Ethiopia TVET system

Electro Mechanical Work

Level - I

Module Title: Cutting and Joining Sheet Metal

TTLM Code: EIS EMW1 TTLM 0919 v1

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This module includes the following Learning Guides

LG30: Analyze work task

LG Code: EIS EMW1 M14 LO1-LG-30

LG31: Plan and prepare work

LG Code: EIS EMW1 M14 LO2-LG-31

LG32: Cut and join sheet metal

LG Code: EIS EMW1 M14 LO3-LG- 32

LG33: Quality assure work and clean up

LG Code: EIS EMW1 M14 LO4-LG-33

Instruction Sheet 1	Learning Guide #30 Analyze work task

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics

- Analyzing work task
- Identifying and adhering quality assurance requirements
- Associating OHS requirements

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

Analyze work task

Identify and adhere quality assurance requirements

design Pumping system

Associate OHS requirement

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the "Information Sheets 1- 3". Try to understand what are being discussed.
4. Accomplish the "Self-checks1, 2, & 3 " in each information sheets on pages 6, 9, and 6.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. After You accomplish self check, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1	Analyzing Task

Introduction

Sheet metal work is generally regarded as the working of metal from 16 mm down to 30 mm with hand tools and simple machines into various forms by cutting, forming into shapes and joining. Each gauge designates a definite thickness. Higher the gauge number, lesser the thickness. The common examples of sheet metal work are pipes, boxes, funnels, photo frames, buckets, and cans etc. In sheet metal work the knowledge of geometry, mensuration and properties of metal are most important for preparation of specific object.

1. Sheet Metal Operations

The major types of sheet metal operations are given below.

Shearing
Bending
Drawing
Squeezing

1.1. Shearing: Shearing is the process of cutting across a sheet or strip. The various shearing operations include

a) Cutting off
b) Parting
c) Blanking
d) Punching
e) Piercing
f) Slitting
g) Trimming

a) Cutting Off: It is the operation of shearing the piece from sheet metal with a cut along a single line.
b) Parting: This means that the strip is removed between the two pieces to part them.
c) Blanking: It is the operation of cutting the flat sheet to the required shape and size using punch and die.
d) Punching: It is the operation of making only circular holes in a sheet metal.
e) Piercing: It is the operation of making a hole of any shape in a sheet metal by punch and die.
f) Slitting: It is the operation of cutting the sheet metal in a line along the length.
g) Trimming: It is the operation of finishing the edges of a part by removing excess metal around it.

Bending: It is the folding operation by using suitable tools. It may be done over stakes. The common forms of bending the sheet metal is single bend and double bend etc.

Drawing: It is the processes of producing thin walled hallow or vessel shaped parts from the sheet metal. Again this process can be divided into two types. a) Deep drawing and shallow drawing. In deep drawing, the height of the component is greater than the diameter or width. In shallow drawing the height of the component is less than the diameter or width.

Squeezing: It is the quick and widely used method. The operation involves severe cold deformation and it requires a greater amount of pressure to deform the metal at cold state.

The most commonly used squeezing operation is sizing, coining, hobbing, riveting.

- Sizing: This operation is used for surfacing or flattening. A special die is needed for every job.
- Coining: This is a process of making impressions or raising of images by a plastic flow by using a punch and die.
- Hobbing: It is the process of producing cavities into surface of material by pressing with a special punch called hub.
- Riveting: It is the process of fastening the two metal sheets by inserting metal pin in to the sheets and spreading out by hammering to form the rivet head.

Self-Check 1	Written Test

Directions: - Answer all the questions listed below and write your answer on the space provided

Name _____

Short Answer Type Questions

1. Name different tools used in sheet metal work.
2. Define Seam in sheet metal work.
3. What is the purpose of mallet?

Long Answer Type Questions

1. Explain about any four important sheet metal operations.
2. Explain different sheet metal joints with sketches.
3. Explain brazing and soldering.

Answer Sheet

Score = 6pts
Rating: _____

Name: _____
Date: _____

Short type Answer

Q.1. ----------
Q.2.----------
Q.3.----------

Long Types answer

Q.1. ----------
Q.2.----------
Q.3.----------

Information Sheet-2	Identifying and adhering quality assurance requirements

Introduction

Quality Assurance Principles

Quality Control Authority is committed to quality assuring all its qualifications to ensure public recognition and credibility through the maintenance of standards. Quality Control Authority quality assurance is based upon the following principles:

- *the Quality Control Authority assessment and quality assurance system should be understandable to stakeholders, effectively administered, publicly accountable and cost effective to operate*
- *qualifications should be accessible to all candidates who have the potential to achieve them*
- *the criteria which define the performance required of candidates for them to achieve qualifications should be appropriate to purpose, explicit and in the public domain*
- *each unit, course and group award should be unique and necessary, and should comply with the relevant qualification specification*
- *assessments should be valid, reliable and practicable, and assessment results should be in line with qualification criteria*
- *qualifications should be offered in centers which have the resources and expertise to assess candidates against the qualification's criteria*
- *staff in Company should be provided with effective support in assessing candidates for certification*
- *responsibility for quality assurance should be devolved to Company where this is consistent with the maintenance of national (required/set) standards*

Quality Assurance Elements

In order to ensure that the qualifications Quality Control Authority offers are designed, delivered and assessed to acceptable national (required/set) standards, we have identified key quality assurance *elements*, based on the quality assurance principles. These elements underpin all Quality Control Authority qualifications, and are the mechanisms through which national (required/set) standards are established and maintained.

We have divided each element into requirements or *criteria.* Quality Control Authority and Company have corresponding responsibilities for these. Quality provision requires an effective partnership, based on the quality assurance criteria, between Quality Control Authority and staff in Company.

Some criteria relate to all of the elements and they have been extracted and described separately.

The elements are:

- *Approval as Quality Control Authority centre* the criteria relate to the management procedures which underpin the implementation and assessment of Quality Control Authority qualifications in Company

- *Approval to offer specific Quality Control Authority qualifications* the criteria relate to resources required of Company for the implementation and assessment of specific Quality Control Authority qualifications

- *Validation of Quality Control Authority qualifications* the criteria relate to ensuring that Quality Control Authority qualifications are fit for purpose *internal moderation of internal assessment* the criteria relate to the processes by which Company ensure that all internal assessment is valid, reliable, practicable and cost-effective

- *External moderation of internal assessment* the criteria relate to external processes by which Quality Control Authority ensures that internal assessment is in line with the national (required/set) standards set out in the qualifications.

- *quality control of external assessment* the criteria relate to the processes by which Quality Control Authority and Company ensure that external assessment is in line with the national (required/set) standards set out in the qualifications *monitoring of Quality Control Authority 's quality assurance elements* the criteria relate to the processes which are used to measure the success of the other elements in supporting the consistent application of national (required/set) standards

Self-Check 2	Written Test

Directions: - Answer all the questions listed below and write your answer on the space provided

Name _____

what is Quality Control Authority?

What are Quality Control Authority principles?

What are elements of quality assurance?

Answer Sheet

Score = 19pts
Rating: _____

Name: _____
Date: _____

Short Answer Questions

Q.1. ----------

Q.2.----------

Q.3. ----------

Information Sheet-3	Associating OHS requirements

Safety Guides to Sheet Metal Works

Some of the safety precautions applicable to sheet-metal tools and equipment have been mentioned throughout this information sheet. Here are a few additional precautions that should be carefully observed when you are working with sheet metal.

1. Sheet metal can cause serious cuts. Handle it with care. Wear steel reinforced gloves (figure 1.1) whenever feasible.
2. Treat every cut immediately, no matter how minor.
3. Remove all burrs from the metal sheet before attempting to work on it further.
4. Use a brush to clean the work area. NEVER brush metal with your hands.
5. Use tools that are sharp.
6. Keep your hands clear squaring shears of the blade on all
7. A serious and painful foot injury will result if your foot is under the foot pedal of the squaring shears when a cut is made.
8. Do not run your hands over the surface of sheet metal that has just been cut or drilled. Painful cuts can be received from the burrs.
9. Get help when large pieces of sheet metal are being cut. Keep your helper well clear of the shears when you are making the cut.
10. Keep your hands and fingers clear of the rotating parts on forming machines.
11. Place scrap pieces of sheet metal in the scrap box.
12. Always remember to keep a clean shop. **GOOD**
13. Do not use tools that are not in proper working condition: hammer heads loose on the handle, chisels with mushroomed heads, power tools with guards removed, and so forth.
14. Wear goggles (Figure 1.2) when in the shop.

(a) (b)

Figure 1.1 Hand Protecting Safety Glove (a) & (b)

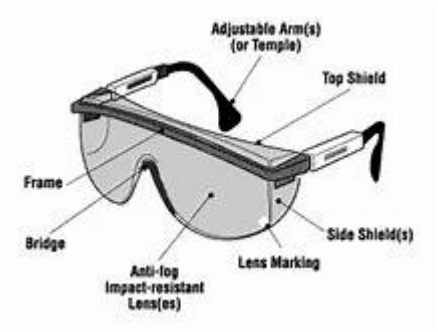

Figure 1.2 Eye protective Goggle

Metal Cutting Guillotines Safety Requirements

The most common metal guillotine injuries are crushed or amputated fingers. Incidents that result in these injuries are often caused by the clamps that hold the metal being cut and not the blade or fingers being jammed under the sheet of metal being cut.

Guarding of the guillotine must prevent a person's fingers, hands or other body parts entering the trapping space during the working or return stroke, and from accessing the blade.

Front guards

For most purposes and especially for the shearing of flat metal sheet, **a fixed guard** at the front of the machine should always be used. The guarding should ideally be slotted so that the operator can see the material being cut and task lights should also be positioned on the guard to illuminate the cutting area.

The guard can be adjusted to allow for materials of varying thicknesses to be cut. The positions of an adjustable guard should be nominated as appropriate and documented for operator training. These settings should be listed on the machine and guard. Alternatively, the guarding should be designed to remain in the appropriate position based on the thickness of the material being worked on.

When a fixed guard is not possible, because heavy plate is to be sheared on large guillotines, this issue may be overcome if the machine is operated through use of a friction clutch, by the use of a moveable hinged guard interlocked with the machine controls.

Rear guards

Guarding such as a physical barrier of sufficiently spaced steel tubing and/or steel mesh should be fitted to prevent people from reaching the blade at the rear of the machine. A chute can be incorporated to allow off cuts to be retrieved.

Throat guards

The openings of each side of the guillotine are also danger areas that present a risk of bodily access to the blade when slitting metal sheets wider than the machine table. Slotted end guards should be fitted to allow the cutting of long or wide metal sheet.

Other safeguards

Guarding of flywheels, belts, pulleys, shafts and other parts should also be provided.

Sealant Product Safety, Handling and Storage: Customers considering the use of sealant, for instance Silicon II and similar, product should review the latest Material Safety Data Sheet and label for product safety information, handling instructions, personal protective equipment if necessary, and any special storage conditions required. Material Safety Data Sheets are available at *manufacturers manual*

Other Sheet Metal Works Safety Requirements

Hand, rotary or squaring shears and hacksaws finish fabricated pieces at the shop and installation site. Use the correct tool for the job and sheet gauge. Keep tools sharp so they work correctly. Wear flexible, protective gloves that allow you to grip tools and materials. A hard hat and hearing protection may be required on a construction site.

For welding and soldering seams and joints, use low-emission materials in a well-ventilated area. A respirator can protect your lungs from fumes. Use power tools for rivets, drive nails, or other fasteners according to manufacturer's recommendations. Treat powered fasteners with respect because they can cause serious injuries if accidentally or improperly discharged.

Duct, pipe, and tube installation work can all require work at heights. Examine each job task and site to determine the safest access method such as ladder, scaffold, or scissors lift, and if fall protection is needed. Watch for unguarded and floor openings, common fall hazards for sheet metal workers.

Maintain your overall health and fitness level because sheet metal work can require crawling into tight spaces and areas for installations. Standing, climbing, bending, and squatting may be required for long periods. Keep your work close to you and rotate your tasks as much as possible to avoid fatigue.

Self-Check 3	Written Test

Directions: - Answer all the questions listed below and write your answer on the space provided

Name _____

Choose the best answers to the following

1. Which one the following safety material is not applicable in cutting and joining sheet metals

   a. Hand glove with leather type
   b. Safety shoes
   c. Eye goggle
   d. Glove with plastic type
   e. None

2. Sheet metal Guillotines safety requirements may prevent a person from:

Finger cut, hands and other parts from entering the trapping space during working or return stroke

A person's eye from affecting emitted metal chips

A person's foot from entering the trapping space

All

None

3. Which part (s) of sheet metal cutting guillotines, shear, break press and similar is used to protect the machine or equipment operator and/or other persons walking around the work areas

Motor part

Rotating parts

Striking parts

Metal guard parts

All except "d"

Score =14pts

Rating: _____

Answer Sheet

Name: _____ Date: _____

Short Answer Questions

Q.1. _____
Q.2._____
Q.3. -_____

Instruction Sheet 2	Learning Guide #31 Plan and prepare work

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics

Planning and sequencing work Tasks

Selecting and checking personal safety tools, equipment and materials

Preparing Work areas

Checking sealants, fixing and sheet metal materials

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

Plan and sequence work Tasks

Select and check personal safety tools, equipment and materials

Prepare Work areas

Check sealants, fix and sheet metal materials

Learning Instructions:

Read the specific objectives of this Learning Guide.

Follow the instructions described below

Read the information written in the "Information Sheets 1- 4". Try to understand what are being discussed.

Accomplish the "Self-checks1, 2, 3 & 4 " in each information sheets on pages 6, 9, and 6.

Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

After You accomplish self check, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1	Planning and Sequencing Work Tasks

Planning and Scheduling Work Tasks

Sheet metal works, cutting and joining, planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The work piece is marked out using the dimensions and datum as specified on the drawing. A basic level of mathematics is required such as addition, subtraction, multiplication, division, fractions, decimals and percentages.

One of the first steps in preparing to lay out a pattern on metal is to square the bottom left hand side of the piece of material. A steel square may be used for this purpose, or a sheet maybe squared using the squaring arm on the guillotine.

The next step is to ensure that the sheet lies perfectly flat on the bench as a sheet that is not flat will cause measurements to be inaccurate.

Self-Check 1	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

Name_____

Choice Part

_____is important prior to starting any task.

Job panning B. patterns

To make sheet metal work or project the first things you do is

Read and Understanding of drawing B. Prepare Sequence of operation

Before starting to any operation sheet metal worker has to prepare_____.

Sequence of operation B. Read and Understanding of drawing

Explain the following questions briefly

Discuss on the importance of sheet metal cutting and joining planning (after discussing the question together with group, answer it individually) (2pts)

Write down sequences of sheet metal work tasks (at least one). (2pts)

Answer Sheet

Score = 7pts Rating: _____

Name: _____ Date: _____

Choice Part

_____ **2.** _____ **4.** _____

Short Answer Questions

1. _____
   _____
   _____

2. _____
   _____
   _____

Information Sheet-2	Selecting and checking personal safety, tools, equipment and materials

Introduction

One of the characteristics of the skilled worker is the way in which he selects and uses the tools of his trade. For this reason, it is essential that you know how to select and properly use both the hand and machine tools of the sheet metal trade. Tools and machine elements like, Iron scissors, hand shear, machine shear, guillotine, Taping screws, Nut and bolts, Rivets, Adhesives, Sealants, etc.

2.1. Selecting and Checking Sheet Metal Hand Tools Equipment

A large number of hand tools used by sheet metal workers. Some of the important tools used are given below.

Measuring tools

- Steel rule
- Folding rule
- Circumference rule
- Vernier Calipers
- Micrometer
- Sheet metal gauge

Straight edge

Scriber

Divider

Trammel point

Chisel

Punches

Hammers

Snips or Shears

Pliers

Stakes

Groovers

Rivet sets

Soldering Iron

2.1.1. Measuring tools

Figure 2.1 Sheet metal gauge

Sheet-Metal gauge: Check the gauge of the metal against this size with a **Sheet-Metal Gauge** (figure 2.1). This figure shows the gauge used to measure the thickness of metal sheets. The gauge is a disc-shaped piece of metal, having slots of widths that correspond to the U.S. gauge numbers from O to 36. Each gauge number is marked on the front and the corresponding decimal equivalent marked on the back.

Vernier Calipers

Named after its inventor, the vernier scale is incorporated in many measuring instruments, the most commonly used of which is the sliding caliper gauge. It can be used for taking both internal and external measurements. These gauges are made from fine quality alloy steels and are very accurately finished.

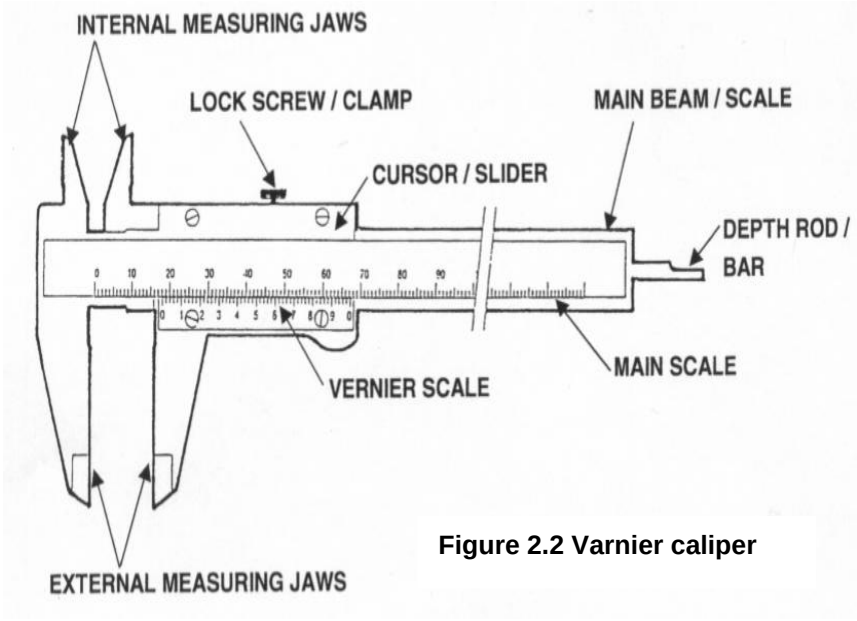

Figure 2.2 Varnier caliper

When measuring an object externally or the thickness of a particular material, the locking screws A and B are both slackened off and the sliding jaw assembly is moved along, almost onto the object. Locking-screw A is tightened down and then, by turning the knurled screw C, the jaws are gently closed on to the surfaces without putting any pressure on them. Locking screw B is then tightened down and the calipers removed from the work for reading.

The jaw tips are stepped and rounded on the outsides so that internal measurements can be taken and to whatever reading is obtained, the widths of the jaws must be added. This measurement is found engraved on the jaw face for reference.

Reading the Vernier Calipers

In the picture (figure 2.2), for example, we see part of the caliper main scale is divided into centimeters and milimetres. The actual length of the vernier scale is 49mm and this length is divided into 50 parts. Each division of the vernier will therefore be equal to 0.980mm, i.e each will be 1/50th mm shorter than each division on the main scale. The reading is taken as follows: reading along the main scale up to the vernier zero, we can see the number of whole mm in the measurement and the line on the vernier which coincides with a line on
the main scale indicates the number of 1/50th mms to be added on.
Tools incorporating the vernier scale are also available with scales in imperial measure.

Circumference Rule

Another method of determining circumference is by use of the circumference rule. The upper edge of the circumference rule is graduated in inches in the same manner as a regular layout scale, but the lower edge is graduated, as shown in figure 2.3. The lower edge gives you the approximate circumference of any circle within the range of the rule. You will notice in figure 2.3 that the reading on the lower edge directly below the 3-inch mark is a little over 9 3/8 inches. This reading would be the circumference of a circle with a diameter of 3 inches and would be the length of a stretch-out for a cylinder of that diameter. The dimensions for the stretch-out of a cylindrical object, then, are the height of the cylinder and the circumference.

Figure 2.3 Circumferential Rule

Rule: **-** instruments are manufactured in a variety of lengths and types; each of which is designed for measuring or laying out different work. Most commonly used for rough measurement.

Folding rule: - the six-foot-length folding rule is commonly used for taking job measurements in sheet metal work. **Tape rule:** the tape rule, either in 6 foot or 2 foot lengths is becoming popular for taking measurements of a job.

2.1.2. Scribing tools

Scratch awls (also called **scribers)**

- There are three types Scratch awls perform the same function of marking lines on metals. Lines are marked on metal for a variety of purposes in laying out patterns.

  - **Ring Scratch Awl: -** the ring scratch awl is made of one solid piece of steel approximately eight inches long with a tapered point on one end and a ring on the other.

  - **Socket Scratch Awl**: - the socket scratch awl ha a steel blade approximately five inches long and is made with a replaceable wooden handle.

  - **Shank Type Scratch Awl: -** for general purposes, this shank type of scratch awl is preferred by most sheet metal mechanics since the steel blade passes through the handle, reinforcing the top.

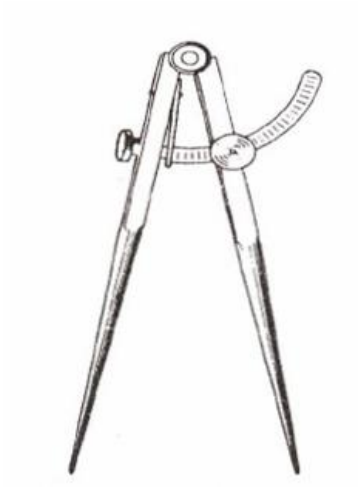

Figure 2.4 Wing Dividers transfer dimensions and scribe arcs and circles

Dividers

Dividers: - are made with each straight leg tapered to a needle point.

These wing type dividers may be adjusted to any position by loosening the knurled screw, changing the distance between points and then tightening the screw to retain the desired distance between points. See figure 2.4.

Dividers are manufactured in a number of sizes and types and are used to space off equal distances, to divide lines into equal parts arid to scribe arcs and circles.

Steel Square

Steel Square is important for accurate layout work in pattern drafting since all layouts must start from a square corner.

- The long arm of the square is known as the *body* (also called *blade),* and
- The short arm is called the *tongue.*

Squares are manufactured in a number of sizes.

The steel square shown in Figure 2.5 (a)

Trammel points (sometimes called a beam compass)

Trammel points are instruments used for drawing large circles, arcs, etc.

- They are manufactured in various types with to straight, removable legs tapered to needle points and attached to separate heads or holders. These heads or holders slide on wood or steel bars or beams, and are held in place by thumbscrews.

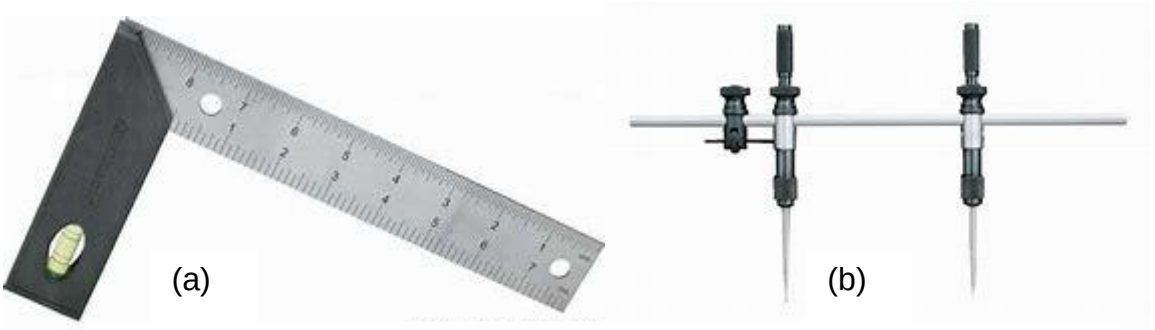

Figure 2.5 (a) Steel Square with leveling and (b) Trammel points

Cutting Tools

- Either of the points can be moved and often one point has a fine adjustment for more accurate setting. A special clamp for pencil can be attached to one of the points. Shown in Figure 2.5 (b)

2.1.3. Cutting Tools

Snips

Various types of **Hand Snips/Hand Shears** are used for cutting and notching sheet metal. Hand snips are necessary because the shape, construction, location, and position of the work to be cut frequently prevent the use of machine-cutting tools.

Hand snips are divided into two groups. Those for straight cuts are as follows: straight snips, combination snips, bulldog snips, and compound lever shears. Those for circular cuts are as follows: circle, hawk's bill, aviation, and Trojan snips. These snips are shown in figure 2.6. The following is a brief description of each type of snip.

Straight Snips (figure 2.6, view A) have straight jaws for straight line cutting. To ensure strength, they are not pointed. These snips are made in various sizes and the jaws may vary from 2 to 4 1/2 inches. The overall length will also vary from 7 to 15 3/4 inches. The different size snips are made to cut different thicknesses of metal with 18 gauge steel as a minimum for the larger snips. These snips are available for right- or left-hand use.

Combination Snips (figure 2.6, view B) have straight jaws for straight cutting but the inner faces of the jaws are sloped for cutting curves as well as irregular shapes. These snips are available in the same sizes and capacities as straight snips.

Bulldog Snips (figure 2.6, view C) are of the combination type, They have short cutting blades with long handles for leverage. The blades are inlaid with special alloy steel for cutting stainless steel. Bulldog snips can cut 16 gauge mild steel. The blades are 2 1/2 inches long and the overall length of the snip varies from 14 to 17 inches.

Trojan Snips (figure 2.6, view D) are slim-bladed snips that are used for straight or curved cutting. The blades are small enough to allow sharp turning cuts without buckling the metal. These snips can be used to cut outside curves and can also be used in place of circle snips, hawk's bill snips, or aviation snips when cutting inside curves. The blades are forged high grade steel. These snips come in two sizes: one has a 2 1/2-inch

cutting length and a 12-inch overall length and the other has a 3-inch cutting length and a 13-inch overall length, They both have a 20 gauge capacity.

Circle Snips (figure 2.6, view E) have curved blades and are used for making circular cuts, as the name implies. They come in the same sizes and capacities as straight snips and either right- or left-hand types are available.

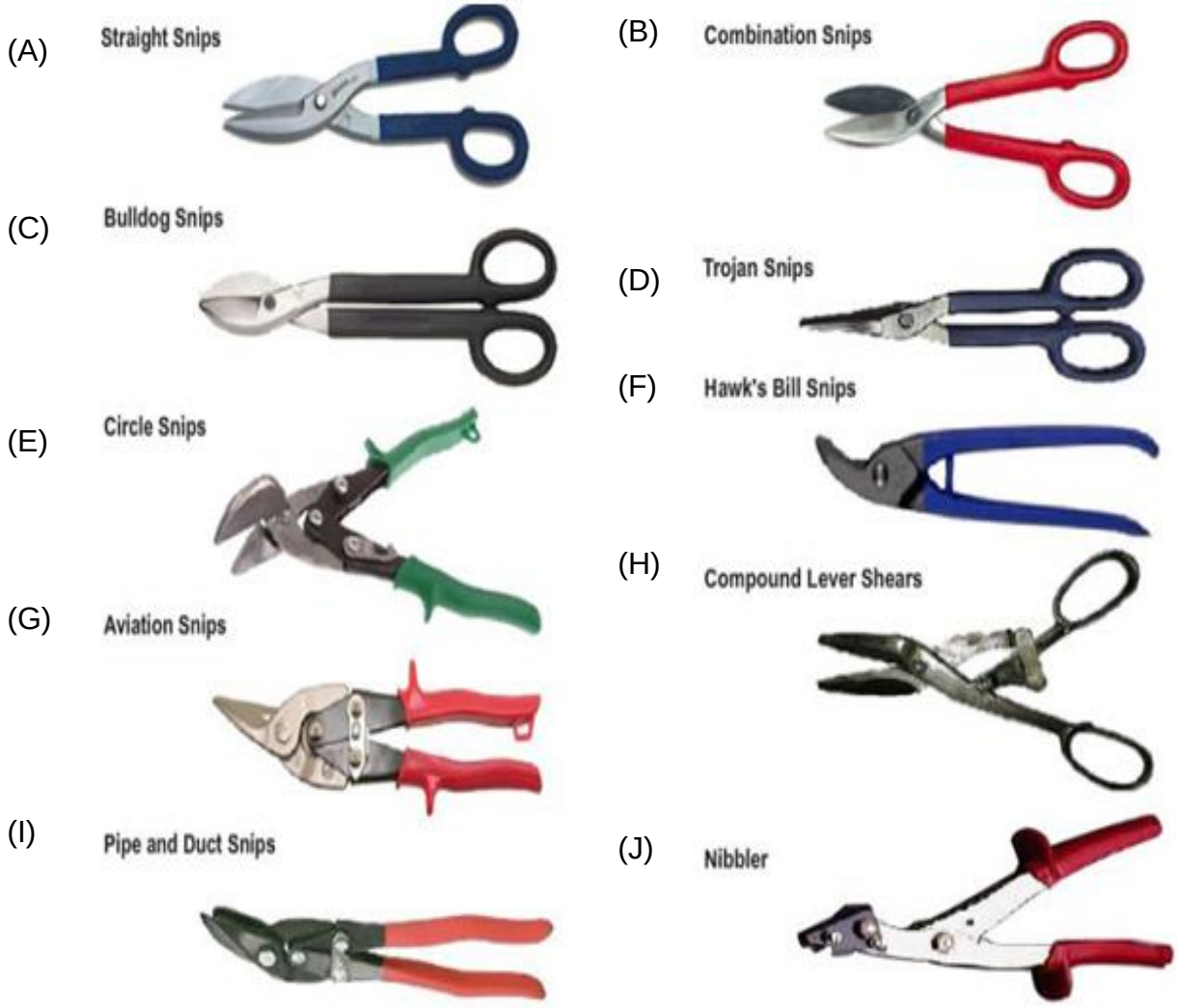

Figure 2.6 Hand snips

Figure 2.7 Proper cutting methods using snips

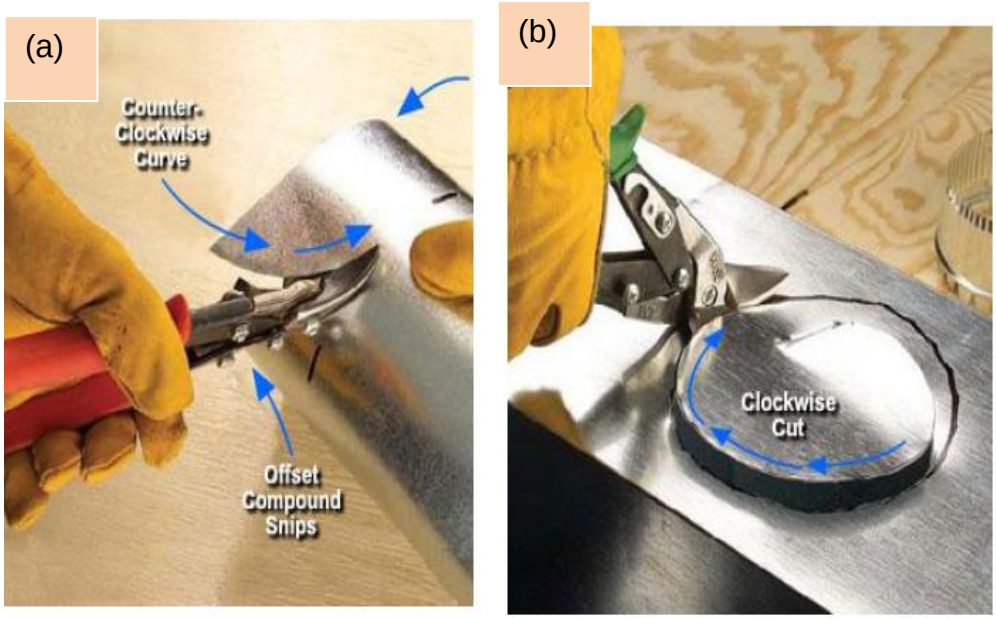

Figure 2.8 Making a circular Cut using offset

Counter-clockwise cut (b) Clockwise cut

Hawk's Bill Snips (figure 2.6, view F) are used to cut a small radius inside and outside a circle. The narrow, curved blades are beveled to allow sharp turns without buckling the sheet metal. These snips are useful for cutting holes in pipe, in furnace hoods, and in close quarters work. These snips are available with a 2 1/2-inch cutting edge and have an overall length of either 11 1/2 or 13 inches and have a 20 gauge mild steel capacity.

Aviation Snips (figure 2.6, view G) have compound levers, enabling them to cut with less effort. These snips have hardened blades that enable them to cut hard material. They are also useful for

cutting circles, for cutting squares, and for cutting compound curves and intricate designs in sheet metal. Aviation snips come in three types: right hand, left hand, and straight. On right-hand snips, the blade is on the left and they cut to the left. Left-hand snips are the opposite. They are usually color-coded in keeping with industry standards-green cuts right, red cuts left, yellow cuts straight. Both snips can be used with the right hand. The snips are 10 inches long and have a 2-inch cut and have a 16 gauge mild steel capacity.

Modern snips are designed to cut freely with a minimum curling of the metal. The snips are generally held in the right hand at right angles to the work (figure 2.7). Open the blades widely to obtain maximum leverage. Do not permit the ends to close completely at the end of a cut or a rough edge will result. Cut circular sections from the right side [figure 2.8 (a)].

Shears

Compound Lever Shears (figure 2.6, view H) have levers designed that give additional leverage to ease the cutting of heavy material. The lower blade is bent to allow the shears to be inserted in a hole in the bench or bench plate. This will hold the shear in an upright position and make the cutting easier. The cutting blades are removable and can be replaced. The capacity is 12 gauge mild steel. It has cutting blades that are 4 inches long with an overall length of 34 1/2 inches.

When making internal circular cuts, you make a small opening near the center of the opening, insert the snips, and cut from the upper side, gradually increasing the radius of the cut until the opening is completed [figure 2.8 (b)].

Large sheet-metal sections are cut on **Squaring Shears** that are discussed later in this chapter.

The most commonly used types of snips in the sheet metal shop are the bulldog Snips, Combination snips and the left—hand and right—hand Aviation snips

Compound-Lever Shears

Compound-lever shears, because of the arrangement of levers, has a mechanical advantage sufficient to allow the cutting of metal up to 12 gage steel.

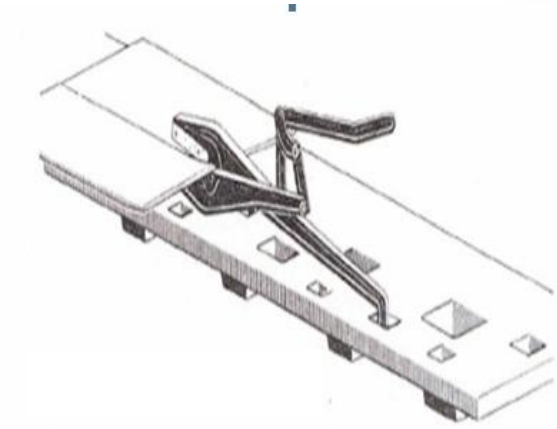

Figure 2.9 Compound-Lever Shears

Figure 2.10 ***Forming, crimping, beading and grooving***

- The lower handle is bent to allow the shears to be placed on the bench plate.

Bench Lever Shears

Bench Lever Shears which is used in almost every sheet metal shop

This is a heavy duty shears models are available to cut 3/" thick metal

They are

- *Plain forming machine,*
- *slip—roll forming machine,*
- *Crimping machine* and
- *Beading machine.*

Groovers

Hand Groover

The hand groover is used when grooving a seam by hand. The end of the tool is recessed to fit over the lock, making the grooved seam. It is available in various sizes (see Figure 2.11).

Cold Chisel

The various types of chisels are used for cutting metal.

Figure 2.11 Hand groover

Figure 2.12 Different types of cold chisel

Flat Chisel. Sheet metal workers generally use this chisel more than the other types since it is used for cutting sheet metal, rivets, bolts, and in chipping operations. (figure 2.12)

Cape Chisel. Cape chisels are used for cutting grooves and keyways.

Diamond Point Chisel. These chisels are used for cutting V shaped grooves, for chipping corners, and sometimes for removing bolts whose heads have broken off.

Round Nose Chisel. Round nose chisels are used for roughing out the concave surfaces of corners arid also for cutting grooves.

Hammers

It is essential that sheet metal workers have a variety of hammers. These should include the following:

- Riiveting hammers,
- Raising hammers,
- Setting hammers,
- Ball peen or machinist's hammers,
- Nail hammers, and
- Mallets.

These hammers (figure 2.13) are manufactured in a variety of weights.

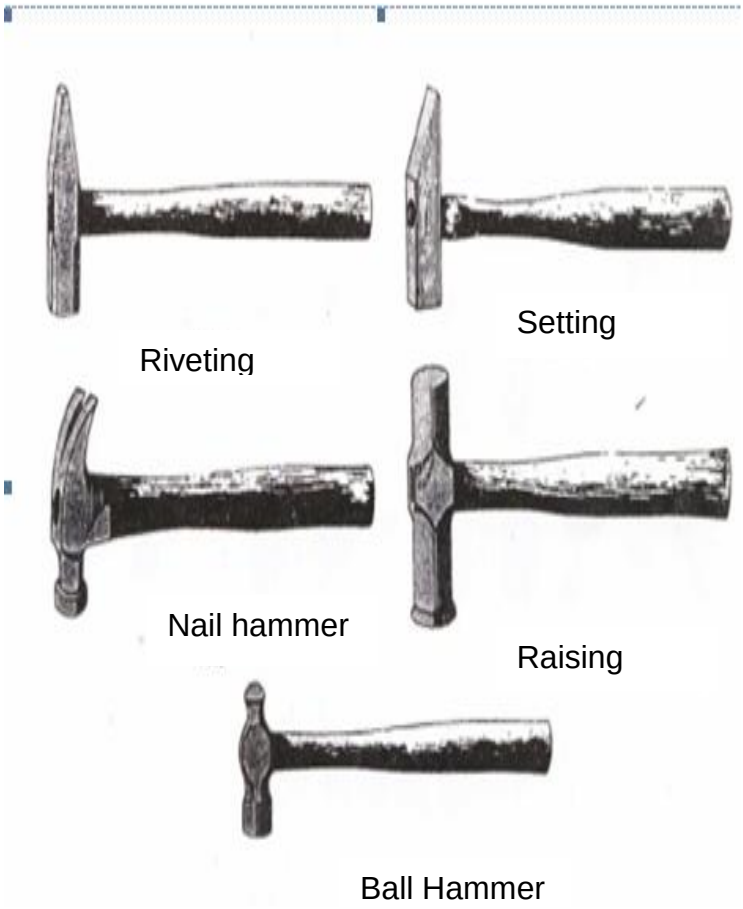

Figure 2.13 Common types Hammers

Riveting hammer: - the riveting hammer has a square, slightly curved face with beveled edges to prevent the head of the hammer from marking the metal. The peen side is double tapered and has a slightly rounded end.

Setting Hammer: - the setting hammer has a square, flat face for flattening seams without damage to the metal. The single-tapered peen with a beveled end is used for pressing operations.

Ball Peen Hammer: - The ball peen or machinist's hammer has a round, slightly curved face and round head. It is a general purpose hammer.

Raising Hammer: - the raising hammer is seldom used in modern sheet metal work and is supplied by the shop rather than by the sheet metal worker. It is one of a set of four hammers used in raising circular disks and ornaments for cornice work and many other raising and bumping operations.

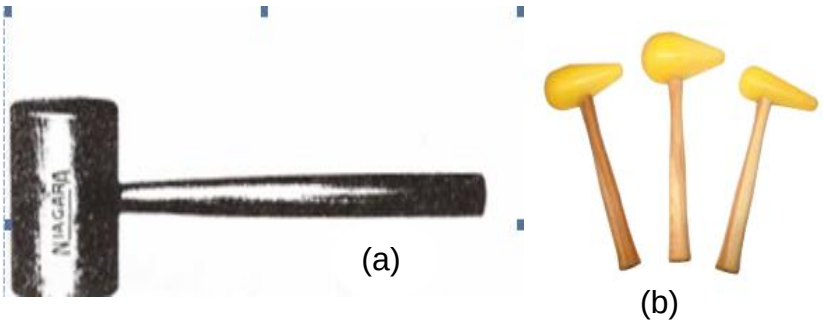

Figure 2.14 (a) Common type Mallet and (b) Boss Mallet type used in Cutting Metal

Moon nail hammer: - is not generally considered a sheet metal worker's tool, though it is very useful in this work and is employed for a variety of operations around the shop.

Mallet: - is one of the most abused tools because it is often used to perform operations for which it is not designed. (see figure 2.14 a & b)

Mallets are properly used where *steel* hammers would deface the work.

Forming Machines

The two types of forming machines commonly used in the sheet metal shop are the

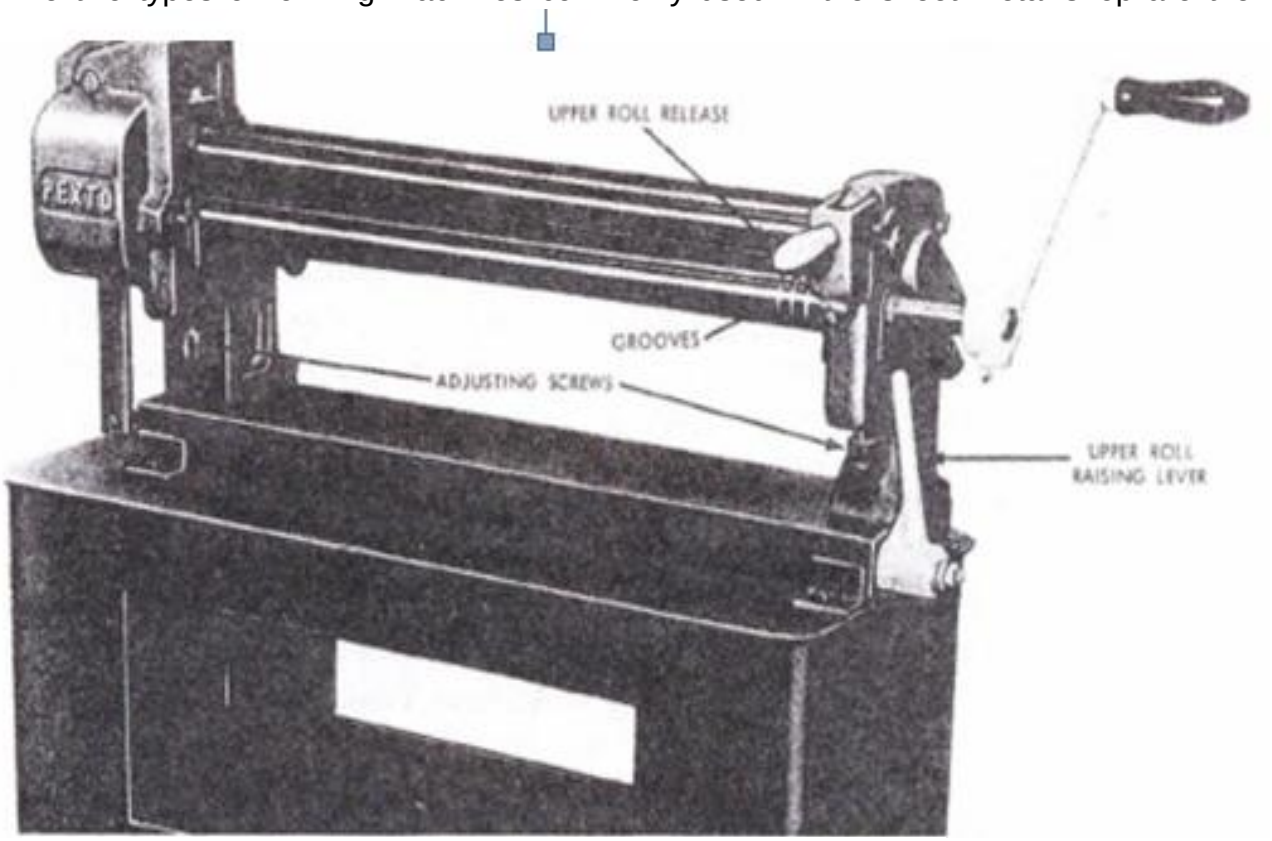

Figure 2.15 Plain Sheet Metal Forming Machine

plain forming machine and the slip-roll forming machine.

Plain Forming Machine:- the plain forming machine consists of three rollers through which flat sheets of metal are feed to be formed into cylindrical shapes. (see figure 2.15)

- The two front rollers are driven either by a hand crank assembly or by an electric motor.

- Most shops will mainly use the hand powered machine.
- The rear, or *idler,* roll does the actual forming of the cylinder. It is adjustable to accommodate different thicknesses of metal and the diameter of the piece to be formed.

Slip-Roll Forming Machine*:* - the slip-roll forming machine, the same way as the plain forming machine.

- The difference is that the upper roll on the slip-roll machine can be released and swung away to facilitate removing the formed piece of metal.
- On both types of forming machines, the two front rolls act as feeding or gripping rolls while the rear roll gives the proper curvature to the work.
- *The* front rolls are adjusted by two screws located at either end of the machine.
- The rear roll is adjusted by **two** screws located at the rear of each housing. The grooves in the front and rear rolls are used for forming pieces with wired edges.

Forming Cylinders: - the forming process is begun by inserting the work piece between the two front rolls.

The front rolls are adjusted by turning the knurled adjusting screws on the front of the machine.

The front rolls should be adjusted to allow just enough clearance between the rolls to avoid crushing the locks.

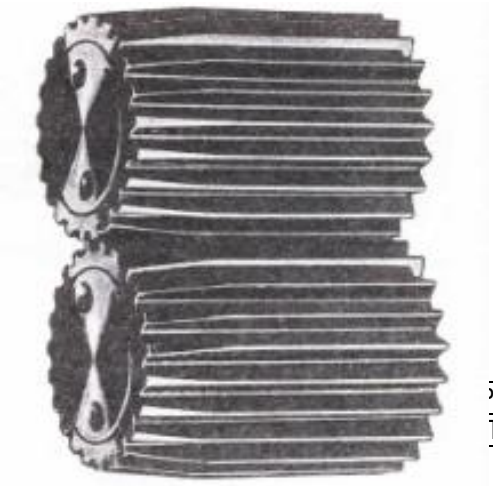

Figure 2.16 Beading Machine

After the work piece is inserted, it is tilted upward

Crimping Machine

Crimping is the process used to corrugate one end of a pipe to make it smaller, so it will fit

easily into the end of another pipe of the same dimension.

This method eliminates the need of making one end of the pattern for the pipe smaller than the other.

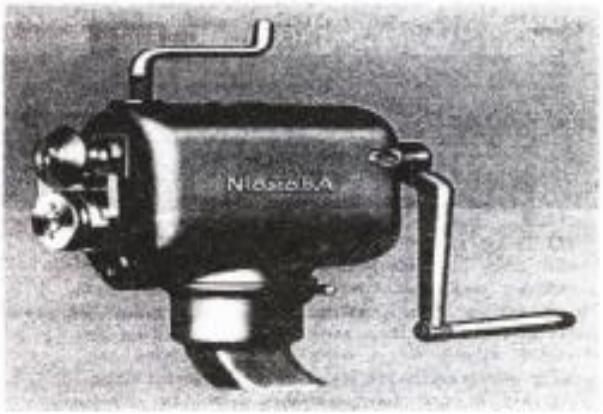

Figure 2.17 Burring Machine

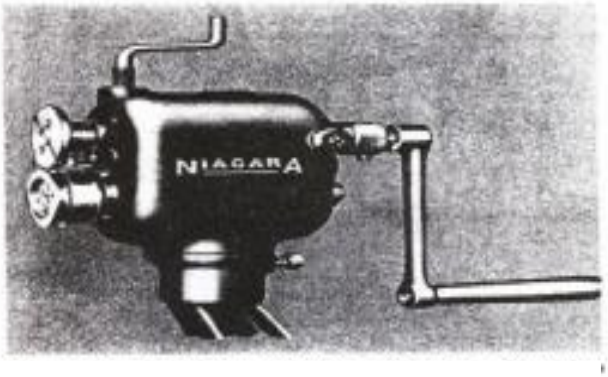

Figure 2.18 Turning Machine

However, crimping can be used on light gage metal only.

Beading Machines

Beads are formed on cylindrical objects to serve as stiffeners, reinforcement or ornamentation.

The beading machine is a rotary machine equipped with special beading rolls.

Burring Machine

Burring Machine: The burring machine shown in is used to turn burrs (edges) on circular disks such as bottoms and covers and also for preparing edges for double seaming cylindrically shoed articles.(see figure 2.17)

Turning Machine

Turning Machine: The turning machine while somewhat similar to the burring machine differs in the sharpness of the edge it makes. (see figure 2.18)

A burring machine produces a sharp edge, while the turning machine makes a rounded edge for wiring operations, for bodies of cylinders, and for double seaming.

The **Combination Notcher, Coper, and Shear** (figure 2-19) is ideal for notching corners or the edge of sheet metal. The blades are adjustable for conventional notching or for piercing, starting inside the blank.

Rotary Circular Shears

The rotary circular shears is used for cutting sheet metal disks for bottoms and tops of cans.
These shears are also designed for slitting sheets of metal into pieces of any desired width.(see figure 2.20)

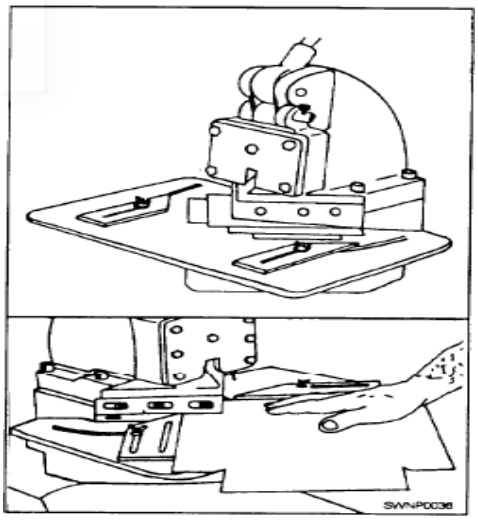

Figure 2.19 Combinations notcher, coper and shear

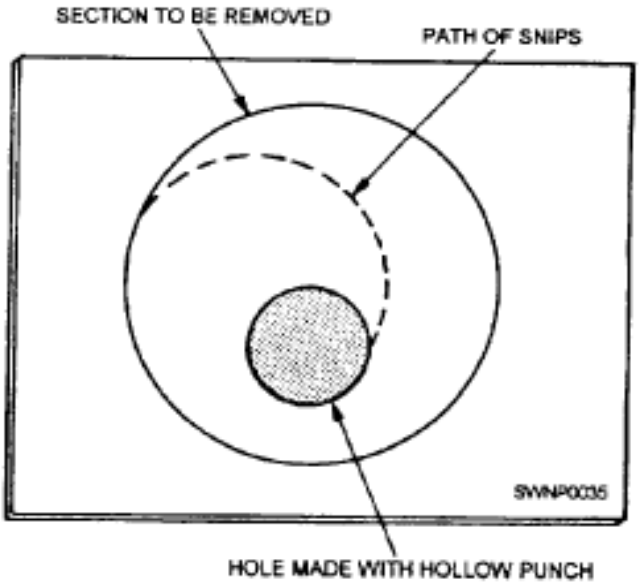

Figure 2-20 Making an internal circular cut.

Squaring Shears

Squaring shears are used for cutting and squaring sheet metal. See *Figure 2.21*. They may be foot operated or power operated. Squaring shears consist of a stationary blade attached to a bed and a movable blade attached to a crosshead. To make a cut, place the work in the desired position on the bed of the machine. Then use a downward stroke to move the blade. Foot-powered squaring shears are equipped with a spring that raises the blade when foot pressure is removed from the treadle. A scale graduated in fractions of an inch is scribed on the bed. Two side guides, consisting of thick steel bars, are fixed to the bed, one on the left and one on the right. Each is placed so that its inboard edge creates a right angle with the cutting edge of the bed. These bars are used to align the metal when square corners are desired. When cuts other than right angles are to be made across the width of a piece of metal, the beginning and ending

points of the cut must be determined and marked in advance. Then the work is carefully placed into position on the bed with the beginning and ending marks on the cutting edge of the bed.

A hold-down mechanism is built into the front of the movable cutting edge in the crosshead. Its purpose is to clamp the work firmly in place while the cut is being made.

This action is quick and easily accomplished. The handle is rotated toward the operator and the hold-down lowers into place. A firm downward pressure on the handle at this time should rotate the mechanism over center on its eccentric cam and lock the hold-down in place. You should reverse the action to release the work.

Three distinctly different operations—cutting to a line, squaring, and multiple cutting to a specific size—may be accomplished on the squaring shears. When you are cutting to a line, place the beginning and ending marks on the cutting edge and make the cut. Squaring requires a sequence of several steps.

First, square one end of the sheet with one side. Then square the remaining edges, holding one squared end of the sheet against the side guide and making the cut, one edge at a time, until all edges have been squared.

When several pieces are to be cut to the same dimensions, use the adjustable stop gauge. This stop is located behind the bed-cutting edges of the blade and bed. The supporting rods for the stop gauge are graduated in inches and fractions of an inch. The gauge bar is rigged so that it may be set at any point on the rods. With the gauge set at the desired distance from the cutting blade, push each piece to be cut against the stop. This procedure will allow you to cut all pieces to the same dimensions without measuring and marking each one separately.

Figure 2.21 Squaring shears

Figure 2.22 Ring and circular shears

Do not attempt to cut metal heavier than the designed capacity of the shears. The maximum capacity of the machine is stamped on the manufacturer's specification plate on the front of the shears. Check the gauge of the metal against this size with a sheet metal gauge. This figure shows the gauge used to measure the thickness of metal sheets. The gauge is a disc-shaped piece of metal, having slots of widths that correspond to the U.S. gauge numbers from 0 to 36. Each gauge number is marked on the front and the corresponding decimal equivalent is marked on the back.

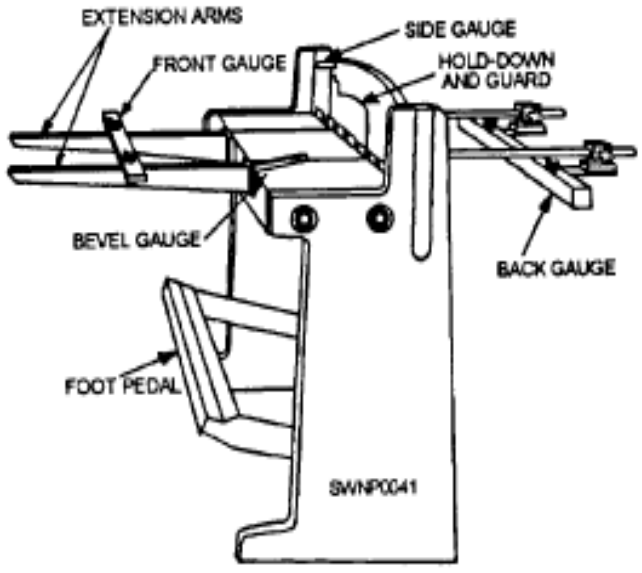

Figure 2-23 Foot-actuated squaring shears

Ring and circular shears (*Figure 2.22*) are intended for cutting inside and outside circles in sheet metal. The clamping is positioned for the desired diameter and the blank is inserted. Lower the cutting disc and make the cut.

Foot-Actuated Squaring Shears (figure 2-23) make it possible to square and trim large sheets. Do not attempt to cut metal heavier than the designed capacity of the shears. The maximum capacity of the machine is stamped on the manufacturer's specification plate on the front of the shears.

2.1.4. Fastening tools

Rivet gun

Pop Riveting Guns

"Pop" Riveting Guns are used extensively with "pop" rivets for the assembly of light fabrications and are particularly useful for the assembly of metal cladding where access

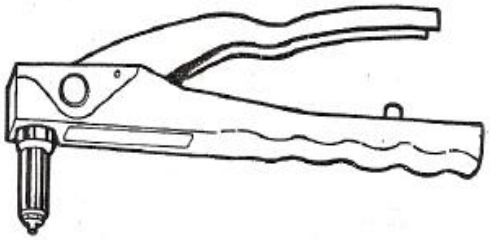

Figure 2.24: Hand pop rivet gun

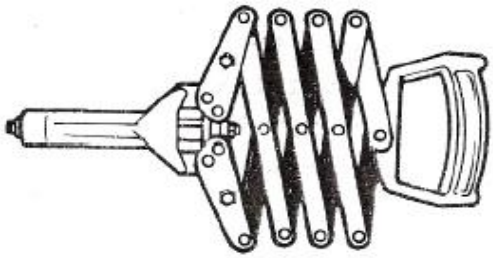

Figure 2.25 Lazy tong rivet

is restricted to one side of the work only. There are three different types available: hand "pop" gun, lazy tongs and pneumatic (air).

1) Hand "Pop" Gun

Riveting in confined spaces requires the use of a hand "pop" gun. These are unsuitable for larger dimensions of rivets, due to the reduced amount of leverage available (figure 2.24)

Lazy Tongs

Lazy Tongs (figure 2.25) are used for the larger diameters of rivets, where sufficient working space is available to permit operation of the tool.

The construction of the tool permits a moderate pressure on the handle to provide a strong pulling force on the rivet mandrel.

2.1.5. Punches

Great care should be used in order to select the proper punch for each operation. The common hand punches are (figure 2.26)

Prick Punch: - Prick punches are made of tool steel and have a tapered point ground to approximately a 30 degree included angle.

These punches are used for making small dents or indentations, and/or establishing points for dividers and trammel points.

Center Punch: - Center punches are similar in design to the prick punch, except that the tapered point is ground to an angle of approximately 90 degrees.

They are used primarily for marking the location of points and the centers of holes to be drilled. Such punches are manufactured in various sizes and may be purchased in sets

Neither prick punches nor center punches should be used to punch holes. These are both intended for establishing points only.

Solid Punch: - Solid punches are used to punch small holes in light gage metal; these punches may also be purchased in sets of various sizes.

Hollow Punch: - Hollow punches, shown in are used for cutting circular holes.

Hand Lever Punches: - this type of punch is equipped with a die and a punch moved by levers.

Solid Hollow

Figure 2.26 Common types of punches

2.1.6. Stakes

Stakes

Metal stakes allow the sheet metal artisan to make an assortment of bends by hand. Stakes come in a variety of shapes and sizes. The work is done on the heads or the horns of the stakes. They are machined, polished, and, in some cases, hardened Stakes are used for finishing many types of work; therefore, they should NOT be used

to back up work when using a chisel. The following is an assortment of the most common stakes that are used within the common sheet metal workshop (*Figure 2.27*):

Square stakes (*Figure 2.27*) have square-shaped heads and are used for general work. Three types are used: the coppersmith square stake with one end rounded the bevel edge square stake that is offset, and the common square stake. Some of the edges are beveled, which allows them to be used for a greater variety of jobs.

The conductor stake (*Figure 2.27*) has cylindrical horns of different diameters and is used when forming, seaming, and riveting pieces and parts of pipes.

The hollow mandrel stake (*Figure 2.27*) has a slot in which a bolt slides, allowing it to be clamped firmly to a bench. Either the rounded or the flat end can be used for forming, seaming, or riveting. There are two sizes available with an overall length of either 40 or 60 inches.

The blow horn stake (*Figure 2.27*) has two horns of different tapers. The apron end is used for shaping blunt tapers and the slender-tapered end is used for slightly tapered jobs.

The beak-horn stake (*Figure 2.27*) is a general-purpose stake. The stake has a round-tapered horn on one end and a square-tapered horn on the other end. This stake is used for riveting and shaping round or square work.

The double seaming stake with four interchangeable heads (*Figure 2.27*) has two shanks and either one can be installed in a bench plate, allowing the stakes to be used vertically or horizontally. This stake is used for double seaming large work of all types and for riveting.

The hand dolly (*Figure 2.27*) is a portable anvil with a handle that is used for backing up rivet heads, double seams, and straightening.

Figure 2.27 Metal Stakes

2.2. Sheet Metal Materials Selection

Not only it is essential for the sheet metal worker to know the tools and machines of his trade and how to use the safely, but it is also important to know the materials equally well. A finished job may look very well, but it may be useless if the wrong material were used. It is extremely important to know the correct material for a given job.

The two main groups are ferrous (steel), non-ferrous and galvanized sheet, each group including several types of metals for different uses. used in sheet metal work operations include:

Black Iron

It is also known as uncoated sheet since it carries no artificial coating on its surfaces. However, it is probably the cheapest of all types of sheets used in sheet metal work. Being uncoated, it is prone to corrosion. Consequently, its use is confined mostly to the manufacture of such items which are to be painted before shipment, e.g. block iron is used in tanks, pans, trunks, stove pipes, etc.

Galvanized Iron

Zinc coated iron is called 'Galvanized iron'. This soft steel sheet is popularly known as GI sheet. The zinc coating resist rust, improves the appearance of the metal and permits it to be soldered with greater ease; but welding is not so easy as zinc gives toxic fumes and residues. Because of zinc it can with stand contact with water and exposure to weather, e.g. articles like cabinets, trunks, buckers, pans, etc. are made of galvanized iron sheets

Copper Sheets

These sheets are relatively costlier but having specific advantages in being good corrosion resistant and good in appearance. They are reddish in colour and their cold rolled variety, which is vastly used in sheet metal work, is highly ductile and malleable

and therefore can be easily worked. Some representative examples of automobiles, various applications in chemical plants, domestic heating appliance

Aluminum Sheets

On account of its inherited weakness it is not used in its pure form. The useful variety of aluminum is aluminum alloy. Which is rolled into sheet form, carries additions of suitable amount of silicon, manganese copper and iron? It is whitish in colour and light in weight. It offers very high resistance to corrosion and abrasion. Its common applications are aeroplane bodies, kitchen ware, etc

Tin Plates

The nomenclature tin plates are used for those iron sheets which are coated with pure tin. As a result, these sheets which are coated with pure tin. As a result, these sheets provide a bright silvery appearance. They offer good resistance to corrosion and rusting and are mainly used for making packed food containers, cans, etc**.**

Stainless Steel

It is highly corrosion resistant alloy steel, which exhibits a bright surface without any coating. Though it is a little tougher than galvanized iron, in sheet form it can be shaped and span. It is widely used for making kitchen ware, food handling equipment, etc**.**

Brass

It is basically an alloy of copper and zinc and is available in many shades and colours. In sheet and strip forms it is used in many cold working processes, such as deep drawing, pressing, stamping, spinning, etc. Earlier it used to be the principal metal for making kitchen ware and utensils. But, now it is largely replaced by stainless steel and aluminum.

Lead

It is a very soft, weak, low melting point, malleable and heavy metal and possesses high resistance to acid corrosion. Due to low mechanical strength it is normally used in foil

form to provide lining for containers and other articles made from some stronger material. It finds its application in sheet form in radiation shielding and an inner lining for acid tanks**.**

Zinc

It is bluish white metal and is quite ductile. In sheet form it is widely used for roofing work. But, in many other forms, it has its applications in coating, die casting, etc.

2.3. Safety, Personal protective equipment (PPE) Selection

Sheet metal worker on the sheet metal workshop fabricate through a number of different operations some vary from job to job like, cutting, folding/ bending, edging, making seams, forming, crimping, beading and swaging. So that it must have to safe from hazards.

Always wear the appropriate protection at all times i.e.

– Safety goggles when grinding and drilling
- Safety shoes and clothes/ overall at all time; gloves when needed; also ear protection
- etc.

Self-Check 2	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

Choose the correct answer

All of the following are marking out tools, **except**

Hand shear B. Punches C. scriber D. try-square

Suppose you want to scribe cutting line on sheet metal/plate; which of the following tool is not used?

Hammer B. Steel rule C. try-square D. scriber

Know you want to cut the line scribed as on question number two, which of the following tool/equipment may you use?

A. Folding machine B. Bench shear C. snips D. B and C

One of the following is used to hold the job

A. Hand shear B. bench vice C. hand shear D. Bench stake

Punches are used as

Scribing work B. Bending the edge of metal C. Measuring

D. Making indentation in metal

6. Suppose you want to cut approximately 5mm from the edge of sheet metal, Which of the cutting tool do you select?

A. Bench shear B. Hand shear C. Guillotine shear

7. _____is capable of cutting tin plate and thin sheet steel up to 2.6mm thick by 1260mm in length

A. Guillotine shear B. Hand shear C. Bench shear

8. _____is made of plastic head and used for forming thin sheet metal

A. Hammer B. mallet C. Hand shear D. Folding machine

9. Which of the following equipment is used to fold tin plate and thin sheet metal?

A. Drilling machine B. Roll bending machine C. Folding machine D. Shearing machine

10. ____is used to carry heat from source to work piece during soldering

A. Grooving tool B. soldering iron C. Rivet set D. None

One of the following is measuring tool.

Steel rule B. Tape rule C. Folding rule D. All

Which one of the following sheet metal marking / layout tools.

A. chisel B. snip C. Scriber

_____is one of handling method tool and equipment.

Good housekeeping B. Safety prevention C. None

Among the listed which one is common material of sheet metal?

Ferrous B. Nonferrous C. Galvanized sheet metal D. All

From the given choose which one is cutting tool and equipment.

Aviation snip B. Chisel C. Arm leaver shear D. guillotine E. All

One of the following is forming tool and equipment.

Hand groover B. Different profiles of stakes C. Crimping and beading E. All

From the given choose which one is personal protective equipment.

A. Safety goggles B. Safety shoes C. Clothes D. gloves

E. ear protection F. all

II. Match part B to A

A	**B**
____1. Measuring tool	A. Rolling machine
____2. Marking out tool	B. Rivet set
____3. Cutting tool	C. Universal snips
____4. Forming tool	D. Taper rule
____5. Joining tool	E. Scriber

III. Give short answer

List at least three tools/equipment that are used to cut sheet metal/plate

_____

_____

_____

Write function of rolling machine

Short Answer Type Questions

1. Name different tools used in sheet metal work.
2. Define Seam in sheet metal work.
3. What is the purpose of mallet?

Long Answer Type Questions

4. Explain about any four important sheet metal operations.
5. Explain different sheet metal joints with sketches.
6. Explain brazing and soldering.

Answer Sheet

Score =15pts

Rating: _____

Name: _____ Date: _____

CHOICE PART

1. _____	**9.** _____	**17.**_____
2. _____	**10.**_____	**Match Part**
3. _____	**11.**_____	**1.** _____
4. _____	**12.**_____	**2.** _____
5. _____	**13.**_____	**3.** _____
6. _____	**14.**_____	**4.** _____
7. _____	**15.**_____	**5.** _____
8. _____	**16.**_____	

Short Answer Questions

1. _____
   _____
2. _____
   _____
3. ._____
4. _____
5. _____

Information Sheet-3	Preparing Work Areas

Introduction

Planning and preparing sheet metal work area is a crucial to success. It requires a careful thought and planning. The work area (shop) does not need to be large, but it does need to be well planned and prepared. If it is well planned, your work would more likely to progress smoothly and your chances for success will be increased.

An often overlooked area is proper lightening, which is important for sheet metal working area. Quite often, you are drawing fine lines then making cut along the line. The accuracy of these cuts always depends on how well you can see those lines. Natural light is ideal. Fluorescents are okay if the fixtures are well located. Lights need to be placed directly above the working area, especially over the layout table. The idea is to reduce or eliminate the shadows. Shadows obscure some of the details of the work, and make it hard to be precise. Therefore, don't through up the fixtures wherever it is convenient. Make sure that the shop you choose has the ability to be well-lit.

3.1. Workshop Organization

Figure 3.1 The equipment is well organized and there is a plenty working room

Placement of equipment

Placement of equipment is one important factor. How easily you can use the equipment depends up on how often the equipment is arranged in the workshop.

Some equipment like the shear, the sheet metal brakes should not be crowded together, they need space around them. A shear needs plenty of room in front of it, where you will work. It also needs room behind it, because some metal pieces extend through the shear and behind it while you are

working. A sheet metal brake needs a space in front and back for the same reason.

Sheet metal benches

Sheet metal benches can be categorized in to two types. The first is the layout bench. It is large and usually made of wood or metal, sometimes both. The other common types of bench are work bench.

Sheet metal rack

Metal sheets, rods or bars needs to be stored in a special units because they are large, heavy and awkward items. A proper rack or storage unit will keep then in good conditions and easily accessible.

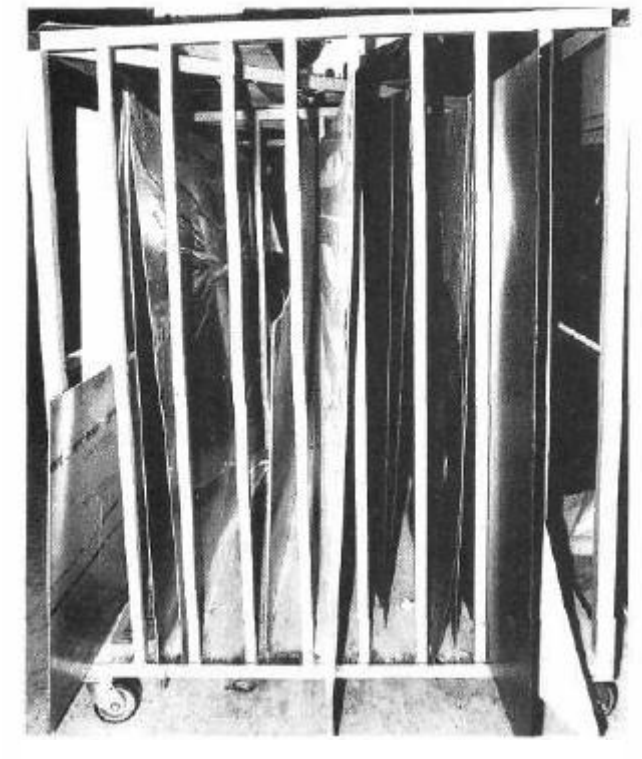

Figure 3.2 The sheet metal rack used to support a lot of weight and has rollers to make it mobile

3.2. Shop Safety

Make sure that you shop is properly equipped to either avoid, or if necessarily, handle emergency. Working with sheet metal may not exactly qualify as hazardous, but it can be dangerous, particularly to a novice who may not see a potentially harmful situation before it happens. It is soundable idea that both profitable and ecological is to set aside a separate container for scrap aluminum to be recycled.

Self-Check 3	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

What are the requirements of work shop area?

What are the categorize type of workshop bench?

How can make your shop safe?

Answer Sheet

Score = 7pts Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____
_____

Q2._____
_____

Q3_____
_____

Information Sheet-4	Checking Sealants, Fixing and Sheet Metal Materials

4. **Checking for sealants, fixing and sheet metal material for job**

4.1. Sealants

Sealants can be readily divided in to tow types, namely strip sealants and gun grade sealants. Gun grade type of sealants can include silicones, polyurethanes and butyl rubber –based sealants. These have the disadvantage of being readily over-compressed by the fasteners installed at the end laps which reduce the effective thickness and therefore its ability to accommodate movement. By comparison, butyl strip sealants are less readily over-compressed, should be appropriately sized for the joint to be sealed and meet the requirements of an NFRC class A butyl sealant.

In situations where sealants are to be installed in to a varying gap dimension, pre-compressed expanding foam sealants may be considered. They exert a pressure on to the fabrication and require fixings at closer centre's to avoid bulging. These sealants require compression to about 20-25% of their uncompressed depth to remain watertight.

To applying sealants you must have consider the following points:

The sealant must always be positioned on the weather side of a fixing.

The life of a sealant needs to be considered. The sealants can be factor that determines the life of the cladding and are not easily replaced.

Care must be taken with sealants on PVDF surfaces as PVDF is virtually non-stick; the long –term bonding of sealants is difficult to achieve.

Sealants must be applied in conditions recommended by the manufacturers, particularly with regard to temperature and they should not be applied in wet conditions or to dirty surfaces.

Sealant (Silicon II) Application:

Apply sealant, for instance Silicon II (figure 4.1), in a continuous operation applying a positive pressure adequate to properly fill and seal the seam, cavity or joint.

- Tool or strike the sealant with a concave tool, applying light pressure to spread the material against the joint surfaces to ensure a void-free application.
- When tooling, use care not to spread the sealant over the face of the substrates adjacent to the joint or masking as the silicone can be extremely difficult to remove on rough or porous substrates. Excess sealant should be cleaned from glass, metal and plastic surfaces while still uncured. On porous surfaces the excess sealant should be allowed to progress through the initial cure or set-up. It should then be removed by abrasion or other mechanical means.
- Sealant application is not recommended when the temperature is below 40°F (4°C) or if frost or moisture is present on the surfaces to be sealed.
- Application of Silicone II* Aluminum & Metal is not recommended to surfaces above 120°F (49°C).

Figure 4.1 Silicon II (aluminum and metal sealant)

The cure rate of this product is dependent upon temperature and the availability of atmospheric moisture. Under Standard Conditions (relative humidity of 50 ±5% at an air temperature of 73.4 ±2°F [23 ±1°C]) this material can attain a cured thickness of 2-3 mm per 24 hours (assuming ample access to atmospheric moisture). As temperature decreases, the cure rate slows down (and vice versa). Low moisture environments will also reduce the cure rate. Near-confined spaces, which limit the overall access to atmospheric moisture, will cure only from that surface which has access to the atmosphere.

Applicable Standards: Silicone II* Aluminum & Metal sealant meets or exceeds the requirements of the following specifications:

American Society for Testing & Materials International • ASTM C920 Standard Specification for Elastomeric Joint Sealants; Type S, Grade NS, Class 25, Use A, G, O

U.S. Federal Specifications: (cancelled Sept. 1996) • TT-S-001543A Sealing Compound: Silicone Rubber Base (for Caulking, Sealing & Glazing in Buildings and Other Structures) • TT-S-00230C Sealing Compound: Elastomeric Type, Single Component (for Caulking, Sealing & Glazing in Buildings and Other Structures)

Canadian General Standards Board (inactive) • CGSB-19.13-M87 Sealing Compound, One-Component, Elastomeric, Chemical Curing • CGSB-19.22-M89 Mildew-Resistant Sealing Compound for Tubs and Tiles

Silicone II* Aluminum & Metal sealant is not recommended: • For structural repairs. • For use underwater or in other applications where the product will be in continuous contact with water. • For use in food contact applications. • When painting of the cured sealant is desired. • For use on aquariums. • For use on surfaces with special coatings, such as mirrors, without approval of the manufacturer of the article.

Silicone II* Aluminum & Metal sealant should not be applied or used: • Under exceedingly hot or cold conditions (see Sealant Application section for additional information). • On wet, damp, frozen or contaminated surfaces. • On excessively basic or acidic substrates.

Method of Sealant (Silicon II) Application:

Remove dirt, grease, moisture, and old caulk from area to be sealed. Use backer rod for gaps larger than ½" x ½".

Cut nozzle to obtain desired bead size & pierce inner foil seal.

Using caulk gun, apply caulk into gap. Smooth the caulk into the gap.

Wipe hands & tools thoroughly before washing.

Allow at least 60 minutes before exposing caulk to water (see below). Not for use below the water line, where FDA compliance is necessary, or in aquariums.

4.2. Fixing materials

Fasteners join two thin materials together and must be purpose-designed for the application. These are generally either self –drilling stitcher screws with bonded sealing washers and integral laps, blind sealed rivet.

Uses of fixing material on the building like, doors, windows, wall sheet metal part and roofs to prevent water, dust and air linking. There are two ways of fixing materials.

They are i. Primary fixings and ii. Secondary fining

Primary fixing:- fixings used to secure the fabrication to the structure or abutting metal sheets. Eg. 1. Rivet-blind sealed is a rivet with a closed bulb; can have a neoprene/ EPDM seal.

Rivet bulbtitel / TLR is a proprietary of rivet with expanding legs and a neoprene / EPDM seal.

Secondary fixing:- fixings used across end lags to compress the seals.

Soaker is a fabricated metal or GRP component which forms the transition from the profiled sheet to the opening.

Stitcher screws is a fasteners with a specially modified thread designed to fix thin sheet together and incorporating an integral coloured head.

Stiffer is a shallow bend with in a flat area to stiffen a wide fabrication.

4.3. Copper Adhesives, Copper Glue, Copper Bonding

Are you looking for copper adhesives for general purpose, electronics or equipment manufacturing needs? When it comes to copper adhesive, Cyberbond is the manufacturer you can depend upon.

Copper is a highly-conductive, corrosion resistant and ductile metal which is easily bonded by epoxies, acrylics or cyanoacrylates offered by Cyberbond. Our copper bonding materials can accommodate all of your copper bonding needs. At Cyberbond, we give you the opportunity to purchase single cases of glue for small applications, as well as mass quantities to meet your growing production requirements. Cyberbond is an international industrial adhesive manufacturer that businesses all over the world can rely on for their copper glue needs.

4.4. Copper Glue Solutions

Cyberbond is highly-regarded for setting the strictest requirements for all of the adhesives we produce. Cyberbond is the adhesives manufacturer you can depend upon for superior quality copper adhesives available in high strength, low viscosity, quick set time or a variety of colors. Cyberbond remains committed to quality through

Self-Check 4	Written Test

Directions Answer all the questions listed below and write your answer on the space

For fixing name plate to sheet metal product, the screws used are:

a. Machine screw b. Self tapping screws

c. Drive in screws d. all of these

Answer Sheet

Score = 7pts
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____

_____

Q2._____

_____

_____

_____

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Instruction Sheet 3	Learning Guide #32 Cut and join sheet metal

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics

Marking out Sheet metals
Cutting to pattern and measuring sheet metals
Preparing and cleaning sheet metals
Joining Sheet metal

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

Mark out Sheet metals
Cut to pattern and measure sheet metals
Prepare and clean sheet metals
Join Sheet metal

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 4”. Try to understand what are being discussed.
4. Accomplish the “Self-checks1,2,3,4 ,5 and 6 ” in each information sheets on pages 4,11,14,19,23 and 26.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1, 2 and 3 on pages 28,29 and 30.and do the LAP Test on page 31”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1	Marking out Sheet metals

Introduction

The **Layout** of metal is the procedure of measuring and marking material for cutting, drilling, or welding. Accuracy is essential in layout work. Using erroneous measurements results in a part being fabricated that does not fit the overall job. This is a waste of both time and material. In most cases, you should use shop drawings, sketches, and blueprints to obtain the measurements required to fabricate the job being laid out. Your ability to read and work from blueprints and sketches is paramount in layout work.

Marking/Laying out Sheet-Metal

Numerous types of layout tools, cutting tools, and forming equipment are used when working with sheet metal. This section will describe the uses of the layout and cutting tools and the operation of the forming equipment.

Marking out Tools

Layout tools are used for laying out fabrication jobs on metal. Some of the more common layout tools that you will use in performing layout duties are as follows: scriber, flat steel square, combination square, protractor, prick punch, dividers, trammel points, and circumference rule.

Flat Steel Square

The **Flat Steel Square** is a desirable tool for constructing perpendicular or parallel lines. In the method of layout, known as parallel line development, the flat steel square is used to construct lines that are parallel to each other as well as perpendicular to the base line. This procedure is shown in figure 3-1. Simply clamp the straightedge firmly to the base line. Slide the body of the square along the straightedge, and then draw perpendicular lines through the desired points.

Before using the flat steel square or at least at periodic intervals, depending on usage, see that you check it for accuracy, as shown in figure 3-2. When the square is off, your

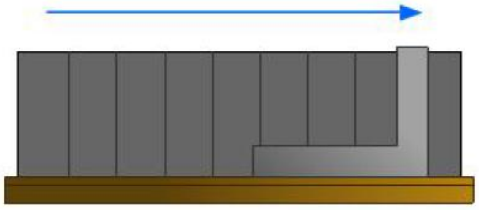

Figure 3.1 Using a square to construct perpendicular and parallel lines.

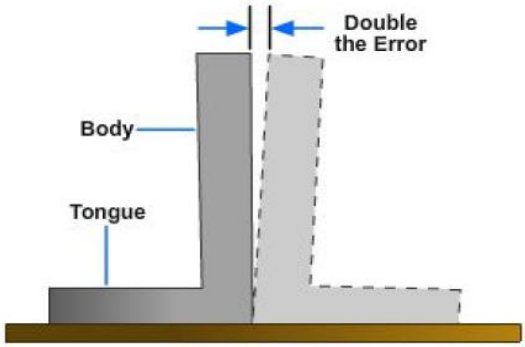

Figure 3.2 Checking a square for accuracy

work will be off correspondingly no matter how careful you are.

Combination Square

The Combination Square can be used to draw a similar set of lines, as shown in figure 3-3. An edge of the metal upon which you are working is used as the base line, as shown in the figure. One edge of the head of the combination square is 90 degrees and the other edge is 45 degrees. Combination squares are delicate instruments and are of little value if you handle them roughly. Store your squares properly when you have finished using them. Keep them clean and in tiptop shape, and you will be able to construct 90-degree angles, 45-degree angles, and parallel lines without error.

Scriber

Lines are scribed on sheet metal with a **Scratch Awl**, coupled with a **Steel Scale** or a **Straightedge**. To obtain the best results in scribing, hold the scale or straightedge firmly in place, and set the point of the scriber as close to the edge of the scale as possible by tilting the scriber outward. Then exert pressure on the point and draw the line, tilting the tool slightly in the direction of movement (figure 3-4). For short lines, use the steel scale as a guide. For longer lines, use a circumference rule or a straightedge. When you have to draw a line between two points, prick punch each point. Start from one prick punch mark and scribe toward the center.

Complete the line by scribing from the other prick punch mark in the opposite direction.

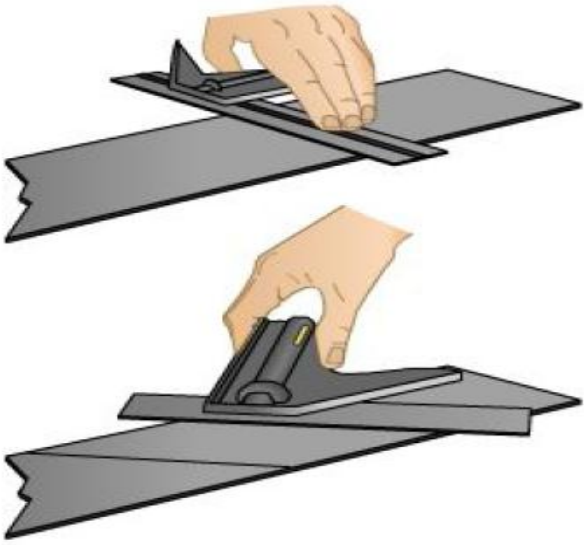

Figure 3.4 Using the combination square

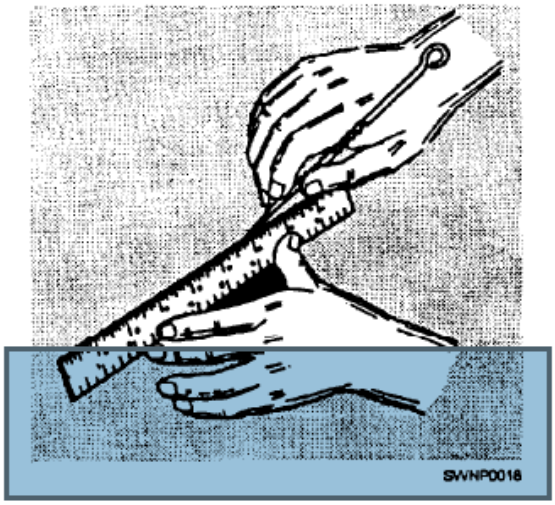

Figure 3.1 Scribing a line

Protractor

To construct angles other than 45 degrees or 90 degrees, you will need a **Protractor**. Mark the vertex of the angle of your base line with a prick punch. Set the vertex of your protractor on the mark and then scribe a V at the desired angle (assume 700). Scribe the line between the vertex and the point located by the V, and you have constructed an angle of 70 degrees.

Prick Punch

When you locate a point and mark it with the PRICK PUNCH, be sure to use alight tap with a small ball peen hammer, ensuring it is on the precise spot intended to mark. The smaller the mark you make (so long as it is visible), the more accurate that mark becomes.

Dividers

You should use **Dividers** to scribe arcs and circles, to transfer measurements from a scale to your layout, and to transfer measurements from one part of the layout to another. Careful setting of the dividers is of utmost importance. When you transfer a measurement from a scale to the work, set one point of the dividers on the mark and carefully adjust the other leg to the required length, as shown in figure 3-5.

To scribe a circle, or an arc, grasp the dividers between the fingers and the thumb, as shown in figure 3-6. Place the point of one leg on the center, and swing the arc. Exert enough pressure to hold the point on center, slightly inclining the dividers in the direction in which they are being rotated.

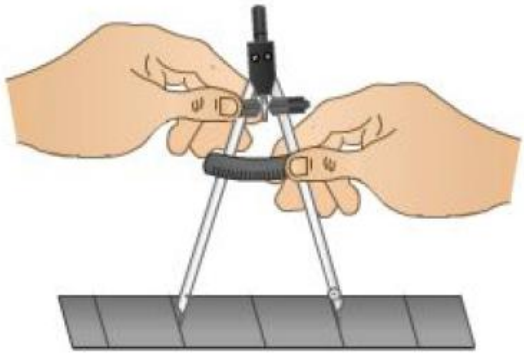

Figure 3-5 Setting the dividers

Figure 3-6 Scribing an arc/circle with dividers

Trammel Points

To scribe a circle with a radius larger than your dividers, you should select TRAMMEL POINTS. The method of adjusting the points, as shown in figure 3-7, is to set the left-hand point on one mark, slide the right-hand point to the required distance, and tighten the thumbscrew. The arc, or circle, is then scribed in the same manner as with the dividers.

Constructing a 90-degree, or right, angle is not difficult if you have a true, steel square. Suppose that you have no square or that your square is off and you need a right angle for a layout. Breakout your divider, scriber and straightedge. Draw a base line like the one labeled AB in figure 3-8. Set the dividers for a distance greater than one-half AB; then, with A as a center, scribe arcs like those labeled C and D. Next, without changing the setting of the dividers, use B as a center, and scribe another set of arcs at C and D. Draw a line through the points where the arcs intersect and you have erected

perpendiculars to line AB, forming four 90-degree, or right, angles. You have also bisected or divided line AB into two equal parts.

Figure 3-7 Setting trammel points

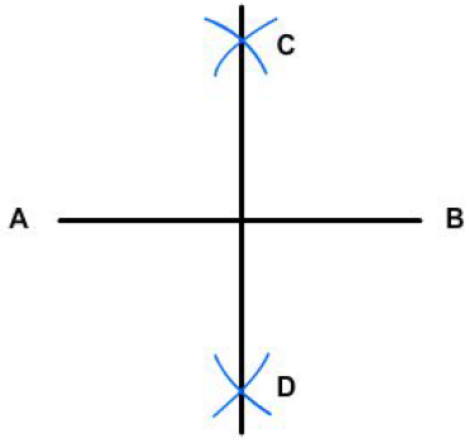

Figure 3.8 Constructing a 90 degree angle by bisecting lines

Constructing a right angle at a given point with a pair of dividers is a procedure you will find useful when making layouts. Figure 3-9 shows the method for constructing a right angle at a given point.

Imagine that you have line XY with A as a point at which you need to fabricate a perpendicular to form a right angle. Select any convenient point that lies somewhere within the proposed 90-degree angle. In figure 3-9 that point is C. Using C as the center of a circle with a radius equal to CA, scribe a semicircular arc, as shown in figure 3-9. Lay a straightedge along points B and C and draw a line that will intersect the other end of the arc at D. Next, draw a line connecting the points D and A and you have fabricated a 90-degree angle. This procedure may be used to form 90-degree comers in stretch-outs that are square or rectangular, like a drip pan or a box.

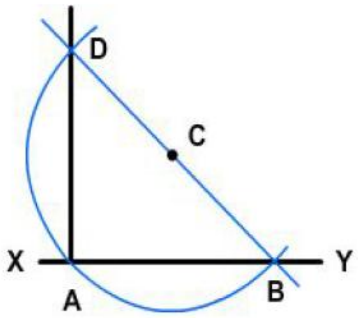

Figure 3-9 Constructing a 90-degree angle at a given point

Laying out a drip pan with a pair of dividers is no more difficult than fabricating a perpendicular. You will need dividers, a scriber, a straightedge, and a sheet of template paper. You have the dimensions of the pan to be fabricated: the length, the width, and the height or depth. Draw a base line (figure 3-10). Select a point on this line for one comer of the drip pan layout. Erect a perpendicular through this point, forming a 90-degree angle. Next, measure off on the base line the required length of the pan. At this point, erect another perpendicular. You now have three sides of the stretch-out. Using the required width of the pan for the other dimensions, draw the fourth side parallel to the base line, connecting the two perpendiculars that you have fabricated.

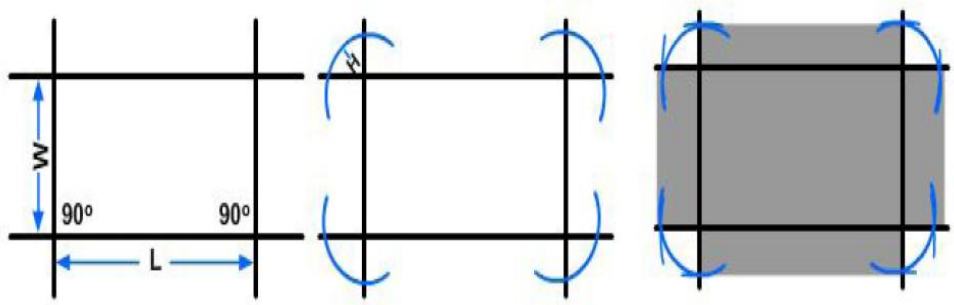

Figure 3.10 Laying out a drip pan with dividers

Now, set the dividers for marking off the depth of the drip pan. You can use a steel scale to measure off the correct radius on the dividers. Using each comer for a point, swing a wide arc, like the one shown in the second step in figure 3-10. Extend the end and side lines as shown in the last step in figure 3-10 and complete the stretch-out by connecting the arcs with a scriber and straightedge.

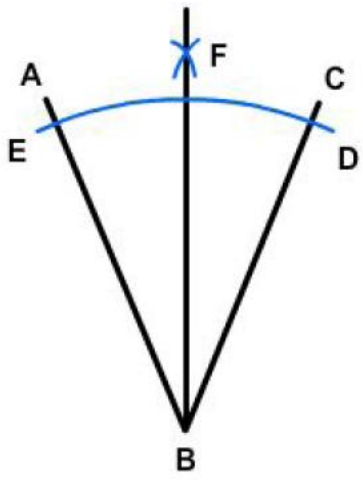

Figure 3.11 Bisecting an arc

Bisecting an arc is another geometric construction that you should be familiar with. Angle ABC (figure 3-11) is given. With B as a center, draw an arc cutting the sides of the angle at D and E. With D and E as centers and a radius greater than half of arc DE, draw arcs intersecting at F. A line drawn from B through point F bisects angle ABC.

Two methods used to divide a line into a given number of equal parts are shown in figure 3-12. When the method shown in view A is to be used, you will need a straightedge and dividers. In using this method, draw line AB to the desired length. With the dividers set at any given radius, use point A as center and scribe an arc above the line. Using the same radius and B as center, scribe an arc below the line as shown. From point A, draw a straight line tangent to the arc that is below point B. Do the same from point B. With the dividers set at any given distance, start at point A and step off the required number of spaces along line AD using tick marks-in this case, six. Number the tick marks as shown. Do the same from point B along line BC. With the straightedge, draw lines from point 6 to point A, 5 to 1, 4 to 2, 3 to 3, 2 to 4, 1 to 5, and B to 6. You have now divided line AB into six equal parts.

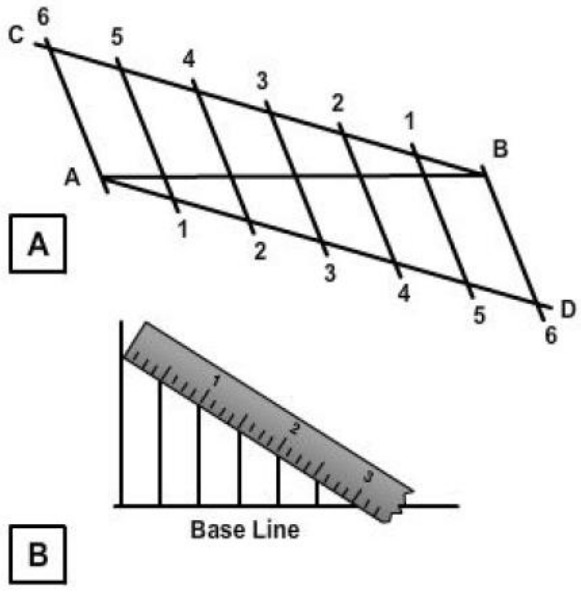

Figure 3.12 Two methods used to divide a line in to equal segments

When the method shown in view B of figure 3-12 is used to divide a line into a given number of equal parts, you will need a scale. In using this method, draw a line at right angles to one end of the base line. Place the scale at such an angle that the number of spaces required will divide evenly into the space covered by the scale. In the illustration (view B, figure 3-12) the base line is 2 1/2 inches and is to be divided into six spaces. Place the scale so that the 3 inches will cover 2 1/2 inches on

the base line. Since 3 inches divided by 6 spaces = 1/2 inch, draw lines from the 1/2-inch spaces on the scale perpendicular to the base line. Incidentally, you may even use a full 6 inches in the scale by increasing its angle of slope from the baseline and dropping perpendiculars from the full-inch graduation to the base line.

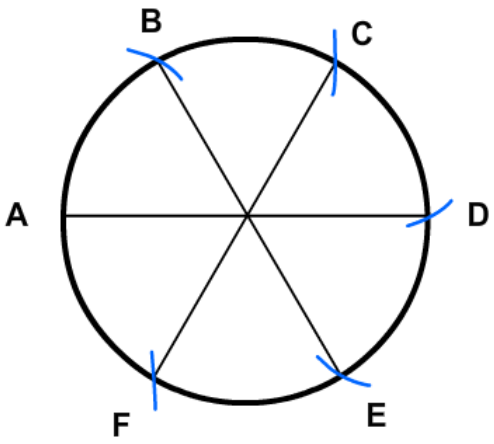

Figure 3.13 Dividing a circle in to six equal parts

To divide or step off the circumference of a circle into six equal parts, just set the dividers for the radius of the circle and select a point of the circumference for a beginning point. In figure 3-13, point A is selected for a beginning point. With A as a center, swing an arc through the circumference of the circle, like the one shown at B in the illustration. Use B, then, as a point, and swing an arc through the circumference at C.

Continue to step off in this manner until you have divided the circle into six equal parts. If the points of intersection between the arcs and the circumference are connected as shown in figure 3-13, the lines will intersect at the center of the circle, forming angles of 60 degrees.

If you need an angle of 30 degrees, all you have to do is to bisect one of these 60-degree angles by the method described earlier in this chapter. Bisect the 30-degree angle and you have a 15-degree angle. You can construct a 45-degree angle in the same manner by bisecting a 90-degree angle. In all probability, you will have a protractor to lay out these and other angles. But just in case you do not have a steel square or protractor, it is a good idea to know how to construct angles of various sizes and to erect perpendiculars.

Many times when laying out or working with circles or arcs, it is necessary to determine the circumference of a circle or arc. For the applicable mathematical formula, refer to appendix II of this text.

Self-Check 1	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

Test your Knowledge (Select the Correct Response)

1. To obtain the best results from scribing, what step should you perform first?
   Insure the work area is quiet C. Scribe the lines with firm pressure
   Lay a thin layer of layout dye D. Make your prick punch points
2. What snips have short cutting blades with long handles?

A. Bulldog B. Hawk's bill C. Compound D. Aviation

3. The procedure for measuring and marking material for the cutting, drilling, and/or welding of metal is known by the term "layout." A. True B. False
4. What type of tool is most frequently used to scribe lines on sheet metal?

A. Prick punches B. Trammel points C. Scratch awls D. Dividers

5. In a simple drip pan layout, the radius of a corner arc is equal to what dimension of the pan?

A. Its depth B. Its length C. Its width D. Its diagonal cross section

6. You set dividers for the radius of a circle and strike off this distance on the entire circumference. Into how many equal arcs have you divided the circumference?

A. Six B. Two C. Three D. Nine

7. Into how many equal parts is the circumference of a circle divided if the lines intersecting at the center of the circle form angles of 30 degrees?

A. 4 B. 6 C. 12 D. 18

8. What is the approximate circumference of a circle that has a diameter of 18 inches?

A. 45.5 inches B. 56.5 inches C. 133.0 inches D. 365.0 inches

9. What is the mathematical formula for determining the area of the stretch-out of a cylinder?

A. A = πr B. A = πrd C. A = 2πr D. A = (πd) h

10. Metal stakes are used to make an assortment of bends by hand and to finish many types of work.

A. True B. False

11. What part of the bar-folding machine is used to make right angles and 45-degree bends?

A. The depth gauge B. The bar handle C. The wing D. The angle stop

12. A total of how many adjustments must be made on a cornice brake before you can use the machine to bend sheet metal?

A. One B. Two C. Three D. Four

13. What feature on the cornice brake enables you to make as many duplicate bends as required?

A. The clamping device B. The balancing weight C. The stop gauge D. The mold clamps

14. The box and pan brake is often referred to as a finger brake.

A. True B. False

15. When forming a curved shape, you can fabricate the most accurate bend by using what piece of equipment?

A. A stake B. A mandrel C. A pipe D. A slip-roll forming machine

16. The slip-roll forming machine is designed to allow one end of the top front roll to be released quickly so you can perform what task easily?

A. Removal of the work B. Cleaning operations C. Repairs on the machine D. Adjustments to the machine

17. What operation of the combination rotary machine is used to reduce the size of the end of a cylinder?

A. The beading B. The burring C. The crimping D. The clamping

18. Instead of scribing directly on the metal when a single piece is being made in quantity, you can make a pattern or template and transfer it to the metal. A. True B. False

19. A patternmaker decides to divide a half plan or top View into 12 equal parts. What number of divisions will be required for the stretch-out line? A. 6 B. 12 C. 24 D. 48

20. What method of pattern development should you use to develop a pattern for an object that has a tapering form with lines converging at a common center?

A. Radial line B. Parallel line C. Triangulation D. Scratching

21. When fabricating a wired edge to a cylinder, you must add how much edging to a pattern?

A. 1 1/2 times the thickness of the metal B. 2 1/2 times the diameter of the wire to be used

C. Twice the diameter of the upper burring roller D. One half of the diameter of the wire to be used

22. In the fabrication of rectangular duct, what seam is used most often?

A. Grooved B. Pittsburgh lock C. Lap D. Standing

23. When laying out a pattern, you consider what feature last?

A. Seams B. Laps C. Notches D. Edges

24. What type of notch is used on a corner when a single-hemmed edge is to meet a 90-degree angle?

A. Square B. Slant C. V D. Wire

What type of connection is used to join a flat sheet and a round pipe/fitting?

A. Dovetail seam B. Drive slip C. Pocket slip D. Standing seam

What type of screw is most often used in sheet metal work?

A. Self-tapping B. Machine C. Thread-cutting D. Drive

Drive screws are simply driven into sheet metal.

A. True B. False

Tinners' are designated by weight per 1,000 rivets.

A. True B. False

25. The distance from the center of the rivet to the edge of the sheet must equal how many rivet diameters?

A. 1 B. 1 ½ C. 2 D. 2 1/2

26. The correct method for riveting using Tinners' rivets is to draw, upset, and head the rivet.

A. True B. False

27. What gauge of aluminum sheet metal is required to construct a duct 62 inches wide at the top and 28 inches high on the sides?

A. 26 B. 22 C. 18 D. 16

You are to construct a duct of 24-gauge sheet metal. Each section is 7 feet 10 inches long. If the total system length is 60 feet, you should place the bracing angles at what location?

A. 2 feet on center along the length of the duct B. 4 feet on center along the length of the duct

C. 2 feet from each joint D. 4 feet from each joint

The cross breaking of a duct having a flat side of 18 inches or greater can be omitted under which of the following conditions?

A. The duct is installed in the vertical position.

B. The material used is at least reinforced at the edges of each duct segment.

C. The duct is insulated with approved materials.

D. The duct is insulated with rigid insulation and the sheet metal used is 2 gauges heavier.

When securing duct systems to heating and cooling units, you should use what material to fabricate the flexible connections?

A. Light-gauge sheet metal

B. Asbestos

C. Heavy canvas

D. Aluminum

28. When S-slips and drive slips are used on a duct system, you lock the joint into position in what way?

A. By bending the S-slip over the drive slip

B. By bending the drive slip over S-slip

C. By cutting off the drive slip even with the S-slip and welding each corner

D. By center punching the S-slip

Answer Sheet

Score =28pts

Rating: _____

Name: _____

Date: _____

CHOICE PART

6. _____
7. _____
8. _____
9. _____
10._____
11._____
12._____
13._____
14._____
15._____
16._____
17._____
18._____
19._____
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27._____
28._____
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31._____
32._____
33._____

Information Sheet-2	Cutting to pattern and measuring sheet metals

Cutting to Pattern

Every metal projects begin with an idea that is based on what you need to make and how to go about doing it. You have already determined where it has to fit what it has to do. However the idea is just that- a vague, mental visualization of the end result. To make it clear and concrete, you must first develop a plan for the before you begin.

Experienced fabricators often think through making the part before they do anything else, visualizing every steps to the final result. For a novice, it is easier to plan the project on paper first.

A pattern is a plan, a diagram, or a model to be followed in order to make something. By this definition, every plan made for a construction is a pattern. In sheet metal work, a "pattern" is farther defined as a detailed paper, chip board or metal form indicating all the important detail of a component that is to be constructed. All preliminary sketches and design are methods to plan for the actual pattern itself.

The first step is to gather all of the dimensions of the metal part to be produced. This includes measurements, holes and angles. You will need to width, depth and over all height of the part.

Sheet Metal Developments

A three-dimensional sheet-metal object, in most cases, is made from flat sheet. In developing an object to be constructed, Several kinds of sheet-metal machines roll, bend, or fold the sheet into the desired shape. The problem is to draw a full size pattern of the flat sheet. This type of drawing is called a development.

The object to be constructed will be made in exactly the same size as the drawing the draftsman makes. Such a drawing is called a pattern. The pattern must, therefore, be drawn to the true dimensions of the object. Depending on the degree of difficulty, the drawing can be done on paper or directly on the metal. The pattern should be drawn as if you were looking at the inside of the object.

The edges of the produced object must be joined in some way. Welding provides the strongest connection, but increases the cost of production. Several methods of folding over the edges on each other, other than welding, have been devised. For example, the edges may be riveted, screwed, or held together with banding. The additional material

must be included on the pattern so that the maker will be able to do the folding over, or seaming, as it is called. Various sheet-metal machines perform such seaming operations for metal objects.

Sheet metal objects are hollow. Therefore, the patterns of the objects to be constructed are actually the shapes of the surfaces of those objects. The different methods for developing these patterns can, for convenience, be divided into **four** categories:

First: Parallel Line Development, which is used in developing regular, continuous shapes whose surfaces do not change along a distance, such as pipes, tanks, cylinders, cubes and boxes. They are, therefore, termed parallel forms.

Parallel line development is based upon the fact that a line that is parallel to another line is an equal distance from that line at all points. Objects that have opposite lines parallel to each other or that have the same cross-sectional shape throughout their length are developed by this method.
To gain a clear understanding of the parallel line method, we will develop a layout of a truncated cylinder (*Figure 3.14*). Such a piece can be used as one half of a two-piece 90-degree elbow.

Figure 3.15. Truncated cylinder

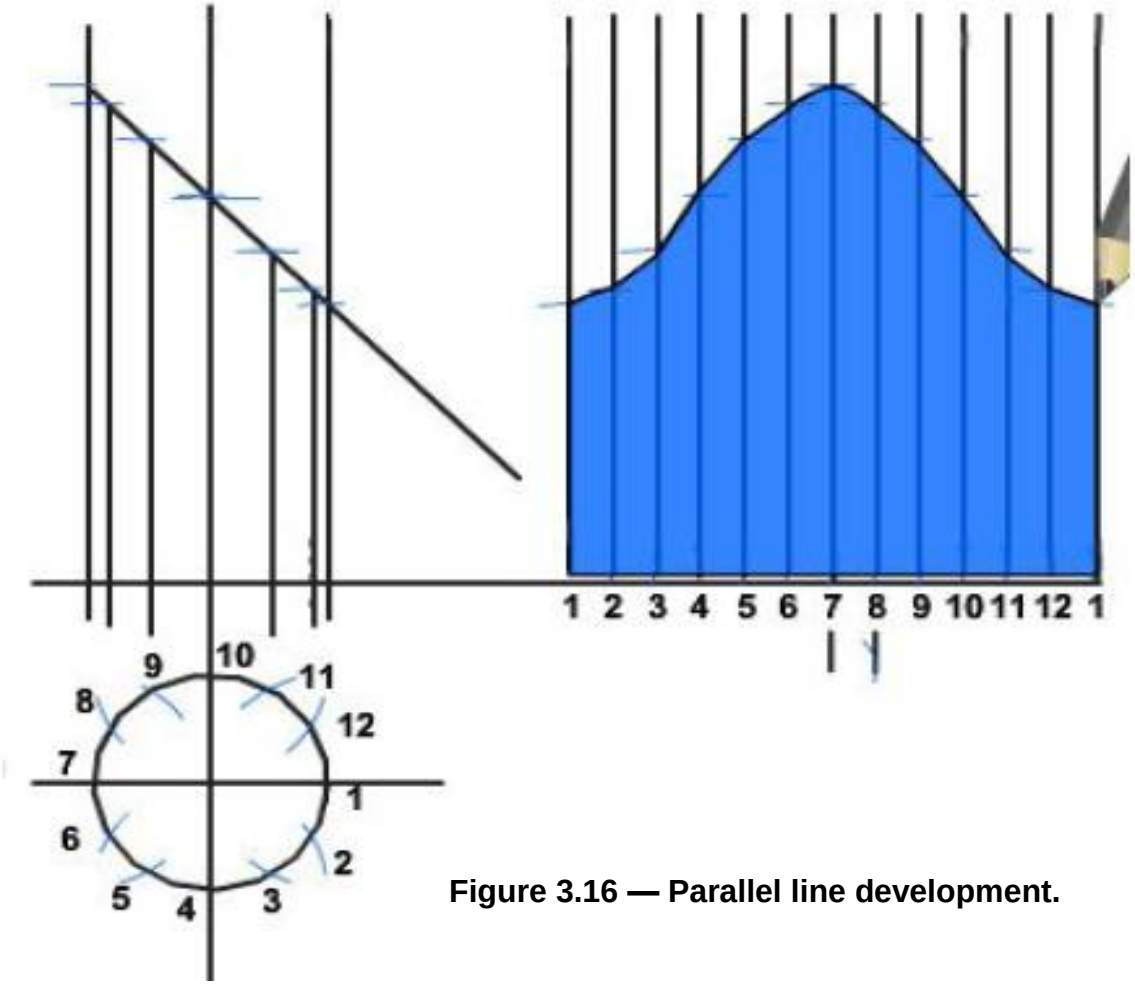


Figure 3.16 — Parallel line development.

Mark out reference lines using a set square.

Identify the diameter measurement and draw a circle. In this example the diameter is 1.5 inches (40 mm).

Use the radius of the circle to divide the circumference into 12 equal sectors.

Label the marks 1 - 12. Note the numbers begin on the right-hand side and go in a clockwise direction.

Identify and mark the height of the cylinder. Here the height is 2.5 inches (60mm).

Determine the angle of the top of the cylinder and use a setsquare. Here the angle is 45 degrees.

Mark off the radius on both sides of the reference line to construct the sides of the cylinder. Transfer numbers 1 - 12 from the circle to the base of the cylinder. Project these points to the top of the cylinder.

Calculate the circumference of the cylinder to determine the stretch out length of the pattern. Use the formula r = D. The diameter here is 1.5 inches (40 mm). Mark out the circumference on the horizontal base line.

Divide the length of the circumference into 12. Draw a reference line and mark on it 1/12th of the circumference. Use this to set the dividers. Splitting the circumference into halves and quarters reduces tolerance error.

Use the dividers to mark the circumference into 12 equal divisions on the base line. Mark these divisions 1 to 12. The final division is numbered 1. Project these divisions upward at 90°.

Now develop the stretch out pattern. Transfer the length of the lines on the side View to the corresponding lines on the stretch out. Draw the top line curve of the pattern by free hand, by using material like packing cord bent to the curve or by using a flexible curve, as used here.

This final shape is the stretch out pattern of the cylindrical shape and can be cut to shape to use as a template.

When the development is finished, add necessary allowances for rivets and joints, then cut out your patterns.

Second: Radial Line Development. This type of development is used in creating shapes with surfaces whose extensions converge at a common point, such as cones, truncated cones, tapers, funnels, etc. Such surfaces may have as their base a circle or any other regular geometric figure.

The radial line method of pattern development is used to develop patterns of objects that have a tapering form with lines converging at a common center.

The radial line method is similar in some respects to the parallel line method. Evenly spaced reference lines are necessary in both of these methods. However, in parallel line development, the reference lines are parallel—like a picket fence. In radial line development, the reference lines radiate from the **apex** of a cone—like the spokes of a wheel.

The reference lines in parallel line development project horizontally. In radial line development, the reference lines are transferred from the front View to the development with the dividers.

Developing a pattern for the **frustum** of a right cone is a typical practice project that will help you get the feel of the radial line method. You are familiar with the shape of a cone. A right cone is one that, if set big side down on a flat surface, would stand straight up. In other words, a centerline drawn from the point, or vertex, to the base line would form right angles with that line.

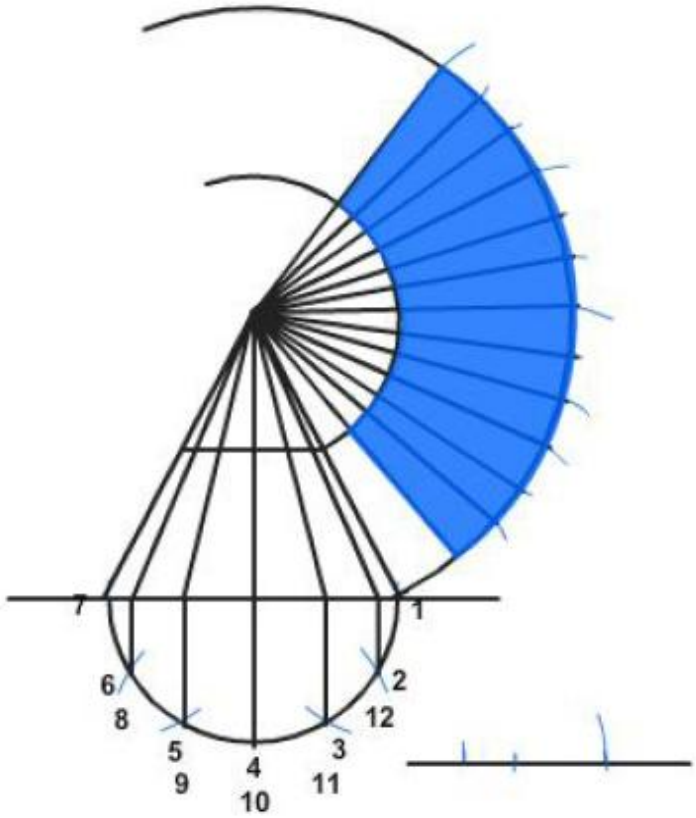


Figure 3.17 — Radial line development.

The frustum of a cone is that part that remains after the point, or top, has been removed.

The procedure for developing a frustum of a right cone is given below. Check each step of the procedure against the development shown in *Figure 3.17*

1. First establish the apex point (H).
2. Draw reference lines using a set square. Mark out the measurements of the:
    - base (D) – 2.75 in (70 mm)
    - apex (H) – 4 in (100 mm)
    - frustum height (h) – 2 in (50 mm)
3. Draw in the reference lines from the apex (H) to the base (D). Check that the frustum diameter (d) is 1.38 in (35 mm).
4. Develop the half circle representing half the bottom View.
5. Set the dividers at 1.38 in (35 mm) - the radius of the base of the frustum (D). Divide the half circle into 6 equal sectors.
6. Label the marks 1-12 as indicated.
7. Project each of the sectors up to the base line at 90°. Project these lines to the apex.
8. Developing the stretch out pattern of the frustum. Place the compass point on the apex. Set the radius to A and seeing an arc as indicated. Repeat with the radius set to B.
9. Draw a line from the apex to the bottom circumference, away from the base of the frustum. The intersection point will be the start for marking out the base circumference into 12 sectors.
10. The frustum circumference is πD = 3.14 x 2.75 in =8.67 inches (220 mm) to the nearest mm. Mark this into 12 equal sectors. Calculate the length of each sector:

$$= \frac{8.67\text{in (220 mm)}}{12}$$

= .72 in (18.3 mm)

Draw a reference line and mark out .72 in (18.3 mm). Set the dividers to this distance. Mark off the 12 divisions along the circumference.

11. Project each of these to the apex to form the radial lines. The radial lines will be used in the forming process. The shape shaded in orange is the radial line stretch out pattern for the right cone frustum.

Third: Triangulation. Triangulation is used to develop irregular shapes when pattern drawing cannot be accomplished by using parallel line or radial line developments. Additionally, this method employs diagrams of triangles which serve in creating otherwise unknown distances used to lay out the pattern.

Triangulation is slower and more difficult than parallel line or radial line development, but it is more practical for many types of figures. Additionally, it is the only method by which the development of warped surfaces may be estimated. In development by triangulation, the piece is divided into a series of triangles, as in radial Line development. However, there is no one single apex for the triangles. The problem becomes one of finding the true lengths of the varying oblique lines. This is usually done by drawing a true, length diagram.

An example of layout using triangulation is the development of a transition piece.

The steps in the triangulation of a warped transition piece joining a large, square duct and a small, round duct are shown in *Figure 3.18*. The steps are as follows:

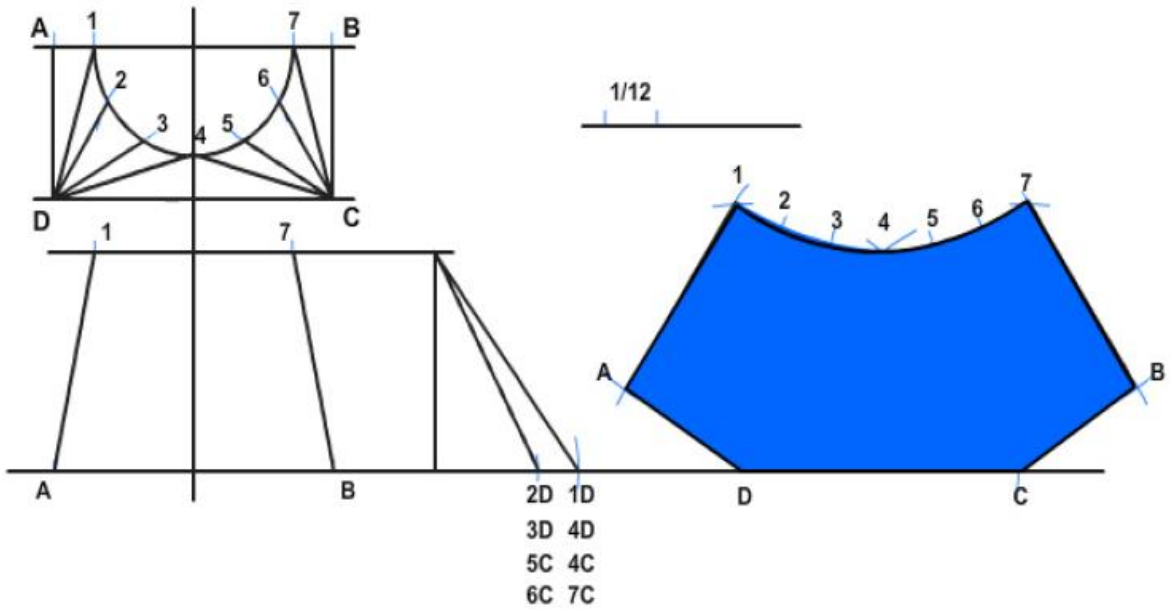


Figure 3.18 — Triangular development of a transition piece.

First establish the reference lines.

Develop the top View. With a set square, mark out the measurements for half the base, and label each corner (from the top left-hand corner, moving clockwise) A to D.

From the center of this half base, draw a semicircle with radius 1 in (25 mm). Check that the diameter (D) is 2 in (50 mm).

Divide the half circle into six equal spacing by placing the compass point on the three points where the semicircle intersects the reference lines and swinging small arcs (R = 1 in (25 mm)) to intersect the circle.

Number the points 1 to 7 as shown.

Using a set square, draw lines from point D on the base of the shape to points 1 through to 4 on the half circle. Next, draw lines from C on the base of the shape to points 4 through to 7.

This completes (half) the top View.

Draw the side View. First, draw a reference line. Remember, the vertical height is 50 mm, and the diameter of the top is 50 mm.

The base is 2.75 in (70 mm) square. Draw lines from the base to the top. Label the base points A and B. Label the top points 1 and 7.

Now develop the stretch out pattern for the square to round. First establish a reference line (extending to the right from point B on the side View) for the base of the stretch out pattern. Draw the vertical height of the square to round somewhere to the right of the side View, perpendicular to the base line. Now place the compass point on D in the top View. Set the radius to point 2 on the half circle. Place the compass point at the intersection of the base line and the vertical height line and swing an arc to mark the base line. Label this point 2D. Note this is the shortest distance from point D to the top of the half circle, the same length as 3D, 5C, and 6C. Now place the compass at D and set the radius to point 1 on the half circle. Transfer the compass to the intersection of the base line and the vertical height line and swing an arc to mark the base line. Label it 1D. Note this is the longer distance from point D to the top of the half diameter, the same length as 4D, 4C, and 7C. Now draw a line from the top of the vertical height line to point 2D, and then from the top to point 1D.

This is called the true length diagram.

Mark a point on the base line to the right of point 1D.

Set the compass at the distance between D and C on the top View (as this is already true length), then transfer the distance D to C to the base line. Label the points D and C.

Reset the compass to the length of the line 4D. Placing one point on D, draw an arc midway between D and C. Shift the compass to C, draw an arc to bisect the previous one. Label this point 4.

Mark out a new short reference line for 1/12th of the circumference of the top of the square to round shape.

Calculate the circumference of the top of the shape, then divide it by 12.

$C = \pi D$

C = 3.14 x 2 in (50 mm)

= 6.2 in (157 mm)

1/12th of the circle

= 6.2 in (157 mm) ÷ 12

= .5 in (13 mm)

Measure and mark out .5 in (13 mm) on the reference line. Set the compass at .5 in (13 mm) (1/12th circumference).

Place the compass on point 4, and swing arcs to mark to the right, and to the left. Set the compass at the true length of reference line 2D. Place the compass on point D, and swing an arc to intersect the arc on the left.

Label this point 3. Place the compass on C, and swing an arc to intersect the arc on the right. Label this point 5.

Reset the compass at .5 in (13 mm), using the measure on the reference line. Place the compass on point 5 and swing an arc to the right hand side. Swing an arc to the left of point 3.

Reset the compass at the length of the reference line 2D. Place the compass on point D, make a mark intersecting the arc, and Label this point 2. Place the compass on C, make a mark intersecting the arc, and label this point 6.

Repeat the process, swinging an arc R13 to the left of 2 and right of 6. This time, however, reset the compass to the length of reference line 1D. Place the compass point on D, make a mark intersecting the arc, and label this point 1.

Place the compass on C and make a mark intersecting the arc. Label this point 7.

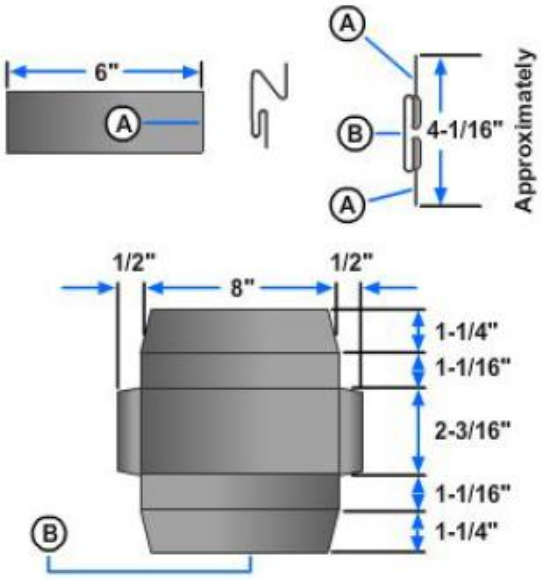


Figure 3.20— Drive slip pattern connections.

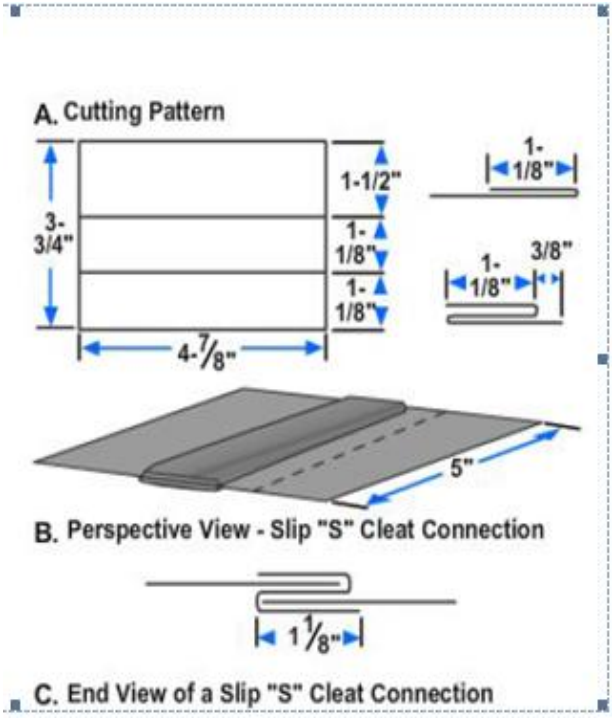


Figure 3.21 — "S" joint slip pattern and connections.

Develop the half square base from point D to point A. Using the side view diagram, set the compass at the distance between B and 7. Place the compass at point 1 on the stretch out pattern, and draw an arc to the lower left. Repeat the process from point 7 to the lower right. Reset the compass to the distance between B and C on the top View diagram. Place the compass on D and make a mark intersecting the arc. Label this point A.

Place the compass on C, make a mark intersecting the arc, and label this point B. Using a set square or ruler, draw lines joining 1 and A; A and D; 7 and B; and B and C.

Draw lines from D to 1, 2, 3, and 4. Draw lines from C to 4, 5, 6, and 7.

Use a flexible ruler, or freehand to join points 1 to 7. This completes the stretch out half pattern for a square to round shape, using the triangulation method.

Fourth: Analytical Definition. This method employs mathematical formulas

to determine the sizes and shapes to be drawn. Whichever method is used, the best way to gain knowledge of all of these methods is to use them in actual practice.

When making a grooved seam on a cylinder, you fit the piece over a stake and lock it with the hand groover (*Figure 3.20*). The hand groover should be approximately 1/16inch wider than the seam. Lock the seam by making prick punch indentions about 1/2inch in from each end of the seam.

Figure 3.21 shows a flat "S" joint. View A is a pattern for the "S" cleat. View B is a perspective View of the two pieces of metal that form the flat "S" joint. In View C, note the end View of the finished "S" joint.

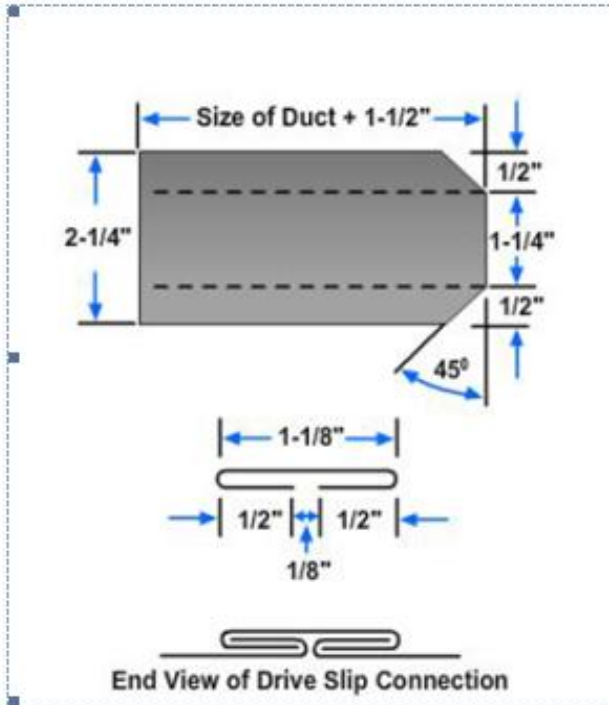


Figure 3.22 — Double "S" joint slip pattern

Figure 3.22 shows a double "S" joint. View B is the pattern for the double "S" cleat. View A is one of two pieces of metal to be joined. Note the cross section of a partially formed cleat and also the cross section of the finished double "S" joint. This is a variation of the simple flat "S" and it does not require an overlap of metals being joined.

Figure 3.23 shows a standing "S" joint. View B is the pattern for the standing "S" cleat. View A is one of the two pieces of metal to be joined. Note the cross section of the finished standing "S" cleat and standing "S" joint.

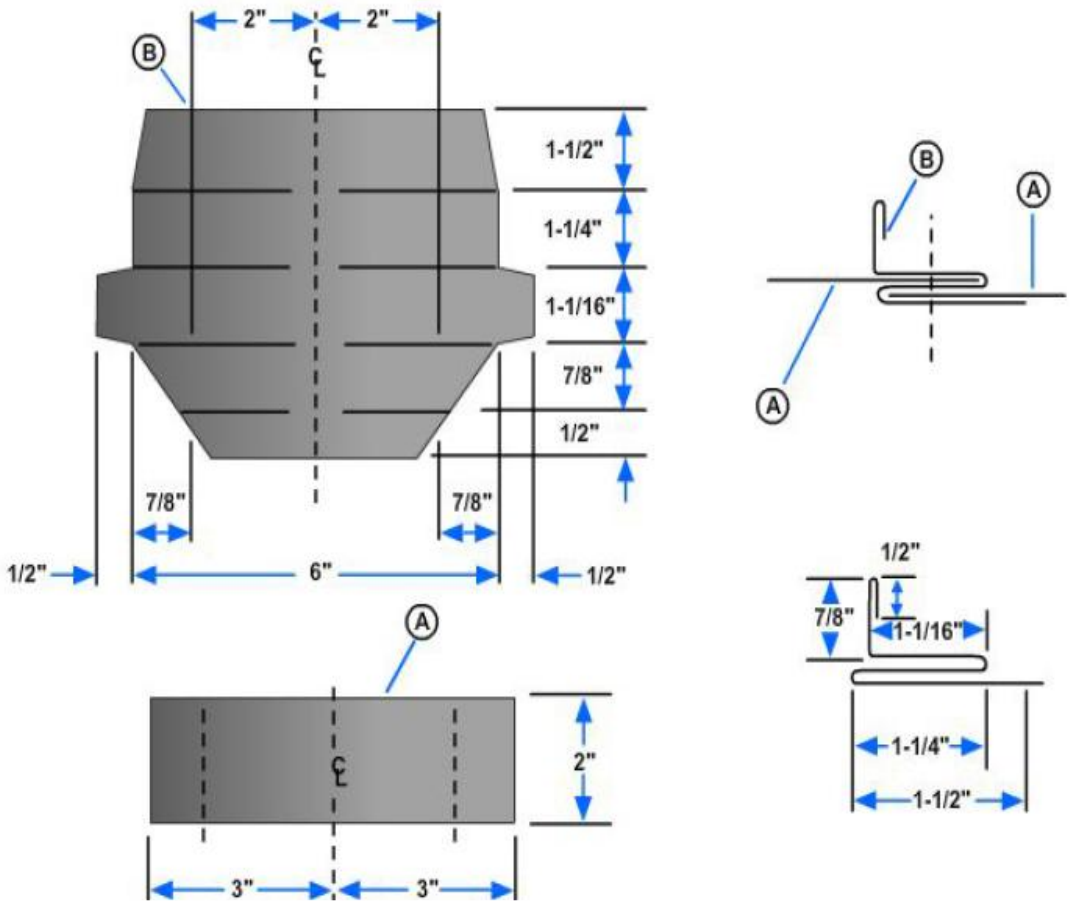


Figure 3.23— Standing "S" cleat pattern

Self-Check 2	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

Write at list three sheet metal Pattern Making method and their purpose of uses(6pts)

What is the purpose use of pattern making? (4pts)

Describe some examples of sheet metal pattern (explain their shape and purpose use)? (5pts)

Answer Sheet

Score =15pts

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____
_____

Q2._____
_____

Q3._____
_____
_____

Operation Sheet 3.1	Cutting sheet metal to a pattern

Cutting of sheet metal as a pattern

Aim: To develop the ability to make a cut sheet metal as a pattern.
Material: one pieces 0.8 mm or 1mm gage steel.
Specifications, Make a sheet metal box of 420x200x270 cut by hand, using snips and other cutting materials.

Techniques

Select material as drawing specification

Measuring and scribing the blank needed from the stocks

After you gate overall size of blank then measure and layout as pattern you can checking what you mark / lay out on sheet metal as working drawing (figure 3.24)

Then cut as pattern.

Finally remove berrs from sheet metal.

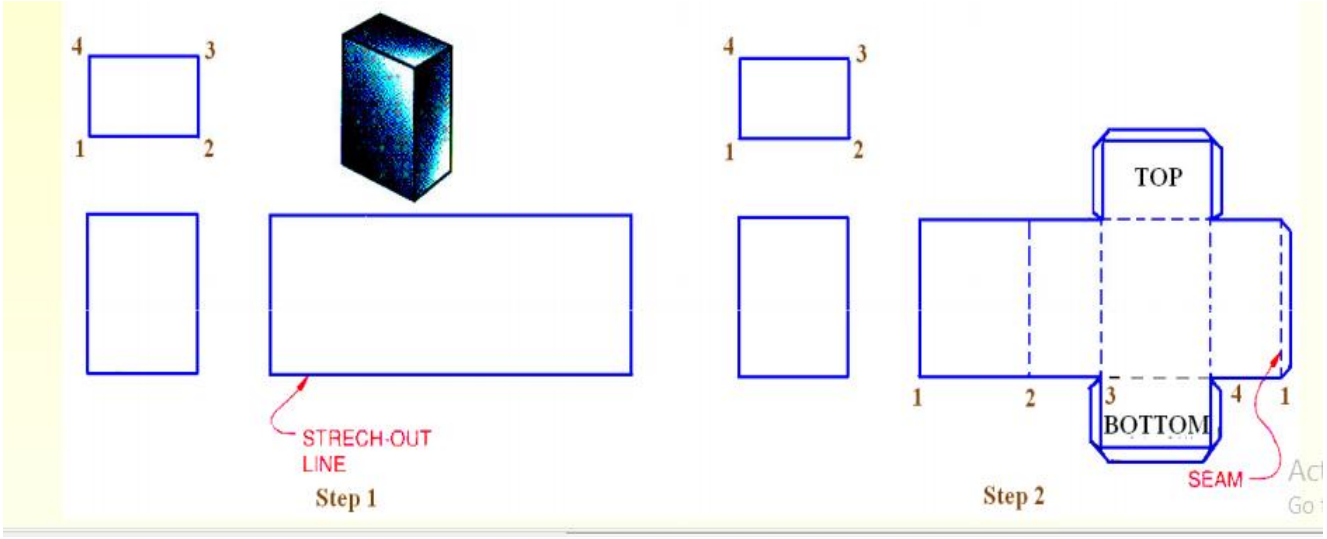


Figure 3.24 Marking out / lay-out box

Operation Sheet 3.2	Cutting sheet metal to a pattern

Making Pittsburgh Lock

Aim: To develop the understanding and skill necessary to make a Pittsburgh lock. Material: One piece 2$-gage galvanized steel 6” **X** *6”, one piece .1” X 6”. Specifications: Make a /8” Pittsburgh lock with scrap metal.*

Steps / procedures

Cut out the two pieces of metal to the specified size.

Lay out the lines on the two pieces according to the drawing in Figure 9-43. 3. *Using the 6” X 6” piece, form the Pittsburgh seam according to the instruction in this chapter.*

Using the 3” X 6” *piece, make the single edge to go into the pocket lock.*

Pound over the edge of the seam and turn in to the instructor. Specifications: Make 6” X *4” 12” tong, with a. Pittsburgh seam on one corner.*

Steps/ procedures

1. *On a piece of 26 gage galvanize steel lay out the pattern shown Figure 9-44.*
2. *Form the pocket. lock for Pittsburgh seam.*

3. *Bend the sig1e edge.*

4. Starting with the side nearest t
5. *Finish the* seam *a id turn in to t.*

Information Sheet-3	Preparing and Cleaning Sheet Metals

Preparing and cleaning surface of grease and other contaminants

Identifying the sheet metal required for work. Before starting to perform your work, you should have to clean the surface of work pieces from sheet metal (foreign materials) like, grease, dust, rust, oil and others. Commonly there are two ways of cleaning surface of sheet metals. They are by mechanically and chemical. Mechanically by using abrasive paper, sand blasting, wire brush, and rage/ stracho, etc. and chemical by using solvents.

Self-Check 3	Written Test

Directions: Answer all the questions listed below and write your answer on the space provided

The common method of clean foreign materials from sheet metal

A. Mechanically C. A & B

B. Chemically

The common removing of grease from sheet metal.

A. Rage B. Abrasive paper

Chemically to remove foreign material from sheet metal

By solvent B. By water

Answer Sheet

Score = 7pts

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1._____(2pts)
2._____(2pts)
3. _____(3pts)

Information Sheet-4	Joining Sheet Metal

Joining Sheet Metal

1. Hem and Seam Joints

1.1. Hem Joint: Hem is an edge or border made by folding. It strengthens the edges and eliminates the sharp edges. Hems are three types a) Single hem b) Double hem c) Wired edged hem

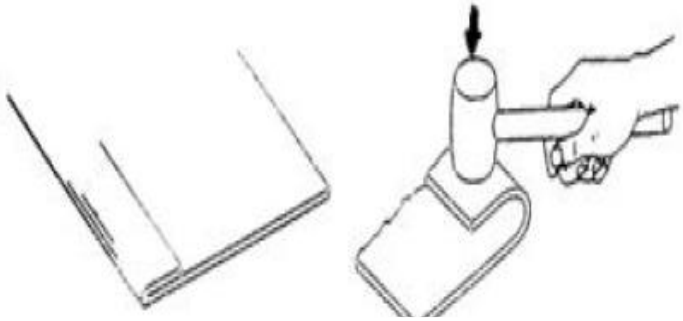


Figure 3. 25 Single Hem

Single Hem: It is made by single folding of the edge of sheet metal. (figure 3.25)

Double Hem: It is made by folding the edge over twice to make it smooth. It provides much greater strength than single hem.(figure 3.26)

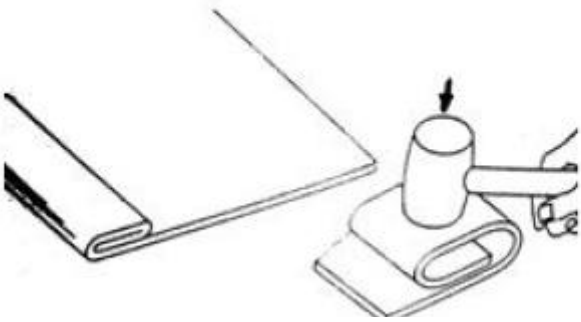


Figure 3.26 double hem

Wired Edged Hem: It consists of holding a piece of sheet metal around a wire of given diameter. (figure 3.27)

1.2. Seam Joint: It is the joint formed by two edges of sheet metal. The process of joining the edges is called seaming. Different kinds of seams are given below. a) Lap seam b) Groove seam c) Single seam d) Double seam e) Dovetail seam f)Flanged Seam

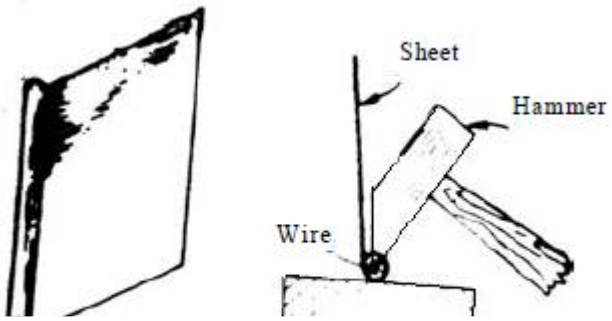


Figure 3.27 Wired Hems

a) Lap Seam: It is a simple type of seam which consists of lapping the edge of one sheet over the other and the joint is made by soldering or riveting.

b) Grooved Seam : It is made by hooking two single hems together

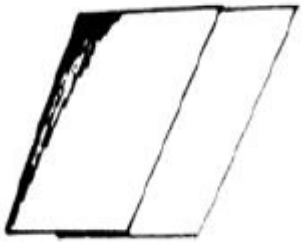


Figure 3.28 Lap Seam

Figure 3.29 Grooved Seam

c) Single Seam: Single seam is used to join a bottom to vertical bodies of various shapes. (figure 3.30)

d) Double Seam: It is similar to single seam with the difference that its formed edges bent upwards against the body. (figure 3.31)

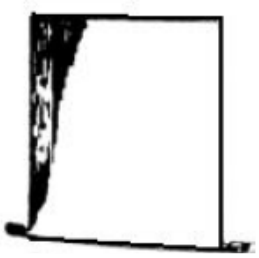


Figure 3.30 Single Seam

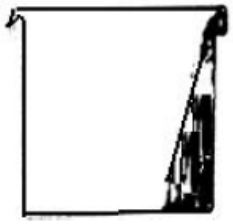


Figure 3.31 Double Seam

Figure 3.32 Flanged Seam

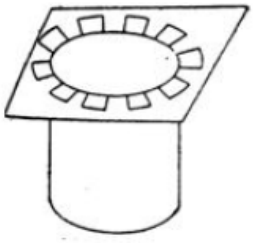


Figure 3.33 Dovetail Seam

e) Flanged Seam: It is used to join the bottom of a container to its body. (figure (3.32)

f) Dovetail Seam: It is used to join sections such as one pipe to another pipe or a sheet to pipe It consists of narrow strips of metal which are formed by slitting the end of pipe.(figure 3.33)

g) The grooved seamed joint (*Figure 3.34*) is one of the most widely used methods for joining light- and medium-gauge sheet metal. It consists of two folded edges that are locked together with a hand groover (*Figure 3.35*).

When making a grooved seam on a cylinder, you fit the piece over a stake and lock it with the hand groover (*Figure 3.25*). The hand groover should be approximately 1/16inch wider than the seam. Lock the seam by making prick punch indentions about 1/2inch in from each end of the seam.

Figure 3.34 — Development of a grooved seam joint.

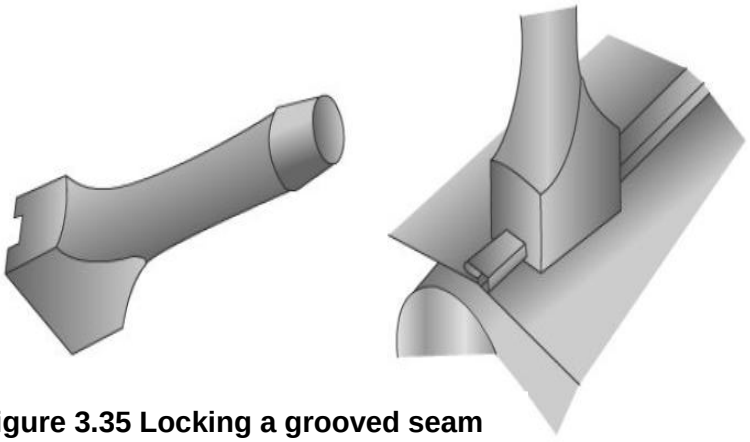


Figure 3.35 Locking a grooved seam

The cap strip seam (*Figure 3.36*, *View A*) is often used to assemble air-conditioning and heating ducts. A variation of the joint, the locked corner seam (*Figure 3.36*, *View B*), is widely accepted for the assembly of rectangular shapes.

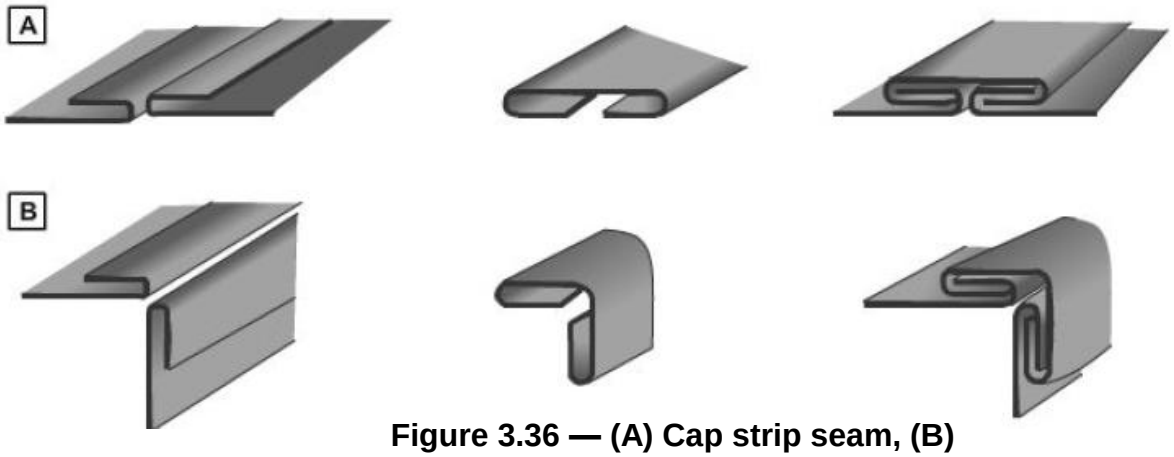


Figure 3.36 — (A) Cap strip seam, (B) Locked corner seam.

A drive slip joint is a method of joining two flat sections of metal. *Figure 3.37 is* the pattern for the drive slip. End notching and dimensions vary with application and area practice on all locks, seams, and edges. “S” joints are used to join two flat surfaces of metal. Primarily these are used to join sections of rectangular duct. These are also used to join panels in air housings and columns.

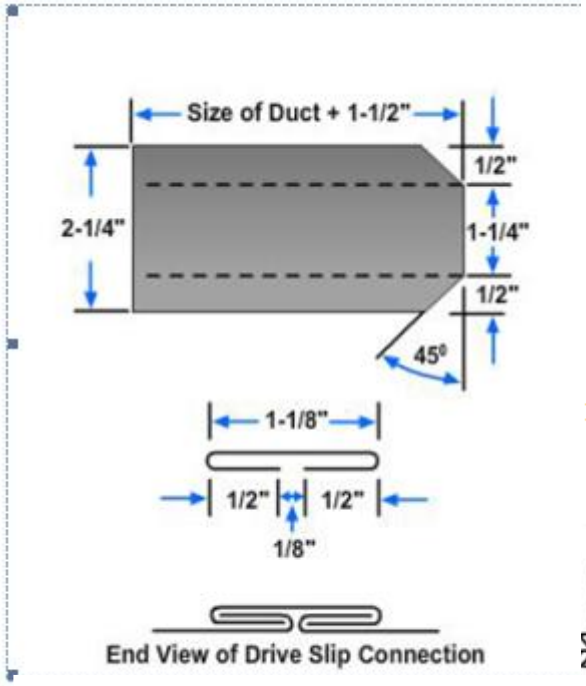


Figure 3.37 Drive slip pattern connections

Rivet consists of head; shank and tail are generally made of same metal as the parts that are being joined.

2. Fastening Methods

The following fastening methods are widely adopted in sheet metal work: (a) Riveting (b) Soldering (c) Brazing (d) Welding.

a) Riveting: It is a permanent fastening method by using rivet.

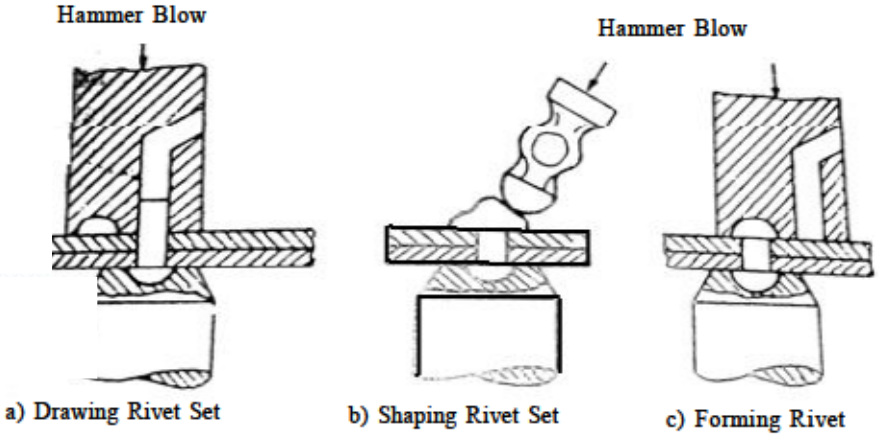


Figure 3.38 Rivet sets a) Drawing b) Shaping c) Forming

The required holes must be either punched or drilled before riveting.

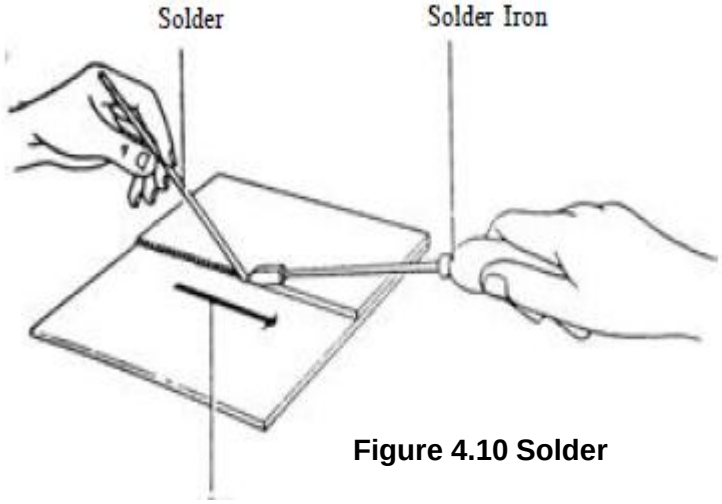


Figure 4.10 Solder

b) Soldering: It is the Sets process of joining two or more metal pieces by means of an alloy. This alloy is called solder made of lead and tin. The melting point of solder is less than the metal to

be joined. For soldering, the base metal is heated by soldering iron which also melts solders and flux. the flux (zinc chloride paste) is used to dissolve the oxide film on the surface and also prevents oxidation during soldering. The molten solder fills the space between mating surfaces. It solidifies and forms a strong joint.

Brazing: It is similar to soldering, but it gives much stronger joint. The major difference is that use of a harder filler material called spelter and its melting point is higher than solder. but lower than

c) the metal being joined. In brazing operation the two metal pieces are to be joined must be cleaned. Flux (Borax) is applied on the joint and heated to a temperature just above the melting point of the spelter. The liquid spelter is distributed between the surfaces by capillary action. After solidification it forms strong joint.

d) **Spot Welding:** The spot welding is used for joining the sheets by application of heat and pressure at specific locations called spots. In this, the sheets to be joined together are held between two electrodes at required located sports. Normally a high amperage current and low voltage is passed through electrodes causing local heating at that spots. The pressure applied on the electrodes squeezes the sheet metal at various locations thus joining the two sheets together to form a joint.

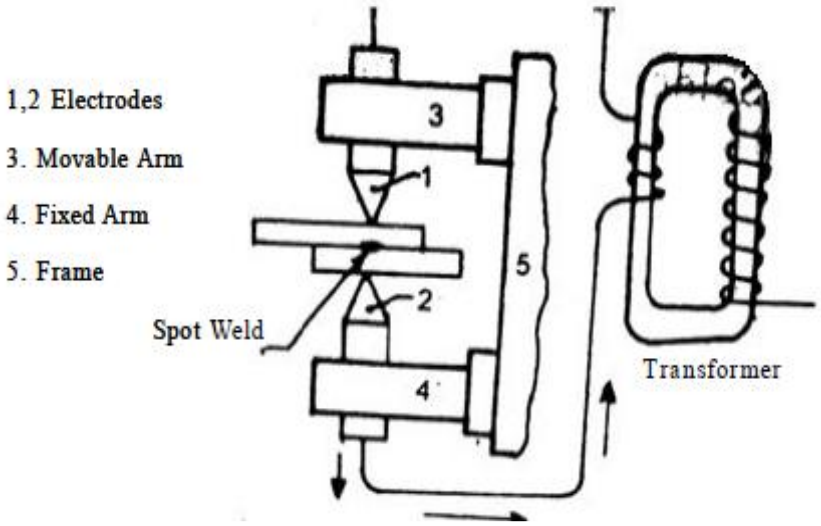


Figure 4.11 Spot Welding

Summary

1. Sheet metal work is the process of making useful articles for household as well as industrial.
2. Commonly used sheet metals are black iron, galvanized iron, copper, aluminum, stainless steel etc.
3. Tools used in sheet metals are measuring tools and operational tools.
4. Most common sheet metal operations are shearing, bending, drawing, squeezing etc.
5. Important fastening methods in sheet metal are riveting, soldering, brazing and spot welding.

Self-Check 3	Written Test

Directions: - Answer all the questions listed below and write your answer on the space provided

Name _____

I. Choose the best answer.

1. Measurement of length is
   Compression of the size of component to standard
   Measuring width, thickness or diameter
   The shortest distance between two points, lines or surfaces
   All

2. Drawing on sheet metal/plate so as to provide guide lines for cutting and folding is
   A. Lay out
   B. Cutting
   C. Folding
   D. Joining

3. After marking out and measuring what is next to be done?
   A. Cutting
   B. Forming
   C. Bending
   D. Joining

4. In shearing machine used for straight line cutting
   A. The lower blade is fixed
   B. The upper blade is movable
   C. The upper blade is inclined to the lower blade
   D. All

5. Which of the following method is used to reduce shearing force
   Making the lower and upper blade parallel
   Making the upper blade incline to the lower blade
   Reducing area under shear
   Making blade clearance wide
   B and C

6. The following are requirement of shearing machine , except
   A. Shearing machine must have two blades
   B. The cutting members must kept sharp
   C. There must be blade adjustment

D. Shearing machine should be flexible.

7. Which of the following is not true about bending
   A. Inside of the material becomes compressed
   B. Thicker material develops more work hardening than thinner one
   C. Small radius cause greater cold deformation
   D. Folding can be done in folding machine only

8. One of the following joining technique is not permanent
   Riveting
   Soldering
   Seaming
   Welding

9. _____is a process of inserting metal pin in to a hole and clinching it so there is a head at each end
   Soldering
   Seaming
   Riveting
   Joining

10. In case of access is limited to only one side of the parts to be assembled you use
   A. Solid rivets
   B. Hollow rivets

11. During riveting, if rivet bends it is effect of
   Rivet too short
   Hole too large
   Rivet too long
   Rivet close together

12. One of the following is not use of soldering flux
   It protect the heated joint from atmosphere
   It removes any residual oxide from the joint surface
   It promote the wetting of the joint surface
   It carries heat from source to joint surface

13. When you want to assemble/join component to be water tight, you use
   A. Soft soldering
   B. Riveting
   C. Seaming\

14. A single seam bent over against the body of the job is
   Single seam
   Double seam
   Grooved seam

15. When using rivets to join sheet metal, what characteristic should the rivets have?
A. Softer than the metal being riveted
B. The same material as being riveted

C. Harder than the material being riveted
D. Different material as being riveted

16. What must be the distance between the rivets being used and the edge of the sheet metal?

A. 2 1/2 inches
B. 2 1/2 times the diameter of the rivet
C. 2 1/2 times the thickness of the completed joint
D. 2 1/2 times the distance to the next rivet

II. Match part A to part B

A	**B**
____1. Notching	A. Metal pins like bolt without threads
____2. Spring back	B. A low temperature thermal process
____3. Rivets	C. The removal of metal from edge/corner of sheet metal
____4. Seaming	D. Self-secured joint
____5. Soldering	E. Slight recovery of shape after bending

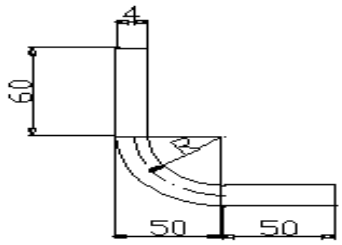
II. **Give short answer**

1. Discuss in group and write below how shearing action is used to cut sheet metal_____
_____
_____

2. Write down stages during riveting
_____
_____
_____

3. List down stapes during soldering
_____
_____
_____

4. Calculate the total blank size to be cut in order to make the following shape from thin plate of 4mm thickness. Consider neutral line is 0.4T from inside



Short Answer Type Questions

5. Name different tools used in sheet metal work.
6. Define Seam in sheet metal work.
7. What is the purpose of mallet?

Long Answer Type Questions

e) Explain about any four important sheet metal operations.
f) Explain different sheet metal joints with sketches.
g) Explain brazing and soldering.

Answer Sheet

Score = 37pts
Rating: _____

Name: _____
Date: _____

CHOICE PART

34._____
35._____
36. _____
37._____
38._____
39._____
40._____
41._____
42._____
43._____
44._____
45._____
46._____
47._____
48._____
49._____
50.

MATCH Part

1. _____
2. _____
3. _____
4. _____
5. _____

Short Answer Questions

1. ----------
2.----------
3.----------
4.----------

Operation Sheet #3.1	Joining Sheet Metal

Carry out Soldering and Riveting operations

1. Prepare a rectangular tray from a given G.I. sheet
2. Prepare a funnel of given dimensions from G.I. Sheet metals.
3. Join the given two sheet metal pieces by soldering.
4. Join the given sheet metal pieces by riveting.

Operation Sheet #3.2	Joining Sheet Metal

Making a Wired Edge Using the pliers and mallet

Steps / procedures

Cut a, piece of metal to the required size.

Measure along the side of the metal 2-1/2 times the diameter of the wire.

Place the metal on the hand brake with the bend lines flush with. the jaws, then bend the edge at right angles as in Figure 3.38.

Cut the wire to the proper length, ‘using a pair of cut ti7g pliers.

Straighten the wire over a smooth surface, using a mallet.

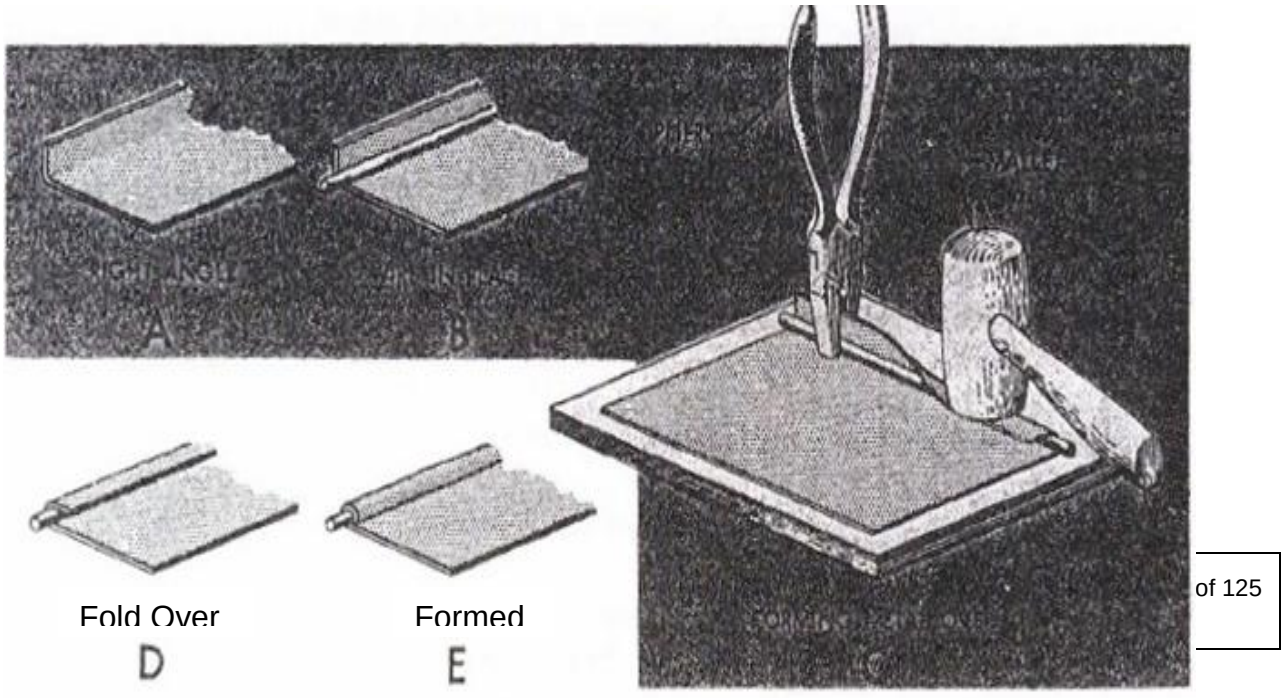


Figure 3.25 making a wired edge using a plier and mallet

Operation Sheet #3.3	Joining Sheet Metal

Carry out Grooved Seam by Hand

Aim: To develop the ability to make a grooved seam by hand. Material: Two pieces 8” x 12” 28- gage steel. Specifications: Make a 1/4” grooved seam by hand, using scrap metal.

Steps / procedures

Cut two pieces of metal to the required size. Set the gage of the folder for a 1/4” lock.

Pull the handle forward as far as possible, completing the single hem, as in Figure 9-40C.

Reset the gage for a 1/4” width hem and repeat the operations, completing the

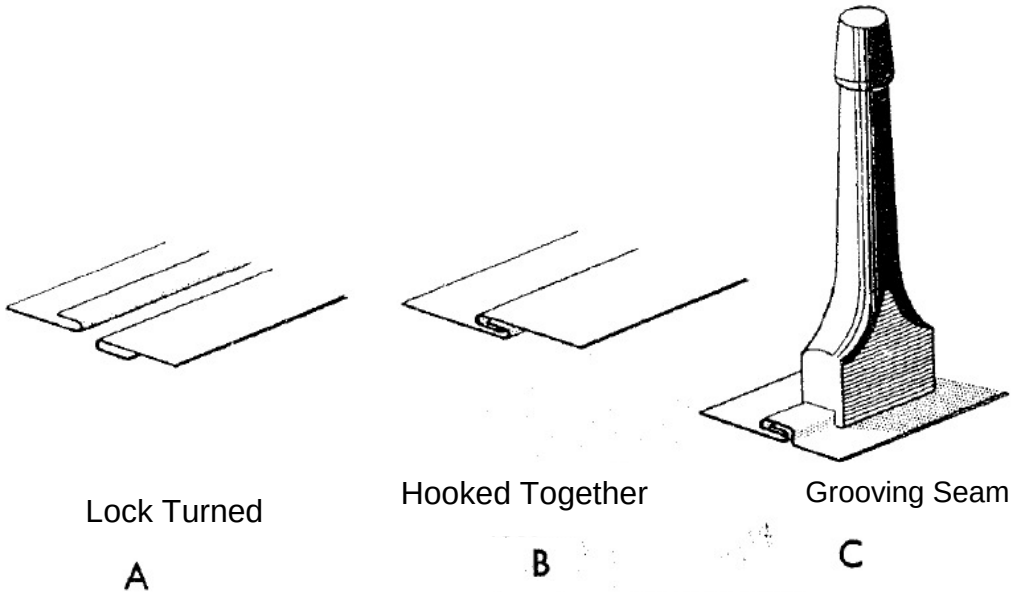


Figure 3.26 Steps in making a hand grooved seam

single hem.

Operation Sheet #3.4	Cutting and Joining Sheet Metal

Operation title:- Producing tool kit from sheet metal

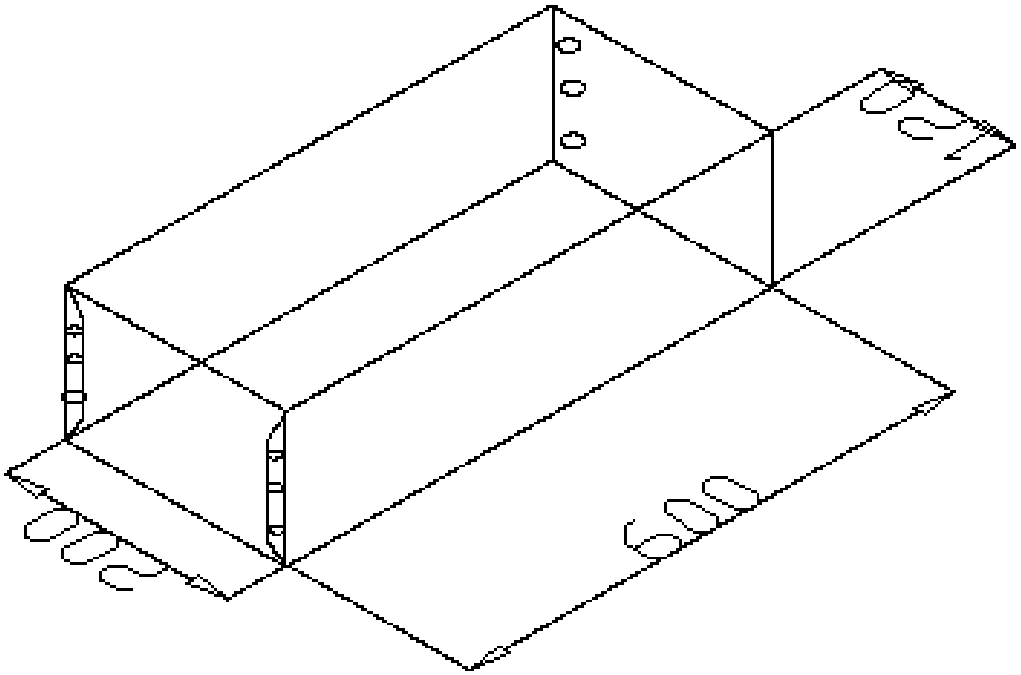
Purpose:- It is used as tool store at each work bench of work shop

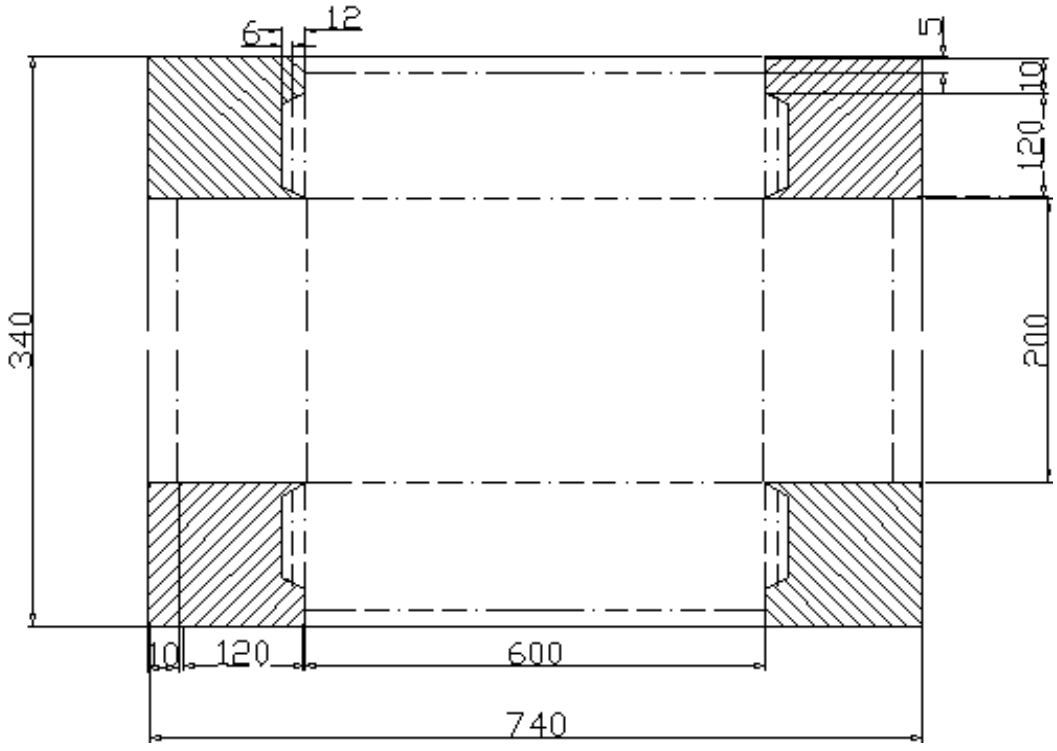
Condition for the operation:- Fully organized work shop, good working condition

Supply and material:- Sheet metal 0.8 thickness and rivet

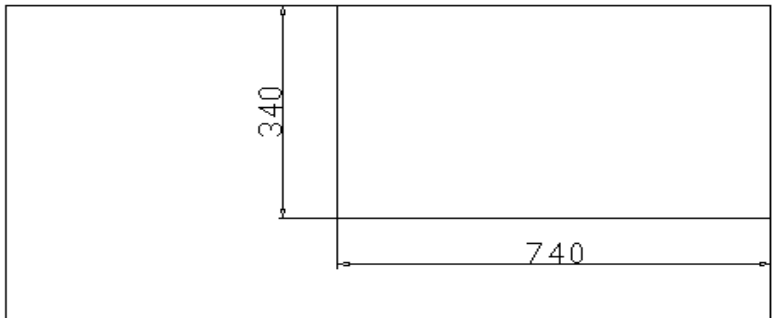
Tools and equipment:- Ruler, scriber, try square, hammer, mallet, folding machine/folding bar, Center punch, snips, bench shear, rivet set, bench stake, bench vice, drilling machine (portable drill).

Procedure:- working drawing

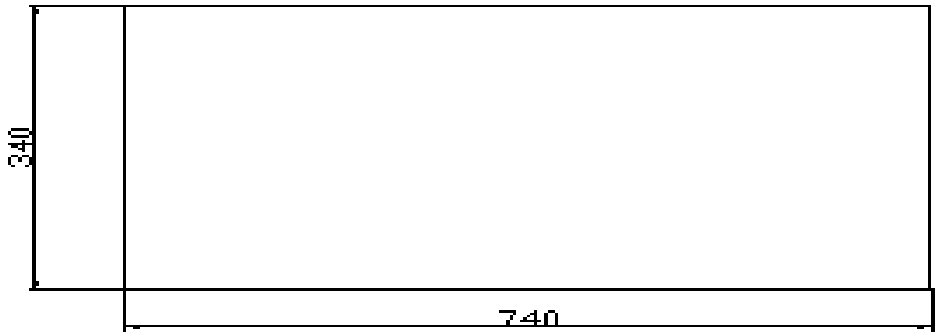



6
12
5
10
120
340
200
10
120
600
740

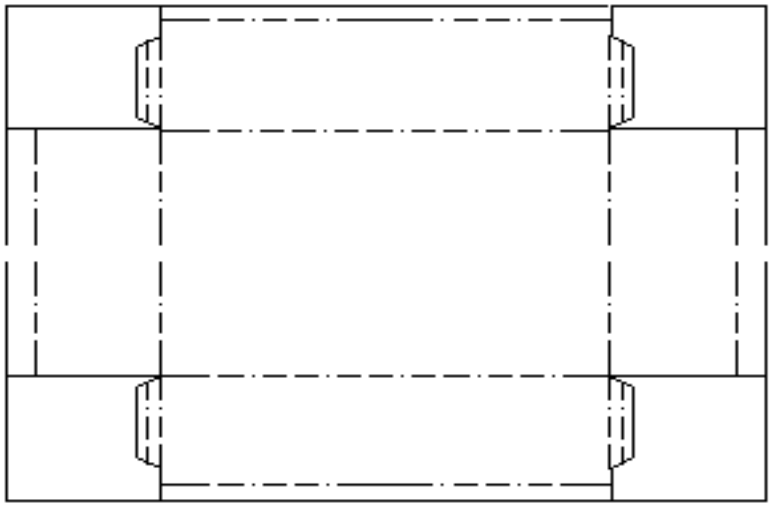
1. Mark out the over all dimension for the blank on a suitable sheet metal of the. Correct thickness.



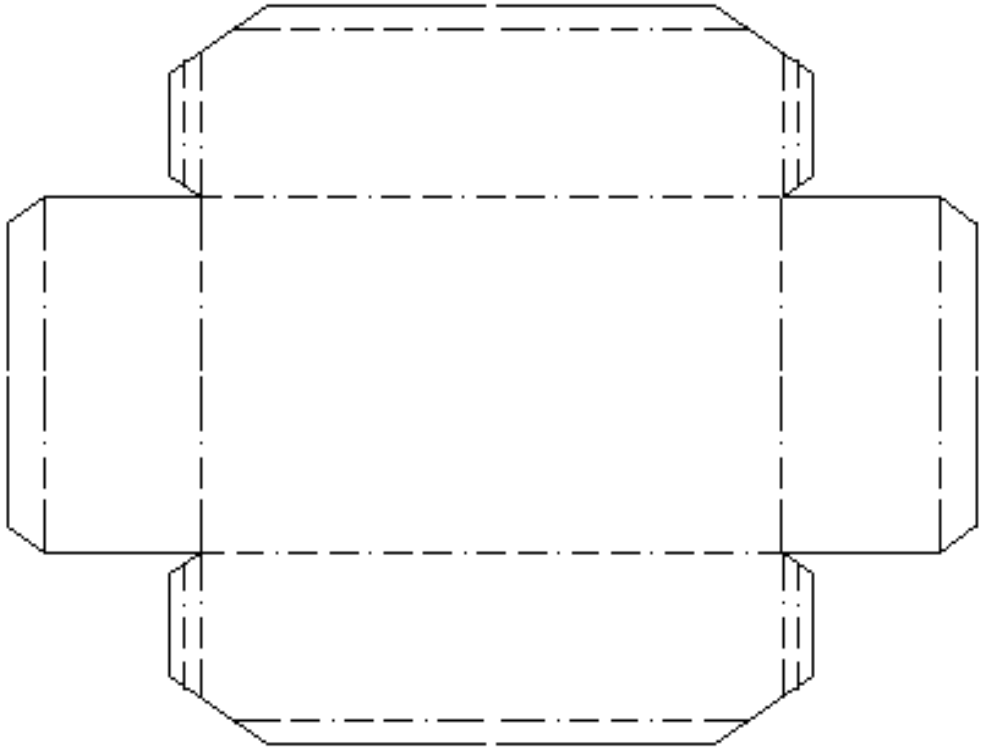
2. Cut out the blank on the bench shear and remove all sharp edges or burrs with a suitable file.



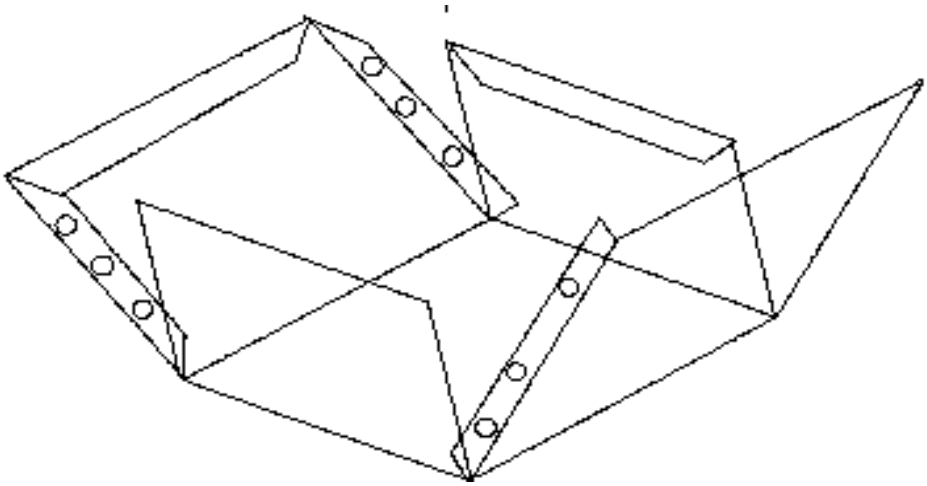
2. Mark off for the notched corner and for the rivet and center punch



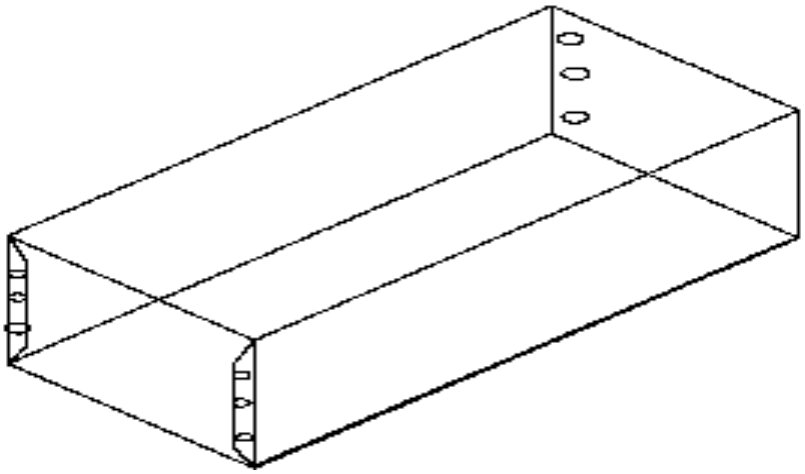
4. Notch the corners and drill the rivet holes



5. Bend the long sides up first in the folding machine to an angle of 45^0 and flatten Back. Fold the shortest side and finish the long side.



6. Assemble/join



Precautions:-

Wear protective clothing
Sheet metal work has an injure, thus be careful while handling and doing

Quality criteria:- The article must be made to the given dimensional accuracy

Join the edge perfectly

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions:

Operation title:- Produce cylindrical can from thin sheet metal

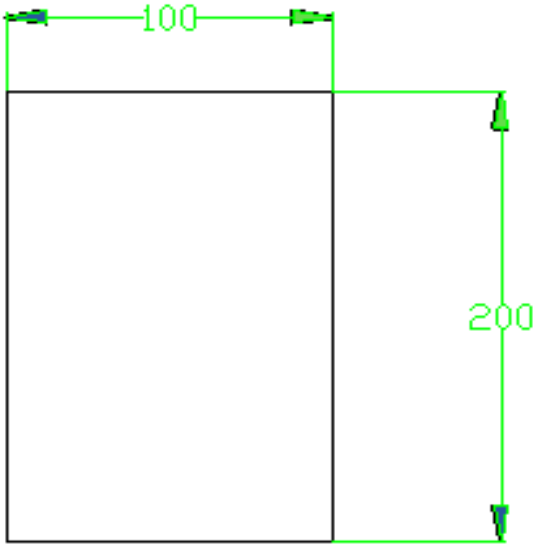
Purpose :- It is used to contain water and to holed food product

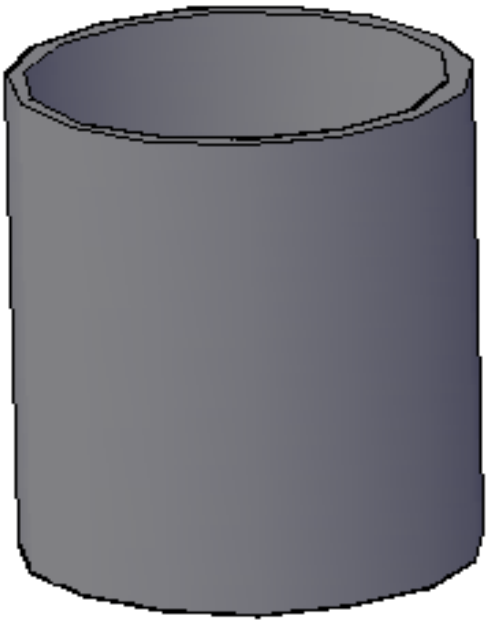
Condition for the operation:- well organized work shop and all necessary tools and equipment

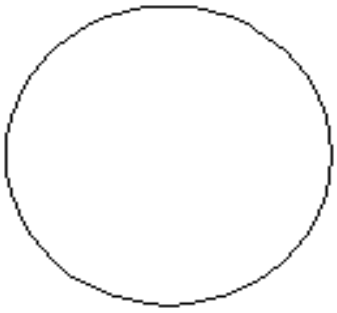
Supply and material:- sheet metal 0.6mm thick and solder

Tool and equipment:- Ruler, scriber, try square, hammer, mallet, folding machine/folding bar, Center punch, universal snips, bench shear, rolling machine, bench stake, bench vice, soldering iron.

Procedure:-







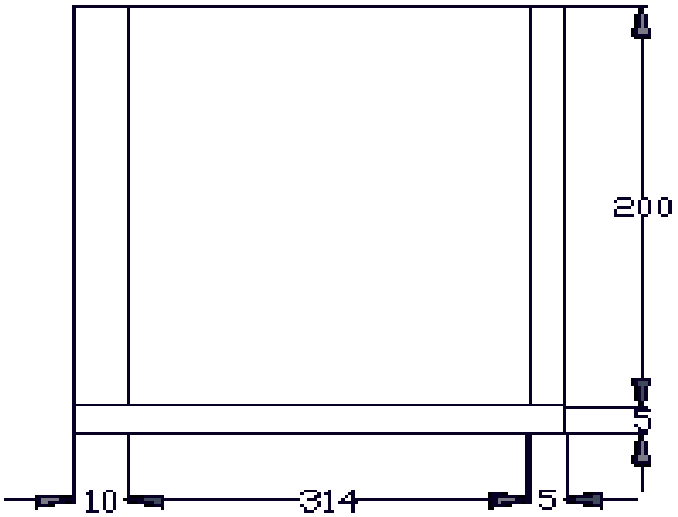
This article has two parts body and bottom

Procedure for body:-

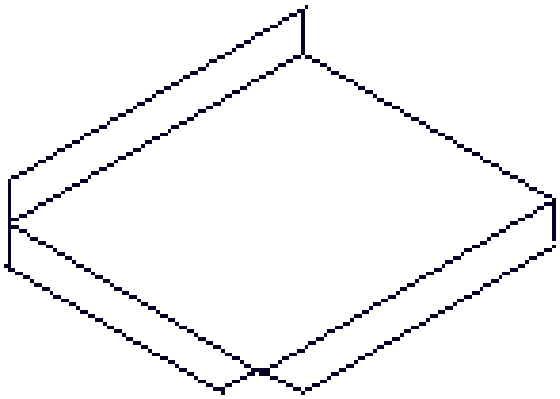
Calculate the circumference c = πD

C= 100*3.14 =314mm

Cut the blank of size 329*205, adding allowance for seaming on both sides of the height and width



After notching bend the sides in opposite directions and bend the bottom

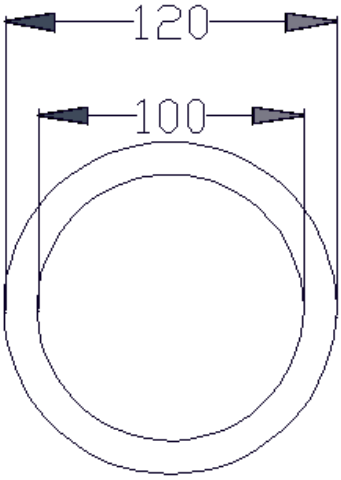


Roll and double seam the sides
Rivet the seamed edge

Procedure for bottom:-

Cut the circular blank of diameter 100 + 20 =120. 20 is added for the double seam
Bend the allowance on stake
Single seam on the body
Bend over the body at 45^0 using mallet

Finish seam by double seam.



Precautions:-

- Wear protective clothing

Sheet metal work has an injure, thus be careful while handling and doing

Quality criteria: - the joint must be water tight

Instruction Sheet 4	Learning Guide #31 Quality assure work and clean up

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics

Visually inspecting aligned, joined and sealed components
Cleaning, checking, maintaining and storing work area, tools and equipment
Completing Documentation

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

Visually inspect aligned, joined and sealed components
Clean, check, maintain and store work area, tools and equipment
Complete Documentation

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the "Information Sheets 1- 4". Try to understand what are being discussed.
4. Accomplish the "Self-checks1,2,3,4 ,5 and 6 " in each information sheets on pages 4,11,14,19,23 and 26.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets 1, 2 and 3 on pages 28,29 and 30.and do the LAP Test on page 31". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG

Information Sheet-1	**Visually inspecting aligned, joined and sealed components**

INSPECTION

is an organized examination or formal evaluation exercise. In engineering, inspection involves the measurements, tests, and gages applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

Visual Inspection

Visual inspection provides a means of detecting and examining a variety of surface flaws, such as corrosion, contamination, surface finish, and surface discontinuities on joints (for example, measure, join, align, welds, seals, and solder connections). Visual inspection is also the most widely used method for detecting and examining surface that are particularly important because of their relationship to failure mechanisms.

As the name itself suggests, the product inspection relates to the final product sent into the market. The main purpose of product inspection is to ensure that the products sent into the market comply with the set standard for quality. In other words, it is to ensure that the product ready for sale is perfect and free of defects.

Self-Check 2	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

What is inspection?

What mean visual inspection?

Answer Sheet

Score = 13pts Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____
_____

Q2._____
_____

Information Sheet-2	**Cleaning, checking, maintaining and storing work area, tools and equipment**

Housekeeping

Poor housekeeping can result in an increased risk of injury and a decrease in work efficiency.

By implementing a good housekeeping plan, areas are kept clean and free of waste and the risk of injuries occurring due to slip, trips and falls, together with injuries resulting from hitting stationary objects, are reduced. Items should be stored correctly with no parts protruding onto walkways.

Electrical cords should not be on the floor, tools should have designated areas for storage and bins for waste should be readily available and be easy to empty.

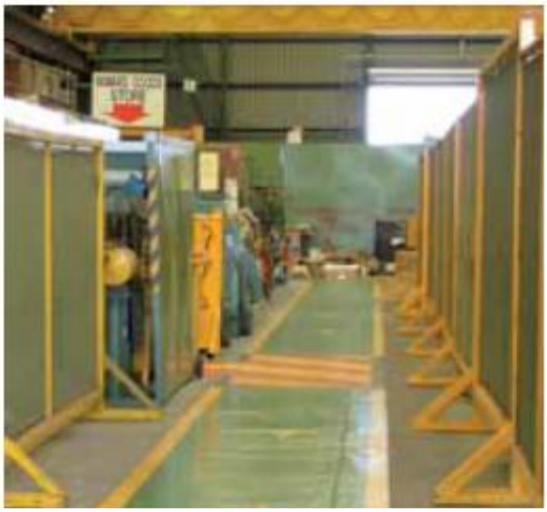


Figure 4.1 clear walkways avoid trips and voids

Figure 42: ***Readily available bin disposal with crane attachment for ease of emptying***

Structured programs that focus on organization, cleanliness and standardization can be introduced to the workplace to assist with this. Cleanliness can be maintained in a 'clean as you go' manner or the need for constant housekeeping can be eliminated from the source e.g. leaks, etc.

1. Cleaning, checking, maintaining and storing work area, tools and equipment

Identify work areas to be cleaned and maintained, work equipment to be cleaned and maintained, Identify and locate instructions in relation to cleaning and maintenance,

Assess area to be cleaned. Select appropriate cleaning equipment and chemicals. Select the protective clothing and equipment to be used. Dispose of waste, Return area to operational condition, Clean, check and store cleaning equipment and chemicals

2. **Preparing Tools and Equipment for maintenance and Storing**

Keeping tools properly storing, cleaning, and maintaining will save time and money. In order to keep tools in good working condition during storage, there are some basic preparatory steps that should be taken. It is important to follow the cleaning and storage instructions, especially for larger power tools such as power saws or plate compactor.

i. **Maintenance of equipment's**

Maintenance of sheet metals machnes

Changing worn blade

Changing deformed gasket

Operating frequently

Changing oil monthly

Greasing rotating or vibratory parts

Regular Lubrication

replacement of worn parts

Maintenance of Grinder

lubricating with cleaned oil

Replacing of worn parts of grinding machine.

Cleaning dusts and other materials

Changing worn blade

ii. Storing tools and equipment's

Storing method of different equipment's

Storing of Block/Brick/Tile Saw .

Storing the sheet metal notchjng in dry place

Storing of Grinder

Store the saw in preferably in mounting brackets or its metal box.

Storing the saw in dry place

Storing of tools

How to Prepare and Store Tools

1. To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.

2. After cleaning, damage or defects should be checked. If the tool cannot be repaired, it should be thrown to away.

3. Any soil and dirt should be scraped away from the metal surfaces with an approved solution. Before placing in storage it should be dried with a towel or rag.

4. The metal parts of the tools should be coated with a lubricant protector spray.

5. Tools is does not directly stored on the ground both small hand and power tools should be Placed on shelving.

Short-handled tools should be stored in a plastic bin or box. All surfaces of Power tools should be cleaned and completely dry before storage and Spraying lubricants

Self-Check 2	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

Answer Sheet

Score =15pts

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____
_____

Q2._____
_____

Q3._____
_____
_____

Information Sheet-3	Completing Documentation

Self-Check 3	Written Test

Directions Answer all the questions listed below and write your answer on the space provided

1.

Answer Sheet

Score = 7pts Rating: _____

Name: _____ Date: _____

Short Answer Questions

Q1._____
_____

Q2._____
_____
_____
_____

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

List of Additional Resources & Reference Materials

Automobile Engineering Technician

Layout and Fabrication of Sheet Metal and Fiberglass Duct

1.
2.
3.