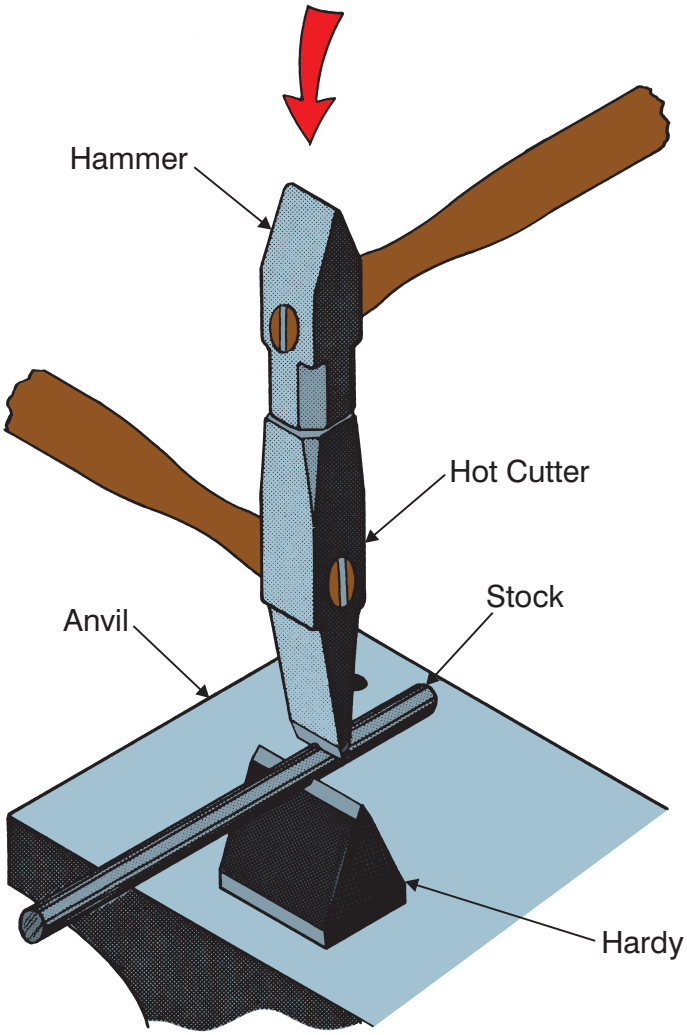


Using a file card

(Courtesy, Interstate Publishers, Inc.)

TM: A5–5F

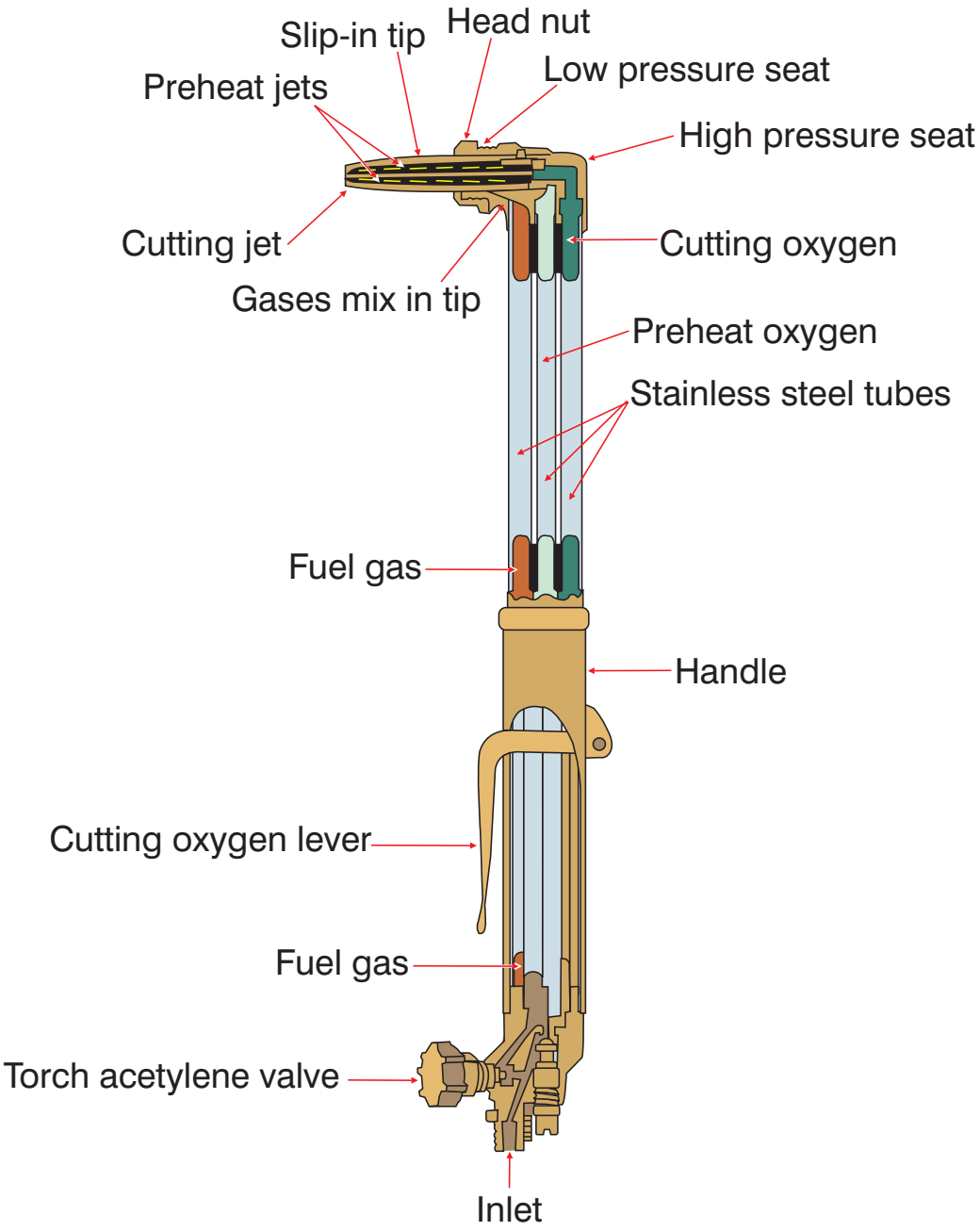
USE OF THE HARDY AND HOT CUTTER



Use the hot cutter and hardy to prevent flattening the end of round stock when you are cutting it on the anvil.

(Courtesy, Interstate Publishers, Inc.)

OXYACETYLENE CUTTING ATTACHMENT PARTS



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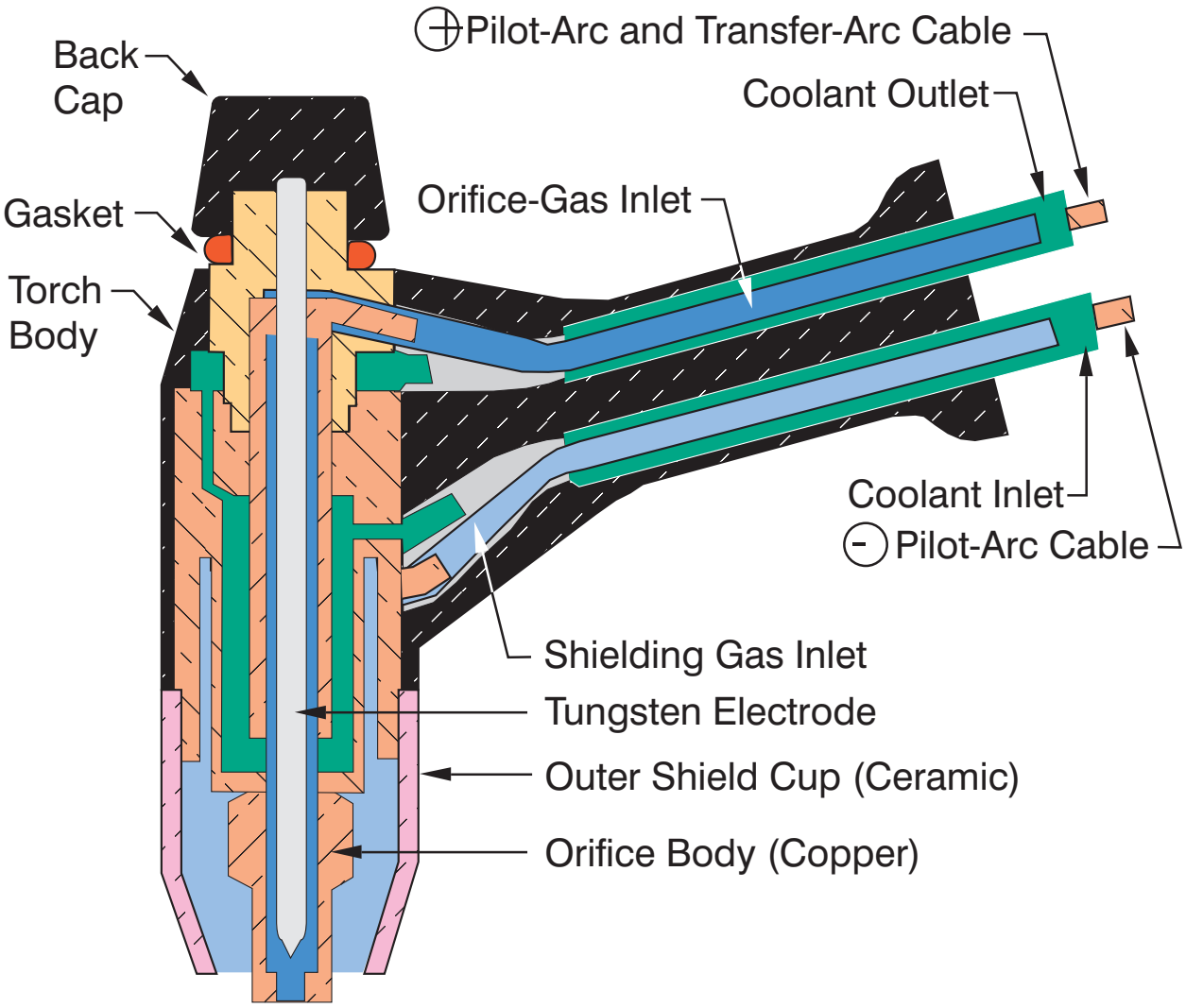
TM: A5–5H

PLASMA ARC TORCH PARTS



(Courtesy, Interstate Publishers, Inc.)

 Name _____

Lab Sheet

Cutting Metal with a Cold Chisel

Materials:

Bench vise
Piece of steel ($^3/_{16} \times 2$ inch)
Ball-peen hammer
Center punch
Cold chisel
Square
Scriber
Safety glasses or face shield

Procedure:

1. Mark the metal where it is to be cut with a center punch and scriber.
2. Place the steel in a heavy vise. The cutting mark should be even with the jaws of the vise.
3. Select a heavy cold chisel and make sure the edge is in good condition. Lay the chisel on top of the moveable jaw of the vise.
4. Hold the chisel so it rests at about a 30 degree angle to the vise jaws. The flat of the chisel edge should be parallel to the top of the vise jaws.
5. Drive the chisel until the metal is cut. The metal is cut by a shearing action. The vise acts as one half of the shear; the cold chisel is the other half.

Name _____

Lab Sheet

Cutting with the Arc Welder

Materials:

Piece of steel ($^3/_{16} \times 2$ inch)
Ball-peen hammer
Center punch
Scriber
Square
Arc welder and mild steel electrodes
Safety glasses and other personal protective equipment

Procedure:

1. Mark the metal where it is to be cut with a center punch and scriber.
2. Clamp the material to the table so there is overhang, so there is plenty of room between the cut and table.
3. Place a bucket of water or box of sand under the cut to catch the material being cut-off.
4. Start the cut at an edge or a corner of the metal. Use a 15 degree angle in the direction of cut.
5. Use the electrode like a chisel with a slow, up-and-down pushing movement.
6. Proceed only as fast as the cut can be kept clean and open.

Name _____

Lab Sheet

Piercing with the Arc Welder

Materials:

Piece of steel ($^3/_{16} \times 2$ inch)
Ball-peen hammer
Center punch
Scriber
Square
Arc welder and mild steel electrodes
Safety glasses and other personal protective equipment

Procedure:

1. Mark the metal where it is to be cut with a center punch and scriber.
2. Clamp the material to the table so there is overhang, so there is plenty of room between the cut and table.
3. Place a bucket of water or box of sand under the cut to catch the material being cut-off.
4. Hold the electrode at a 90 degree angle to the workpiece.
5. Strike the arc and pre-heat the area slightly by holding a long arc, then push the electrode through.

 Name_____

Lab Sheet

Cutting with the Oxyacetylene Torch

Materials:

Piece of flat steel
Ball-peen hammer
Center punch
Scriber
Square
Oxyacetylene torch
Safety glasses and other personal protective equipment

Procedure:

1. Mark the metal where it is to be cut with a center punch and scriber.
2. Clamp the material to the table so there is overhang, so there is plenty of room between the cut and table.
3. Place a bucket of water or box of sand under the cut to catch the material being cut-off.
4. Heat the edge of the piece of metal at the line. Hold the torch so that the flame will cut straight through the metal with the inner cone of preheated flames about $^1/_8$ inch above the metal.
5. When the top of the metal starts to melt, press the oxygen cutting valve slowly until it is wide open.
6. After cutting has started, move the torch along the cut-off line. The speed of travel will be determined by the thickness of the metal being cut.
7. When the cut is finished, any slag that remains on the edge of the cut may be removed easily by a cold chisel and hammer.