Lesson A5–3

Applying Cold Metalworking Techniques

Unit A. Mechanical Systems and Technology

Problem Area 5. Metal Fabrication

Lesson 3. Applying Cold Metalworking Techniques

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: VIII: Plan, implement, manage, and/or provide support services to facility design and construction; equipment design, manufacture, repair, and service; and agricultural technology.

Benchmark: VIII-B: Follow architectural and mechanical plans to construct building and facilities.

Performance Standard: 3. Construct with wood and metal.

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

1. Identify the types of steel stock.
2. Identify the tools used in cold metal work.
3. Describe how cold metal stock is marked, bent, shaped, cut, drilled, filed, and punched.
4. Describe the methods used in tapping, threading, bolting, and riveting metal.
5. Identify safety practices that should be observed in working with cold 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:


Other Resources. The following resources will be useful to students and teachers:


List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Types of steel stock
Types of cold metal tools
Types of fasteners (bolts, rivets, etc.)

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

Carriage bolts
Die
Die stock
Machine bolts
Rivet
Stove bolts
Stud bolts
Tap

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.

Ask students to identify different types of steel stock and their possible uses. Another approach would be to show tools used in cold metal work and have students explain their uses.
Objective 1: Identify the types of steel stock.

Anticipated Problem: How is steel stock identified and how is metal that can be worked cold identified?

I. Metals can be purchased in several different shapes, sizes, hardmesses, weights, by lineal foot, or by piece.
   A. Knowing the shapes, sizes, and standard lengths of commonly used stocks can be beneficial in planning repair projects.
   B. Be certain the metal you are working with is softer than your cutting tool. Know the hardness of your metal before trying to drill, chisel, shear, or saw. Twist drills, saw blades, cold chisels, and shear cutting parts of equipment are easily broken or worn out in a matter of minutes on hardened stock.
   C. There are different methods of determining the hardness of metals.
      1. One method of determining the hardness is using the corner of a file; make three 6 inch filing strokes, using half your pushing strength on the metal to be cut, drilled, or worked. If the file does not dig in readily or if it rings or chatters, this an indication that it is too hard to work when cold.
      2. Another method is to use a center punch. Strike the punch with a hammer, and then observe the depth of penetration. Repeat this several times. Try a piece of metal that you are certain is soft enough to work. Try a piece of car or truck spring and observe the depth of penetration of the punch. Compare the metal you tested to the metal you plan to work.

Use TM: A5–3A to illustrate shapes of steel stock. 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 and Section 1 and 3 in Cold Metal Work (VAS 3002a) are recommended.

Objective 2: Identify the tools used in cold metal work.

Anticipated Problem: What are the tools used in cold metal work?

II. The first step in any project is measuring and marking the stock to get the desired size and proper location of holes.
   A. A metal worker needs access to several tools.
      1. Instruments used to measure cold steel are a push-pull rule and steel tapes. These tapes and rules are thin and flexible and must be laid flat and straight for accurate measurement.
2. Select a rule or tape that is long enough to measure the entire distance at one time. The most suitable rules and tapes are those in which the inches are divided into one or more of the following: \( \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \) and \( \frac{1}{64} \). A \( \frac{1}{10} \) and \( \frac{1}{12} \) rule is used for special jobs.

3. Some rules and tapes utilize both the English and Metric systems.

B. Several types of squares are suitable for layout work.
   1. The framing square is used for squaring large pieces.
   2. The T-square is used for squaring small objects.
   3. The combination square has a blade to which three different heads may be attached.
      a. These heads consist of one square and miter head, one centering head, and one bevel protractor head.
      b. The heads may be purchased as a set or separately and can be attached quickly and locked in any position along the blade.

C. There are several different types of marking devices used with cold steel.
   1. A straight edge is used for marking straight lines between two points.
   2. The steel square, steel rule, or any metal or wood straight edge is satisfactory for most shop work.
   3. A chalk line can be used for marking long lines.
   4. The scriber is made of high carbon steel in different patterns and shapes, and is sharpened to a needle point.
   5. The scratch awl is made of high carbon steel and a hardwood handle, and is used to scribe lines on metal. Since the metal of the awl protrudes through the handle, it can be tapped with a hammer to make a light center punch.
   6. The prick punch and center punch are ground to a sharp point.
      a. The prick punch is ground to about a 15 degree angle to the center line and is used for marking reference points, locating the centers of holes, and making small marks along the layout lines. It can be used to transfer a layout from paper to metal by placing the paper over the metal and punching through the paper to locate holes, curves and other layout lines.
      b. The center punch is ground to about a 60 degree angle to the center lines and is used to mark the location of holes and to make a starting hole for a drill.
   7. Dividers are used for marking circles, dividing circles, and stepping off equal lengths for spacing of holes.
      a. The two legs of the dividers are sharpened to needle points; they can be adjusted to varying widths.
      b. The size of dividers is determined by the length from the pivot to the point of the leg.
   8. Layout fluid is a quick-drying liquid that may be painted on metal to form a colored surface for marking.
D. Machinist’s hammers are available in three types of peens: ball peen, straight peen, and cross peen.

1. The flat face of the machinist’s hammer is used for striking punches or chisels and for bending or shaping metal. The peen is used for drawing and bending metal, as in ornamental work, and for forming curved shapes on thin metal.

2. Select the proper-sized hammer for the type of work being done. The size of a hammer is determined by its weight, which ranges from ¼ lb. to 4 lbs.

Use TM: A5–3B and A5–3C as examples of layout tools. 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 and Section 1 and 3 in Cold Metal Work (VAS 3002a) are recommended.

**Objective 3:** Describe how cold metal stock is marked, bent, shaped, cut, drilled, filed, and punched.

**Anticipated Problem:** How is cold metal stock marked, bent, shaped, cut, drilled, filed, and punched?

III. Working with cold metal requires different techniques depending upon the type of work to be completed.

A. Metal needs to be marked for cutting, welding, bending, and drilling.

1. Marks for holes to be drilled are made with a center punch.
2. Lines on metal are made with a scribe, which is a sharp-pointed tool.
3. A sharp prick punch or a nail sharpened to a point, may also be used for marking metal.

B. Light pieces of metal can often be bent cold.

1. A vise is used in bending metal rods and bars.
2. If a heavy piece of strap iron is to be bent cold, clamp it in a machinist’s or blacksmith’s vise of adequate size. Slip a piece of pipe over the strap iron to provide leverage. The bend can also be made by hammering after the piece of strap iron has been clamped in the vise.
   a. A sharp bend in a piece of strap iron can be made by clamping it in a vise against a piece of round stock. Then, hammer or pull the piece of strap iron around the piece of round stock.
   b. A large bend can be made in a piece of strap iron by placing it between the jaws of a vise. Do not clamp the jaws against the piece of strap iron. Slip the piece down between the jaws of the vise as it is bent.

C. Cold metal may be cut with a hacksaw, a bolt cutter, or a cold chisel.

1. When using a hacksaw, cut a notch at the mark with a file. Apply slight pressure on the forward strokes and release the pressure on the return strokes to insure proper cutting. Run the saw evenly, using long strokes, with all the teeth cutting to prevent...
wear on a small portion of the blade. Thin metal can be cut more easily with a hack-
saw if a thin piece of wood is clamped on each side of the metal. Saw through the
metal and wood pieces simultaneously.

2. A bolt cutter can be used to cut small pieces of iron quickly and easily.
3. A cold chisel can also be used to cut cold metal. Watch the edge of the chisel and
use sharp, quick blows.

D. When cutting round stock, cut halfway through. Turn the stock and make the rest of
the cut from the opposite side.

E. Cutting sheet metal with a chisel should be avoided because it will stretch the metal.

F. Holes may be drilled in metal with a twist drill. Drilling may be done with a hand drill, a
portable power drill, or a drill press. Mark the location of the hole with a center punch
and place a drop of oil in the center punch mark. Ease the pressure and drill slowly when
the point of the drill is about to break through the bottom. When drilling holes in round
stock, hold the work in V-blocks.

G. Small amounts of metal may be removed where needed with a file. Use pressure on the
forward stroke only, and use only enough pressure to make the file cut evenly. Files are
classified by the coarseness of their teeth, length, and shape.

H. When punching holes with a solid punch, mark the metal with a center punch, place the
metal on a block of wood, and strike the solid punch with a heavy hammer.

Use TM: A5–3D, A5–3E and A5–3F as visual material for lecture and discussion. 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 4 and 16 in Mechanics in Agriculture and Section 1 and 3 in Cold Metal Work
(VAS 3002a) are recommended.

**Objective 4:** Describe methods used in tapping, threading, bolting, and riveting metal.

**Anticipated Problem:** What are the methods used in tapping, threading, bolting, and riveting
metal?

IV. There are different ways to join metal and other materials.

A. A common metalworking job in agricultural mechanics is the cutting of threads on bolts
and nuts. Taps and dies are used for thread cutting.

1. A **tap** is a screw-like tool used to cut inside threads. There are three types of taps.
   a. The taper tap, with the first 0 to 10 threads that do not cut full-depth threads, is
      used alone for tapping a hole that is drilled completely through the metal. When
tapping a blind hole all three taps must be used.
   b. The plug tap, with five or six partial threads, is used after the taper tap. It is
      screwed down to the bottom of the hole.
   c. The bottoming tap is used after the plug tap to cut full-size threads to the bottom
      of the hole.
2. A die is used for cutting outside threads, like those found on the threads of bolts. There are three common types of dies: the round-split die, the two-piece die and the solid die. The round-split and two-piece dies can be adjusted to vary the depth of cut, but the solid die is not adjustable.

3. Taps and dies have their sizes and classifications stamped on them.

B. There are three classifications of threads: the National Coarse (NC), National Fine (NF) and National Pipe Thread (NPT).
   1. NC threads are commonly used on parts of machinery where there is very little vibration.
   2. NF threads are used where vibration is excessive. Fine threads will stand more vibration than coarse threads before the nut loosens.

C. There is a precise procedure to follow when threading bolts.
   1. Place the rod in a perpendicular position in a vise and clamp securely.
   2. File off any projections on the end of the rod or bolt, slightly tapering it.
   3. Select the proper size of die. The tool used for holding and turning the die is called the die stock.
   4. Place the die squarely on the rod or bolt and apply pressure evenly as the die is turned.
   5. Apply oil so that the die will run through it while cutting.
   6. Move the die back and forth so the chips of metal will fall out.
   7. Remove the die by turning it counterclockwise after the required number of threads are made.

D. A precise procedure must be followed when tapping a hole.
   1. Drill the proper sized hole for tapping.
   2. Select the proper taper tap and insert the square end in a tap wrench.
   3. Place the item to be tapped in a vise and clamp securely.
   4. Grasp the tap wrench with the hand directly over the tap and place the end of the tap in the hole.
   5. Apply downward pressure on the wrench, and turn it clockwise to start the tap. Continue turning the wrench in this manner until the tap starts to feed itself.
   6. When the tap begins to feed itself, grasp the tap wrench handles with both hands, and continue turning slowly. Apply the same turning power on each handle to prevent breaking the tap. Apply the proper lubricant to keep the tap cool so that it will cut properly.
   7. After the tap has been properly started, turn it one full turn forward. Then, back it up one-quarter turn to break and clear away the chips. This will help to make a smoother thread. Continue in this manner until the tap reaches the bottom or turns freely in the hole.
   8. Back the tap out slowly.
   9. Thoroughly clean the tap before placing it in the rack.
E. Bolts are used in heavy construction work in which permanency and strength are desired or in which an object may need to be dismantled frequently. Bolts may be purchased with fine or coarse threads. The bolt head can be held with a wrench when the nut is tightened or loosened.

1. **Machine bolts** have hexagonal heads and are used to fasten wood or metal in places where the protruding head is not objectionable. Machine bolts are preferred for fastening wood where the bolt needs periodic re-tightening or removing.

2. **Carriage bolts** have a rounded head and a square shank to fit square slotted holes in machinery or in heavy wood construction. Carriage bolts are used when the protruding head of a machine bolt would be objectionable.

3. **Stove bolts** have round or flat heads and are used for lightweight structures of either metal or wood. Stove bolts are threaded their full length.

4. **Stud bolts** are used for fastening frequently removed metal parts, such as cylinder heads or cover plates. One end of the stud bolt is screwed into a tapped hole, and a nut is screwed on the other end.

F. When two pieces of metal cannot be welded satisfactorily, they are often riveted together.

1. A **rivet** is a bolt-shaped piece of iron used to fasten sheet metal, or to fasten knife sections on a sickle, by peening the end to form a head.

2. There is a procedure for properly riveting materials.
   a. Make holes the same diameter as the size of the rivets selected.
   b. Select rivets which are slightly longer than the metal thickness so that they will extend \( \frac{1}{8} \) to \( \frac{1}{4} \) inch beyond the pieces being riveted.
   c. Insert the rivets and place the heads on the face of the anvil.
   d. Place the washers on the rivets if washers are used.
   e. Deliver several blows to the center of each rivet, first with the peen of the hammer and then with the face of the hammer, until the pieces are closely united.
   f. Round the edges of the head and finish to an oval shape or to the shape the manufacturer recommends.
   g. Use a rivet set to obtain a smooth finish.

Use TM: A5–3G, A5–3H, A5–3I, A5–3J and A5–3K to reinforce the major topics in this objective. 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 9 and 16 in Mechanics in Agriculture and Section 1 and 3 in Cold Metal Work (VAS 3002a) are recommended.
Objective 5: Identify safety practices that should be observed in working with cold metal.

Anticipated Problem: What are the safety practices that should be observed when working with cold metal?

V. When working with cold metal, observe the following safety practices.

A. Keep the work area clean. Wipe up oil and grease spills immediately to prevent injuries caused by slipping and falling. Keep paths to exits clear.

B. When doing cold metalwork, wear approved safety glasses or a face shield.

C. Store oily and greasy rags in a fireproof metal container to prevent the spreading of spontaneous fires.

D. Serious injury may result from straining due to incorrect lifting. Lift heavy objects with the leg muscles, not the back muscles. When lifting heavy objects, obtain assistance.

E. Always use the proper-sized tools and equipment for the job.

F. Use equipment only with the instructor’s permission. Notify the instructor immediately if you are injured.

G. Wear clothing that is not loose or bulky and wear hard-toed shoes with non-skid soles.

H. Each electrical tool should be equipped with a three-prong plug and plugged into a grounded three-hole receptacle. When used outside, portable tools should be connected to ground fault circuit interrupter outlets.

I. Restrain excessively long hair with a band or cap to keep hair from getting entangled in machines. When using a drill or drill press, be extremely careful with long hair.

J. Be certain that stock to be cut, filed or chiseled is securely fastened in a vise or by clamps to prevent tools from slipping. Mount vises, anvils, and clamps securely for cold metalwork.

Use text material to strengthen student understanding of concepts. Chapter 5 in Modern Agricultural Mechanics, Chapter 9 and 16 in Mechanics in Agriculture and Section 2 in Cold Metal Work (VAS 3002a) 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 sheets will be helpful to students in applying the content of this lesson:

LS: A5–3A—Using a Hacksaw
LS: A5–3B—Tapping a Hole
LS: A5–3C—Using a Die to Cut Threads
**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 = j, 2 = h, 3 = f, 4 = a, 5 = e, 6 = b, 7 = d, 8 = c, 9 = i, 10 = g

**Part Two: Completion**

1. measuring, marking
2. v-blocks
3. taper, plug, bottoming
4. flatface, peen
5. Stove bolts
6. National Coarse (NC), National Fine (NF), and National Pipe Thread (NPT)

**Part Three: Short Answer**

Filing and center punch.
Lesson A5–3: Applying Cold Metalworking Techniques

**Part One: Matching**

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

- a. carriage bolt  
- b. center punch  
- c. die  
- d. dividers  
- e. framing square  
- f. machine bolt  
- g. rivet  
- h. scratch awl  
- i. stud  
- j. tap

_______ 1. Screw-like tool used to cut inside threads.
_______ 2. Used to scribe lines on metal.
_______ 3. Have hexagonal heads and are used to fasten wood or metal in places where the protruding head is not objectionable.
_______ 4. Rounded head and a square shank to fit square slotted holes in machinery or in heavy wood construction.
_______ 5. Used for squaring large pieces.
_______ 6. Used to mark locations of holes and to make a starting hole for a drill.
_______ 7. Used for marking circles, dividing circles, and stepping off equal lengths for spacing of holes.
_______ 8. Used for cutting outside threads, like those found on the threads of bolts.
_______ 9. Used for fastening frequently removed metal parts.
_______ 10. Bolt-shaped piece of iron used to fasten sheet metal or to fasten knife sections on a sickle, by peening the end to form a head.

**Part Two: Completion**

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

1. The first step in any construction is __________________________ and __________________________ the stock to get the desired and proper location of holes.
2. When drilling holes in round stock, hold the work in _________________.

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3. The three types of taps are ________________, ________________ and ________________.

4. The _______________ of machinists hammer is used for striking punches or chisels and for bending or shaping metal, while the _______________ is used for forming and bending metal and for forming curved shapes on thin metal.

5. ________ ________ have round or flat heads, used for lightweight structures of either metal or wood.

6. The three classifications of threads are _______________________________, _______________________________ and _______________________________.

**Part Three: Short Answer**

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

What are the methods of determining the hardness of metals?
# TYPES OF STEEL STOCK

<table>
<thead>
<tr>
<th>Type of Metal</th>
<th>Shape</th>
<th>Standard Lengths</th>
<th>How Measured for Purchasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle</td>
<td><img src="angle.png" alt="Angle" /></td>
<td>20' to 40'</td>
<td>leg length \times leg length \times leg thickness</td>
</tr>
<tr>
<td>Band</td>
<td><img src="band.png" alt="Band" /></td>
<td>to 20'</td>
<td>thickness \times width</td>
</tr>
<tr>
<td>Channel</td>
<td><img src="channel.png" alt="Channel" /></td>
<td>to 60'</td>
<td>depth \times web thickness \times flange width</td>
</tr>
<tr>
<td>Hexagon</td>
<td><img src="hexagon.png" alt="Hexagon" /></td>
<td>12' to 20'</td>
<td>distance across flats</td>
</tr>
<tr>
<td>Octagon</td>
<td><img src="octagon.png" alt="Octagon" /></td>
<td>12' to 20'</td>
<td>distance across flats</td>
</tr>
<tr>
<td>I-Beam</td>
<td><img src="i-beam.png" alt="I-Beam" /></td>
<td>to 60'</td>
<td>height \times web thickness \times flange width</td>
</tr>
<tr>
<td>Plate</td>
<td><img src="plate.png" alt="Plate" /></td>
<td>to 20'</td>
<td>thickness \times width</td>
</tr>
<tr>
<td>Round</td>
<td><img src="round.png" alt="Round" /></td>
<td>12' to 20'</td>
<td>diameter</td>
</tr>
<tr>
<td>Sheet Metal</td>
<td><img src="sheet-metal.png" alt="Sheet Metal" /></td>
<td>to 144'</td>
<td>thickness \times width \times length</td>
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<tr>
<td>Square</td>
<td><img src="square.png" alt="Square" /></td>
<td>20' to 40'</td>
<td>width \times length</td>
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<tr>
<td>Tubing</td>
<td><img src="tubing.png" alt="Tubing" /></td>
<td>20' to 40'</td>
<td>thickness \times width \times length</td>
</tr>
</tbody>
</table>
LAYOUT TOOLS

1. Framing Square
2. Combination Square
3. T-square
4. Center Punch
5. Scratch Awl
6. Scribe
7. Spring Dividers
8. Ball-peen Hammer
9. Straightedge

(Courtesy, Interstate Publishers, Inc.)
COMBINATION SQUARE BLADE HEADS

(Courtesy, Interstate Publishers, Inc.)
MAKING A LARGE BEND

To make a large bend, slip the material down between the jaws of the vise as you bend it.

(Courtesy, Interstate Publishers, Inc.)
PARTS AND SHAPES OF FILES

Heel
Length
Edge
Face
Point
Tang
Heel
Tapered
Blunt

Square
Flat
Triangular
Circular
Half Round
Knife
Oval

(Courtesy, Interstate Publishers, Inc.)
CUTS, CARE AND USE OF FILES

Single-cut
Second-cut
Smooth
Bastard

Double-cut
Second-cut
Smooth
Bastard

Setting a file handle
Removing a file handle

Hold handle in right hand and tip with left

Holding a file properly

File card
Using a file card

(Courtesy, Interstate Publishers, Inc.)
TYPES OF TAPS AND ORDER OF USE FOR A BLIND HOLE

(Courtesy, Interstate Publishers, Inc.)

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USING THE DIE TO CUT OUTSIDE THREADS

Using a die to cut outside threads on round stock.

The correct position of the diestock in relation to the chamfered end of the work when external threads are cut.

(Courtesy, Interstate Publishers, Inc.)
TYPES OF BOLTS AND RIVETS

BOLTS
- Carriage
- Machine
- Stove

CAP SCREWS
- Flat
- Hexagon
- Button
- Fillister
- Socket

MACHINE SCREWS
- Flat
- Oval
- Fillister
- Round

STUD

RIVET

(Courtesy, Interstate Publishers, Inc.)
SQUARING A TAP WITH THE WORK

(Courtesy, Interstate Publishers, Inc.)

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RIVETING TECHNIQUE

Rivet
Rivet set
Ballpeen hammer

(Courtesy, Interstate Publishers, Inc.)
Lab Sheet

Using a Hacksaw

Materials:
- Steel rule
- Square
- Bench vise with soft jaws
- Hand hacksaw
- Soapstone
- Flat steel strap, \( \frac{3}{8} \) inch × 2 inch
- File with handle
- File card

Procedure:
1. Clamp flat strap in bench vise so that about 6 inches extend past the edge of vise.
2. Use steel rule to mark a 5 inch length with sharp soapstone.
3. Use a file to make a V-groove on the 5 inch mark.
4. Check hacksaw to make sure that blade is tight, teeth are sharp, and teeth are going the correct direction.
5. Place saw blade in V-groove.
6. Hold saw firmly by the handle and front of frame.
7. Start a back-and-forth movement of the saw, applying pressure on forward strokes and lifting saw slightly on return strokes. Use entire length of blade when cutting.
8. Cut at an approximate rate of forty strokes per minute. When saw is about to cut through the stock, ease up on the pressure.
10. Clean work area and put away equipment and materials.

Questions:
1. How many teeth per inch did the hacksaw blade have that you used?
2. Is your cut square?
3. How can you check if it is square?
Lab Sheet

Tapping a Hole

Materials:

- Bench vise
- Piece of steel (the flat strap cut in LS: A5–3A)
- Center punch
- Ball-peen hammer
- Hand power drill or drill press, and twist drill
- Square
- Tap and tap wrench
- Cutting fluid
- Tap drill chart
- ¼ inch, 3/8 inch and ½ inch bolts

Procedure:

1. You will drill and thread ¼ inch, 3/8 inch and ½ inch holes.
2. Check proper tap drill size on drill chart.
3. Mount piece of steel in vise.
4. Mark location of center of ¼ inch hole in middle of strap, 1 inch from the end.
5. Mark location of center of ½ inch hole in middle of strap, 2½ inches from the end.
6. Mark location of center of 3/8 inch hole in middle of strap, 4 inches from the end.
7. Use center punch to make a starting hole at each of the marks.
8. Select the proper size twist drill for the hole to be tapped. Refer to the tap drill chart.
9. Insert twist drill into chuck of drill press or hand power drill and tighten.
10. Clamp material to be drilled.
11. Drill hole in material.
12. Place the correct tap for the hole in tap wrench.
13. Cup hand over tap wrench and place tap in hole.
14. With tap parallel to hole, start turning clockwise, applying a downward pressure on tap. Apply cutting oil as needed.
15. Remove tap wrench after a few threads have been cut.
16. Use a small square to check for squareness.
17. Reset tap wrench.
18. Continue turning and tapping hole.
19. Clean chips from hole.
20. Check thread with a bolt of correct dimensions.
21. Repeat steps 8–20 for the second hole.
22. Repeat steps 8–20 for the third hole.
23. Clean work area and put away equipment and materials.
Lab Sheet

Using a Die to Cut Threads

Materials:

- bench vise
- 4 inch steel rod of correct size(s) to thread and screw into the tapped holes made in bench grinder or file
- die
- die wrench
- thread gauge
- cutting fluid

Procedure:

1. Place steel rod in vise.
2. Use grinder or file to chamfer end of the ¼ inch steel rod.
3. Select the proper die and die wrench.
4. Adjust die for proper depth of cut.
5. Place die in wrench and tighten.
6. Cup hand over die and place it on top of rod.
7. Turn die clockwise while applying downward pressure.
8. After cutting several threads, move your hands to the ends of the die wrench handles.
9. After approximately three turns, reverse the die about one-half turn to break the chips. Remove the chips and continue cutting the threads.
11. Apply cutting fluid to the die as required.
12. Continue cutting threads until you have threaded 1 inch of the rod.
13. Clean chips from threads.
14. Check thread by screwing the rod into the tapped hole in the strap.
15. Repeat steps 1–14 on the 3/8 inch rod.
16. Repeat steps 1–14 on the ½ inch rod.
17. Clean work area and put away equipment and materials.