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Email: cavite@tup.edu.ph / Website: www.tup.edu.ph



Seminar: General Education for Teachers

SHEET METALWORKS

Prof. Isagani A. Maliksi



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Sheet Metalwork

- Sheet metalwork is the process of metalworking that forms new products from various types of sheet metal.





Different Ways of Measuring Flat Metals

- Millimetre
- Mils
- Gauges

1 Mil equals to a thousandth of an inch.

Gauge represents the thickness of a metal in relation to its weight per square foot.

Gauges are only common in engineering and manufacturing.

A higher gauge number means a smaller thickness.



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Thickness



Metal Foil

- Metal **foil** is a very thin sheet of metal that has been hammered or rolled flat.
- Most found foils are aluminum foil and gold foil.
- Aluminum foil typically has a thickness of .03mm
- Any sheet of metal with a thickness of less than 0.2mm is considered a foil.



Foil Used in Food Preparation



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Thickness



Sheet Metal Coil

- **Steel Sheet** is any metal that is thicker than a foil and thinner than 6mm
- Steel Sheet is often used for building structures, automobile parts, etc.



Aluminum Corrugated Metal Roofing Sheets



Car Body Parts



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Thickness

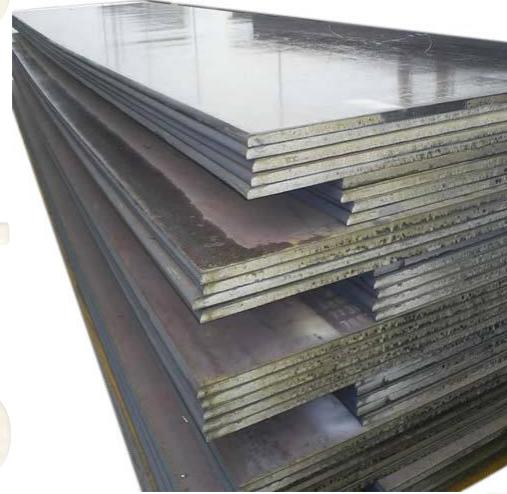


Plate Metal

- Once the steel is more than 6mm thick it is known as **steel plate**.
- Steel Plate is used in applications where durability is more important than saving weight.



Ship Hull

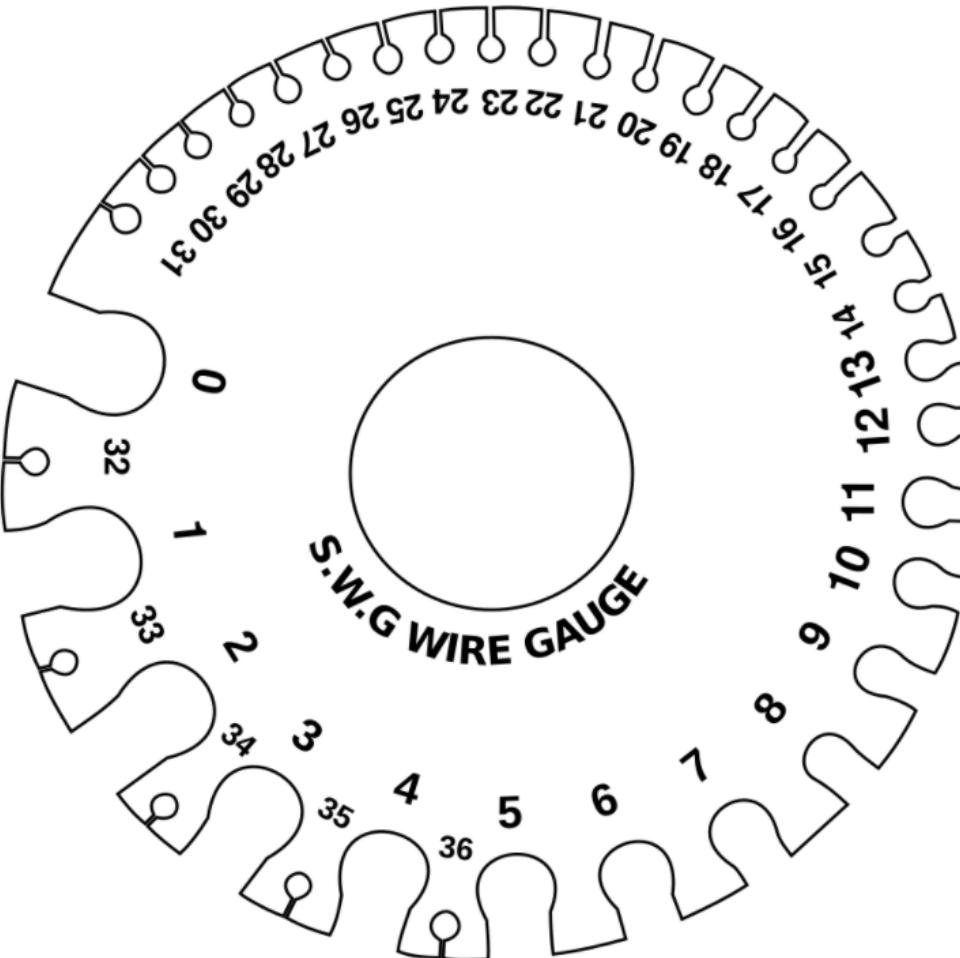


Boiler Steam Drum



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Standard Wire Gauge



Gauge	US Standard for steel sheet in inches (mm)	Steel inch (mm)	Galvanised steel inch (mm)	Stainless steel inch (mm)	Aluminium inch (mm)
3	0.2500 (6.35)	0.2391 (6.07)	-	-	-
4	0.2344 (5.95)	0.2242 (5.69)	-	-	-
5	0.2188 (5.56)	0.2092 (5.31)	-	-	-
6	0.2031 (5.16)	0.1943 (4.94)	-	-	0.162 (4.1)
7	0.1875 (4.76)	0.1793 (4.55)	-	0.1875 (4.76)	0.1443 (3.67)
8	0.1719 (4.37)	0.1644 (4.18)	0.1681 (4.27)	0.1719 (4.37)	0.1285 (3.26)
9	0.1563 (3.97)	0.1495 (3.80)	0.1532 (3.89)	0.1563 (3.97)	0.1144 (2.91)
10	0.1406 (3.57)	0.1345 (3.42)	0.1382 (3.51)	0.1406 (3.57)	0.1019 (2.59)
11	0.1250 (3.18)	0.1196 (3.04)	0.1233 (3.13)	0.1250 (3.18)	0.0907 (2.30)
12	0.1094 (2.78)	0.1046 (2.66)	0.1084 (2.75)	0.1094 (2.78)	0.0808 (2.05)
13	0.0938 (2.38)	0.0897 (2.28)	0.0934 (2.37)	0.094 (2.4)	0.072 (1.8)
14	0.0781 (1.98)	0.0747 (1.90)	0.0785 (1.99)	0.0781 (1.98)	0.0641 (1.63)
15	0.0703 (1.79)	0.0673 (1.71)	0.0710 (1.80)	0.07 (1.8)	0.057 (1.4)
16	0.0625 (1.59)	0.0598 (1.52)	0.0635 (1.61)	0.0625 (1.59)	0.0508 (1.29)
17	0.0563 (1.43)	0.0538 (1.37)	0.0575 (1.46)	0.056 (1.4)	0.045 (1.1)
18	0.0500 (1.27)	0.0478 (1.21)	0.0516 (1.31)	0.0500 (1.27)	0.0403 (1.02)
19	0.0438 (1.11)	0.0418 (1.06)	0.0456 (1.16)	0.044 (1.1)	0.036 (0.91)
20	0.0375 (0.95)	0.0359 (0.91)	0.0396 (1.01)	0.0375 (0.95)	0.0320 (0.81)
21	0.0344 (0.87)	0.0329 (0.84)	0.0366 (0.93)	0.034 (0.86)	0.028 (0.71)
22	0.0313 (0.80)	0.0299 (0.76)	0.0336 (0.85)	0.031 (0.79)	0.025 (0.64)
23	0.0281 (0.71)	0.0269 (0.68)	0.0306 (0.78)	0.028 (0.71)	0.023 (0.58)
24	0.0250 (0.64)	0.0239 (0.61)	0.0276 (0.70)	0.025 (0.64)	0.02 (0.51)
25	0.0219 (0.56)	0.0209 (0.53)	0.0247 (0.63)	0.022 (0.56)	0.018 (0.46)
26	0.0188 (0.48)	0.0179 (0.45)	0.0217 (0.55)	0.019 (0.48)	0.017 (0.43)



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US Standard Sizes for Sheet Metals





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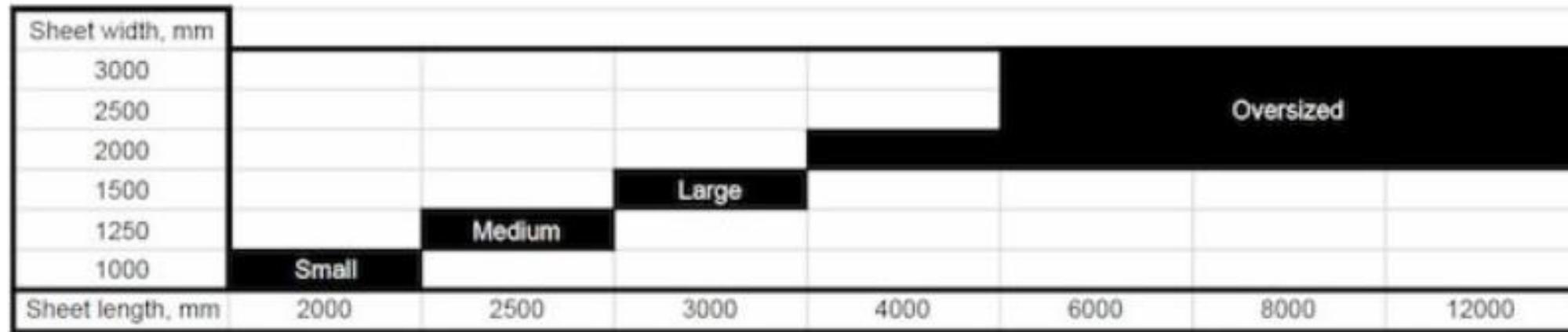


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Standard Sizes

- Standard measurements apply to both sheet sizes and thicknesses.



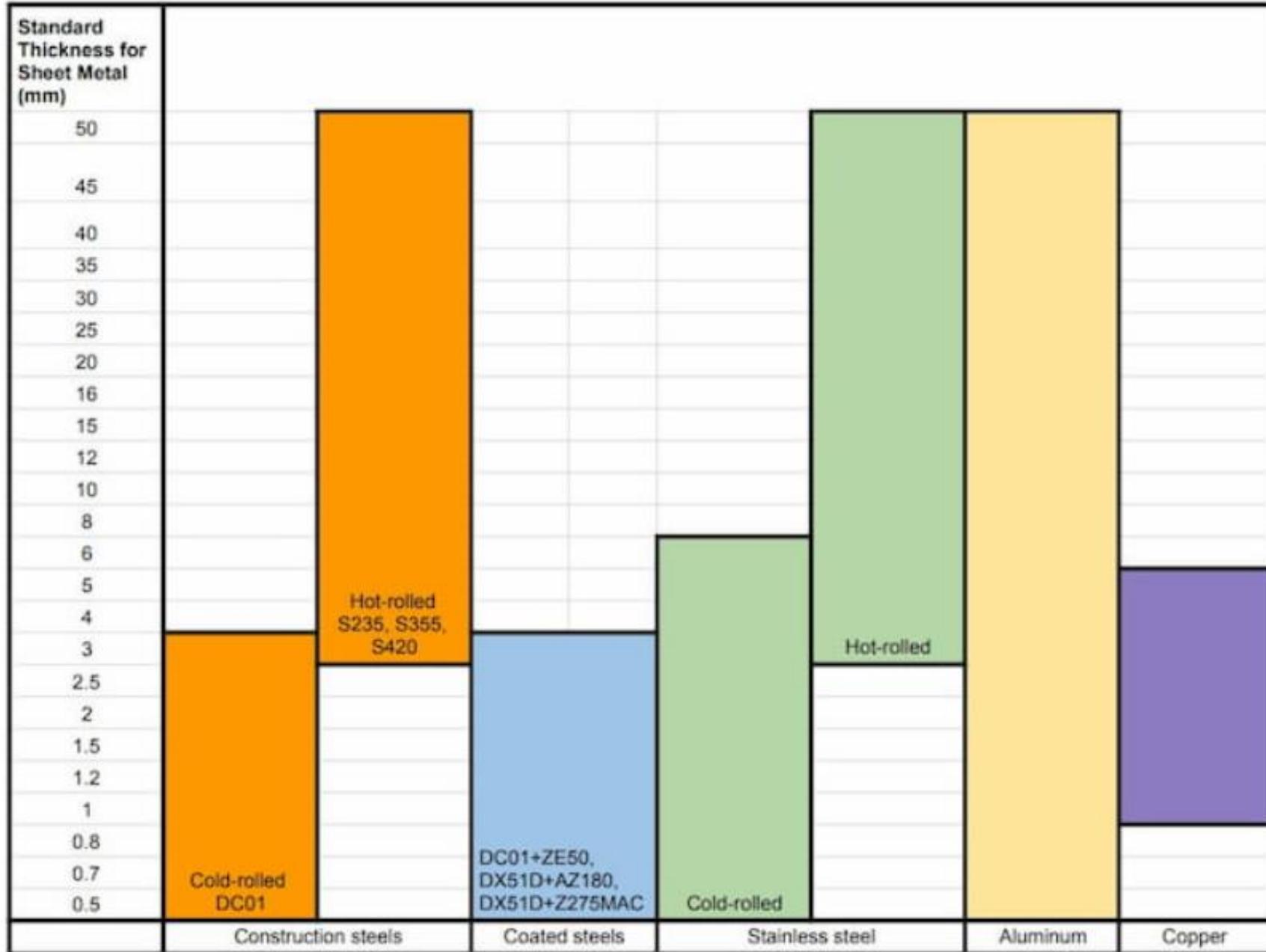
Sheet Sizes

Dimensions: Plain undecorated metal and metal laminates

Material Dimensions Inches: 48" x 96" or 48" x 120"

Material Dimensions mm: 1220 x 2438 or 1220 x 3048





Standard Sheet and Plate Metal Thickness





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Measuring and Marking Tools

- **Steel rules** come in many sizes and formats.
- Basic 6" and 12" steel rules come in flexible and rigid forms.
- Flexible rules are usually $\frac{1}{2}$ " wide and $1/64$ " thick.
- Graduations in inches (decimals, fractions) and millimeters





Measuring and Marking Tools

- **Steel Square** is more commonly referred to as the **framing square** or **carpenter's square**.
- It consists of a long, wider arm and a shorter, narrower arm, which meet at an angle of 90 degrees (a right angle).
- It can also be made of aluminum or polymers, which are light and resistant to rust.





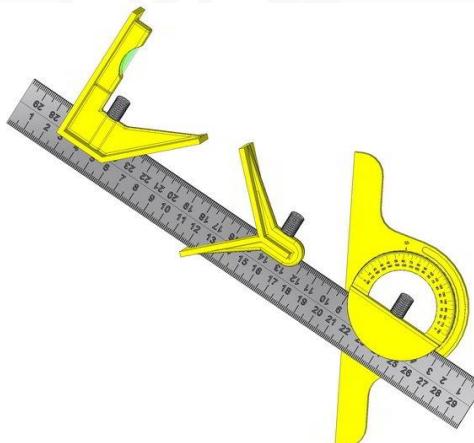
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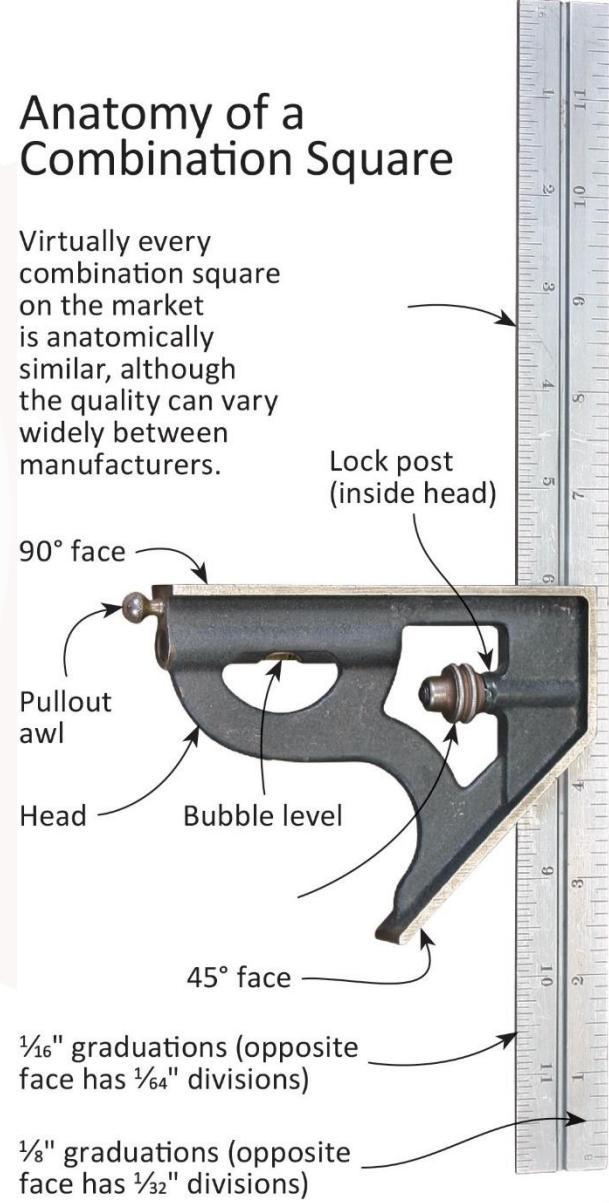
Measuring and Marking Tools

- A **combination square** is a multi-purpose measuring and marking tool used in metalworking, woodworking, and stonemasonry.
- It is composed of a rule and one or more interchangeable heads that can be attached to the rule.



Anatomy of a Combination Square

Virtually every combination square on the market is anatomically similar, although the quality can vary widely between manufacturers.





Measuring and Marking Tools

- A **steel tape measure** or steel measuring tape is a flexible ruler and used to measure distance.
- It consists of a metal blade with linear-measurement markings, pocket protective case, stopper button, belt clip, end hook and hand stripe.





Measuring and Marking Tools

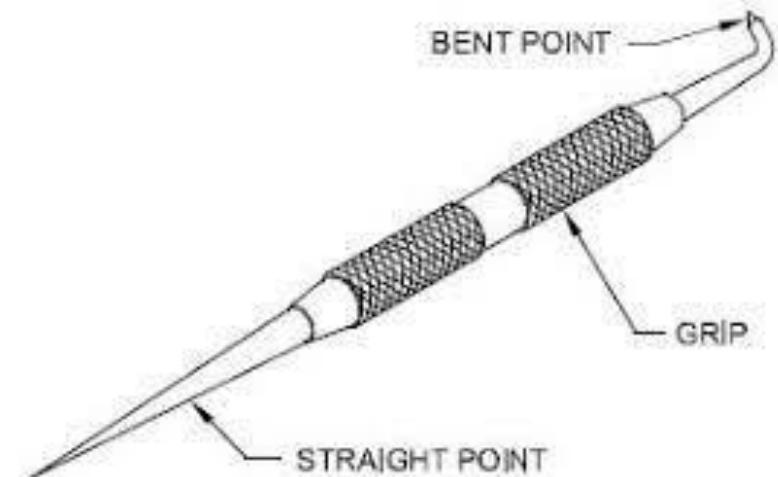
- **Engineer's blue** (or layout ink)
- Applied to the surface of the sheet metal before lay out is drawn
- Mixed with methylated spirits and becomes a quick drying fluid, that is brushed on to the metal surface.
- When it is dry, scribe marks show up clearly, making them easy to see.





Measuring and Marking Tools

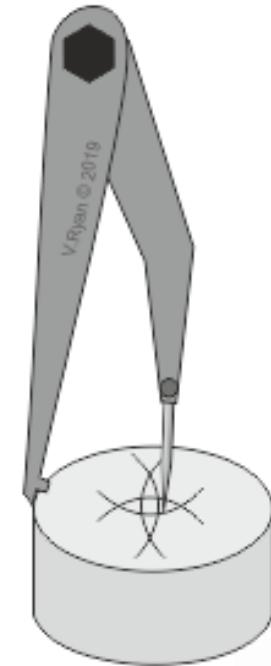
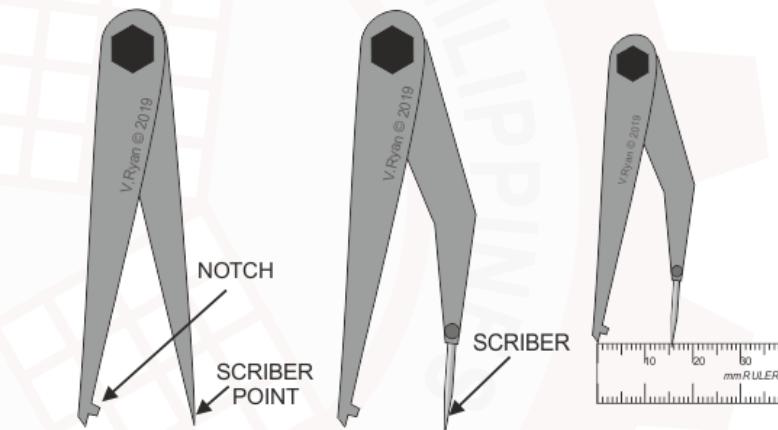
- A **scriber** is a hand tool used in metal work to mark lines on workpieces, prior to machining.
- The process of using a scribe is called scribing and is just part of the process of marking out.





Measuring and Marking Tools

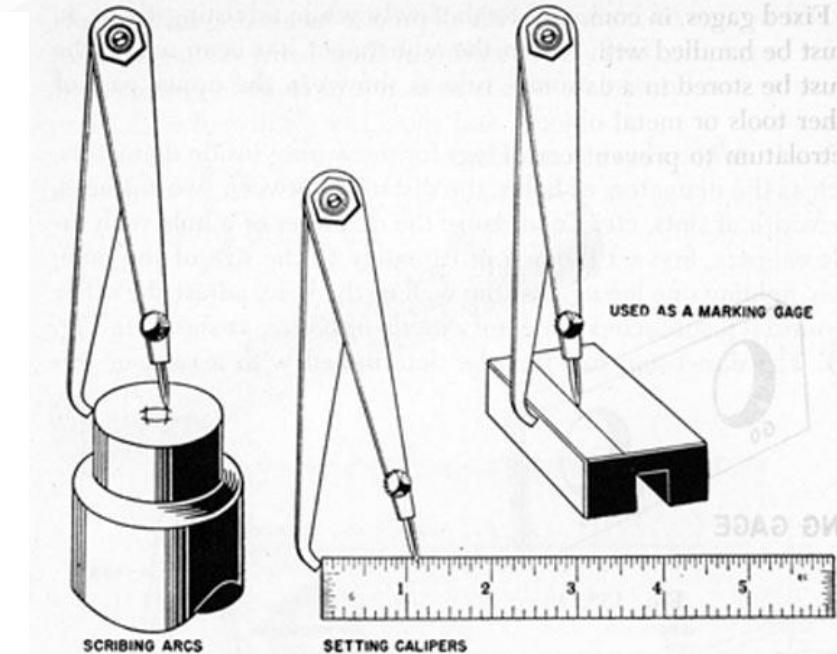
- **Odd Leg Calipers (Jenny Calipers)**
- Manufactured from tool steel and each scriber / scriber point, has been hardened and tempered.
- Used for marking out the surface of sheet metal, for checking parallel edges, locating centers
- Can be used to find the center of a piece of round section material.





Measuring and Marking Tools

- A **hermaphrodite caliper** has one leg bent inward and one straight leg ending in a sharp point;
- This type of **caliper** is used for scribing lines at a specified distance from a flat or curved surface.

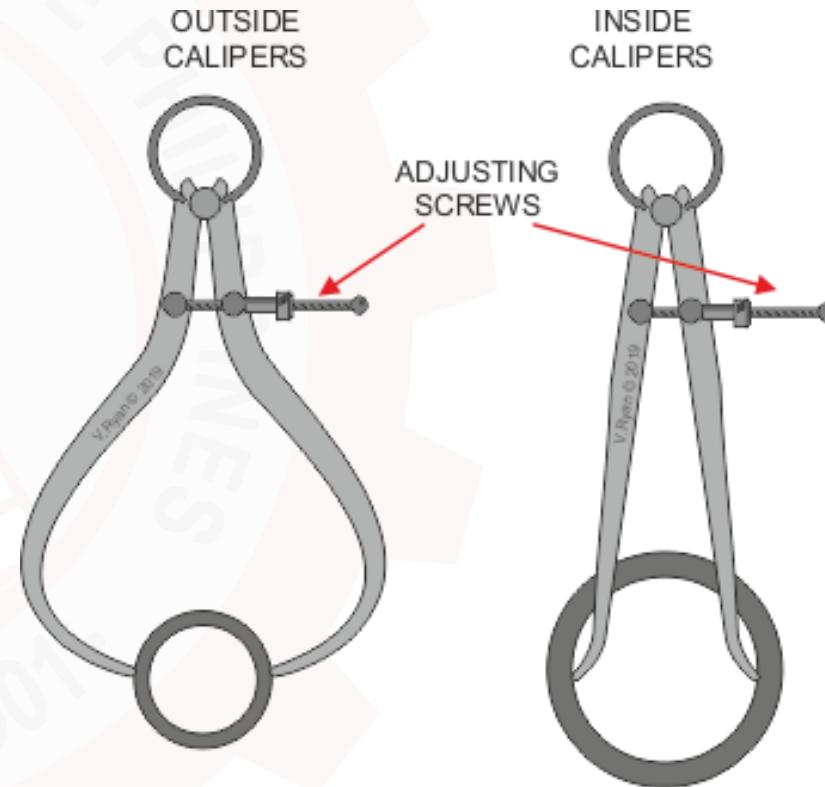




Measuring and Marking Tools

Firm Inside and Outside Calipers

- Manufactured from polished tool steel.
- ‘Firm’ calipers are held together by a ‘nut’ type joint, and it is the friction of this joint, that allows for adjustment and setting to a specific measurement.

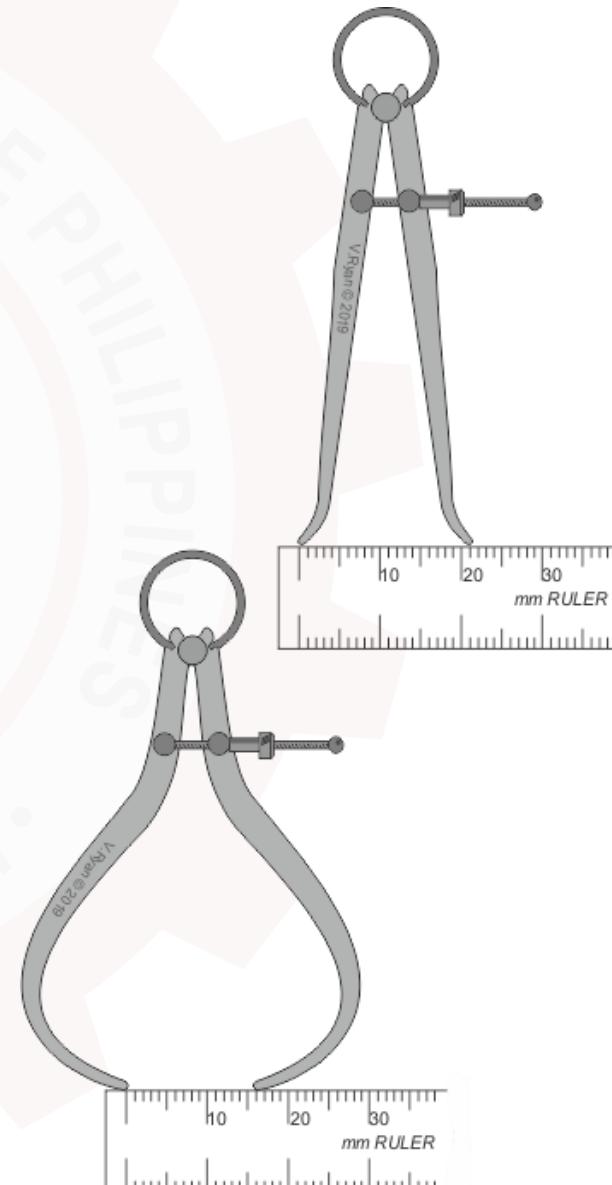




Measuring and Marking Tools

Firm Inside and Outside Calipers

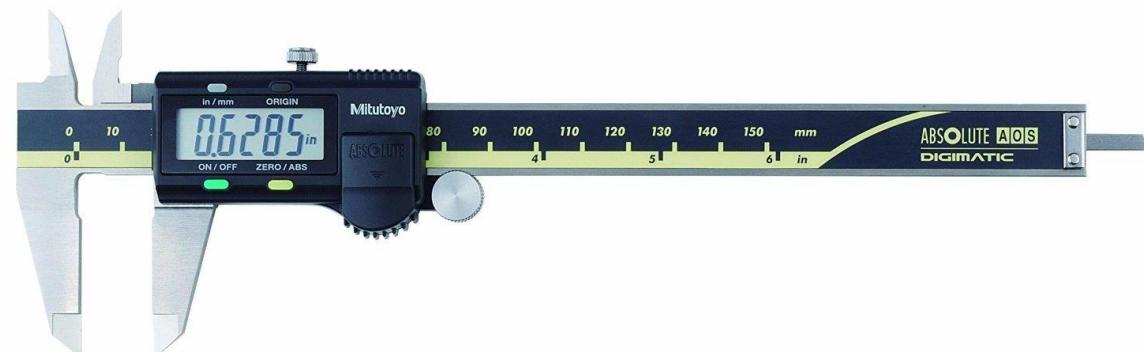
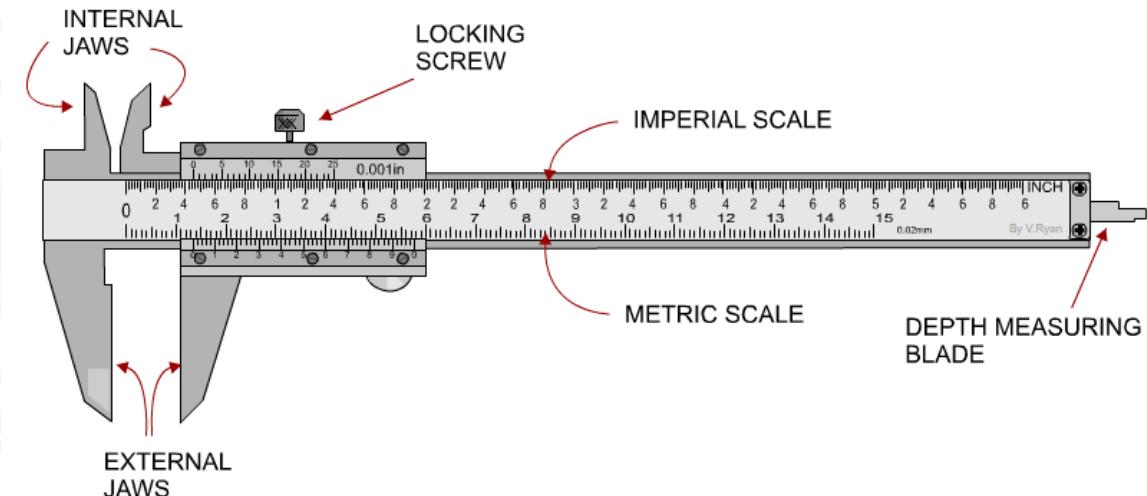
- Adjusted until each leg touches the outside surface.
- The caliper is then transferred to a steel rule, so that the measurement can be read from the scale.





Measuring and Marking Tools

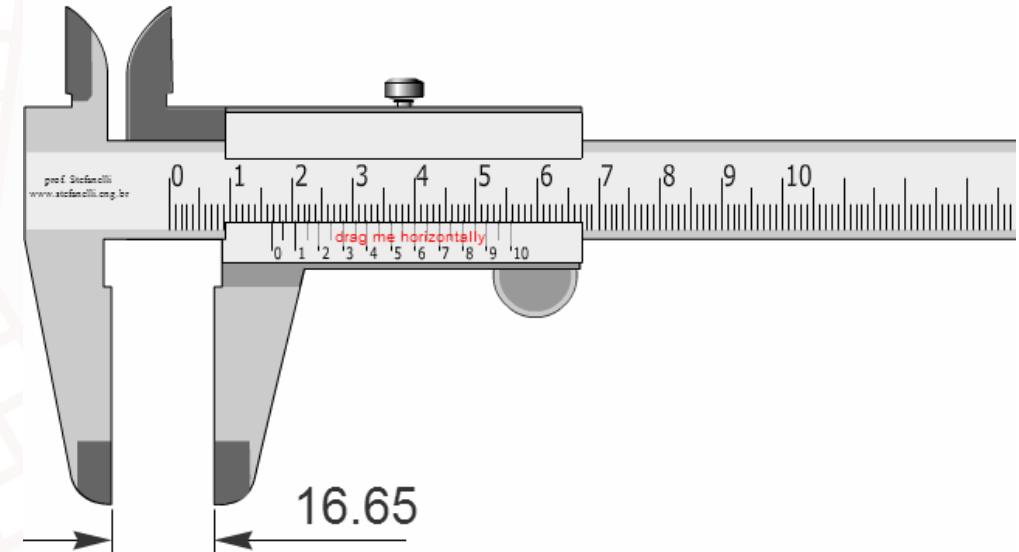
- **Vernier caliper**, instrument for making very accurate linear measurements introduced in 1631 by Pierre Vernier of France.
- Two graduated scales:
 - a **main scale** similar to a ruler and an
 - a **vernier**, that slides parallel to the main scale and enables readings to be made to a fraction of a division on the main scale.





Measuring and Marking Tools

- The vernier scale is sometimes called “**Nonius**”
- The Nonius can read graduations of up to a thousandth of an inch.





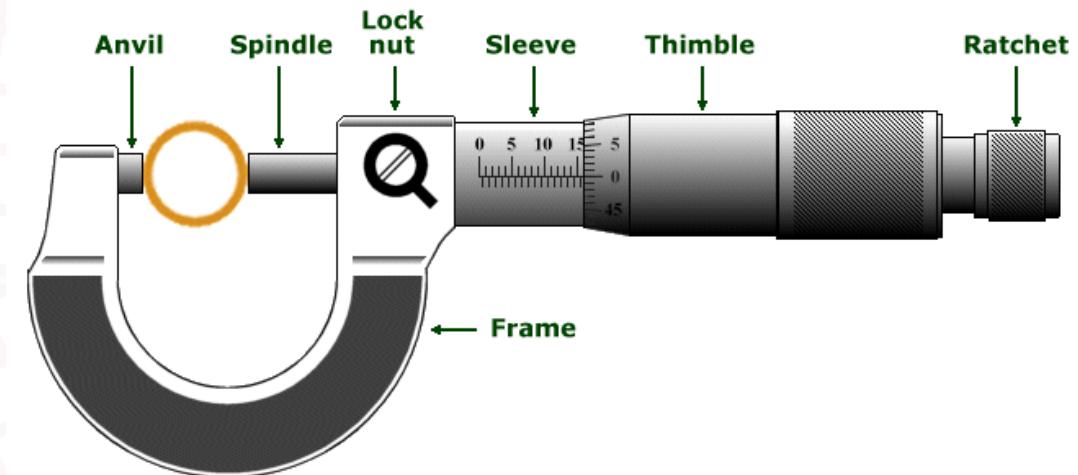
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Measuring and Marking Tools

- **Micrometer caliper**, instrument for making precise linear measurements of dimensions such as diameters, thicknesses, and lengths of solid bodies;
- Consists of a C-shaped frame with a movable jaw operated by an integral screw.
- Invented by **William Gascoigne** in 1638
- Modern micrometer was patterned after “Systeme Palmer” (1848) named, after **Jean Palmer**, a French inventor.





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Measuring and Marking Tools



T U P





Measuring and Marking Tools

- A **center punch** is used to mark the center of a point.
- It is usually used to mark the center of a hole when drilling holes.
- The tip of center punch has an angle of 90 Degrees.





Measuring and Marking Tools

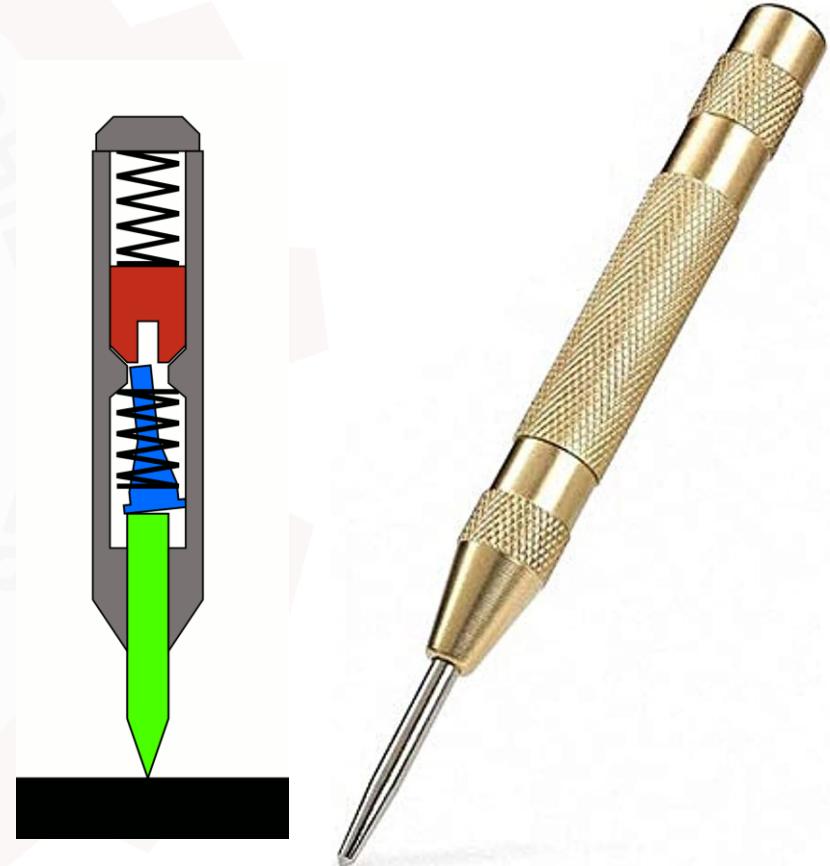
- A **prick punch** is similar to a center punch but used for marking out.
- It has a sharper angled tip to produce a narrower and deeper indentation.
- The indentation can then be enlarged with a center punch for drilling.
- The tip of a prick punch is 40 degrees





Measuring and Marking Tools

- An **automatic center punch** is a hand tool used to produce a dimple in a workpiece.
- It performs the same function as an ordinary center punch but without the need for a hammer.





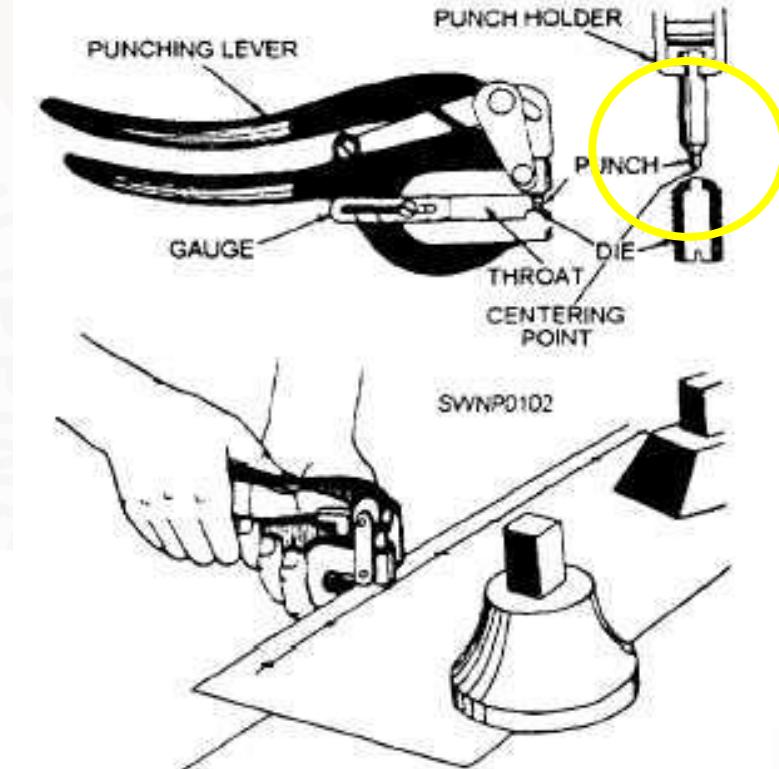
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Cutting Tools

- A **hand lever punch** or hand punch is a device that can be used to accurately create a hole in sheet metal and other thin materials.
- It has a punch and a die and is available for different sizes of holes





Cutting Tools

Straight Aviation Snips



- Designed to make straight or slightly curved cuts, towards either the left or the right.
- Usually have a yellow colour code.
- Best suited to cutting notches on the edge of sheets.
- The length of the blades are usually between 30 and 45mm (1.25 inch-1.75 inch).



Cutting Tools

Left Cut Aviation Snips



- Most suited to cutting straight, and for curves towards the user's left.
- Usually have a red colour code.



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Cutting Tools



Right Cut Aviation Snips

- Designed to cut straight and for tight arches towards the right.
- Usually colour coded green.





Cutting Tools



Upright, Vertical, Right angle Aviation Snips

- Blades are set at a right angle to the handles
- Designed for making cuts overhead or awkward places
- Do not have as much leverage as other aviation snips
- Suitable for lighter gauge metal
- Available in right (green) and left (red) cut styles



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Cutting Tools



Bulldog Tinner Snip

- These snips have much shorter blades
- Ideal for cutting out notches or working on trim.
- They're called bulldog because they have a short 'nose'



Cutting Tools



Heavy Duty Tin Snip

- Heavy duty tin snips have longer blades
- Designed to cut faster compared to other snips





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Cutting Tools



- **Portable electric shears** are used when precision and speed is needed





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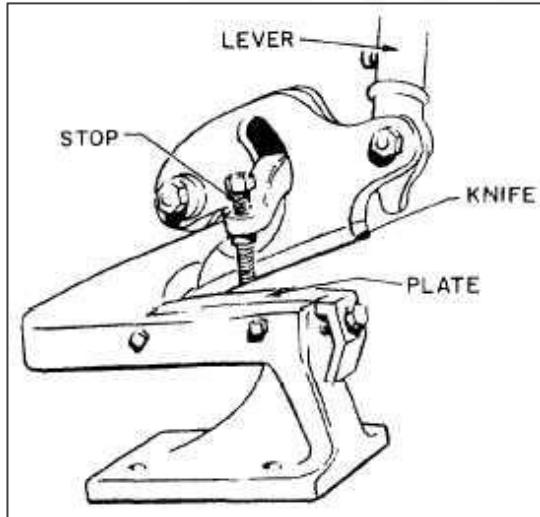
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Cutting Tools



- **Hand lever guillotine shears** are ideal for cutting sheet up to 2 mm thickness.





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Forming Tools



- A **Planishing hammer** is used to flatten, sheet metal by hammering.
- The process of planishing uses many light blows to smooth metal which has already been formed by some other means.



Forming Tools



- Besides for peening (surface hardening by impact), the **ball-peen hammer** is useful for many tasks, such as striking punches and chisels (usually performed with the flat face of the **hammer**).
- The peening face is useful for rounding off edges of metal pins and fasteners, such as rivets.



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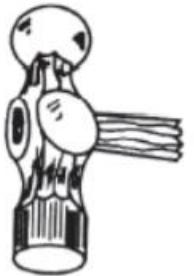


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Forming Tools

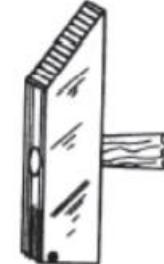
HAMMERS



Ball peen



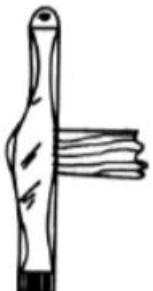
Rivetting



Setting



Hollowing or
Blocking



Raising



Planishing



Collet



Tray





Forming Tools



Tapered T-Dolly



Egg Dolly



Heel Dolly



Toe Dolly



Wedge Dolly



General Dolly

- A **dolly** is the name given to a category of tools used in shaping sheet metal.
- In general, a dolly is a solid piece of metal, small enough to hold in one hand, with a curved or shaped face.



Forming Tools

Bench Stakes

- The stakes are steel anvils used to perform operations like bending, seaming or forming on sheet metal, when suitable machines are not available.
- The stakes are available in various shapes and sizes.



Half moon



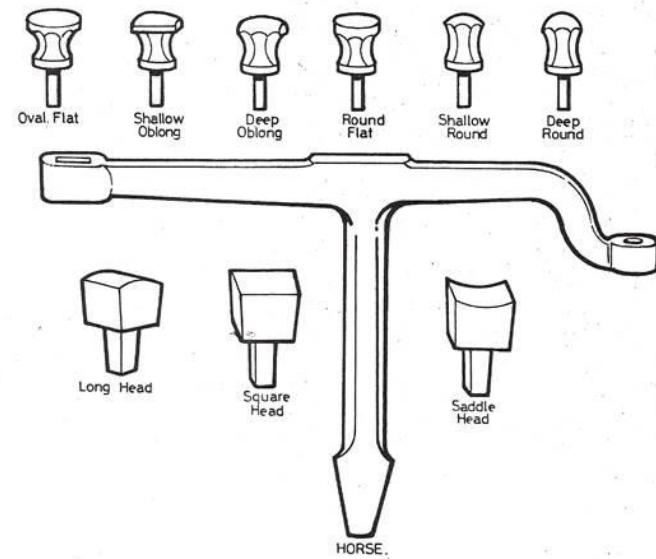
Beak horn



Funnel stake on a
Swage Block



Hatchet



Horse head with Stake Inserts



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Forming Tools



Convex/Concave



Square





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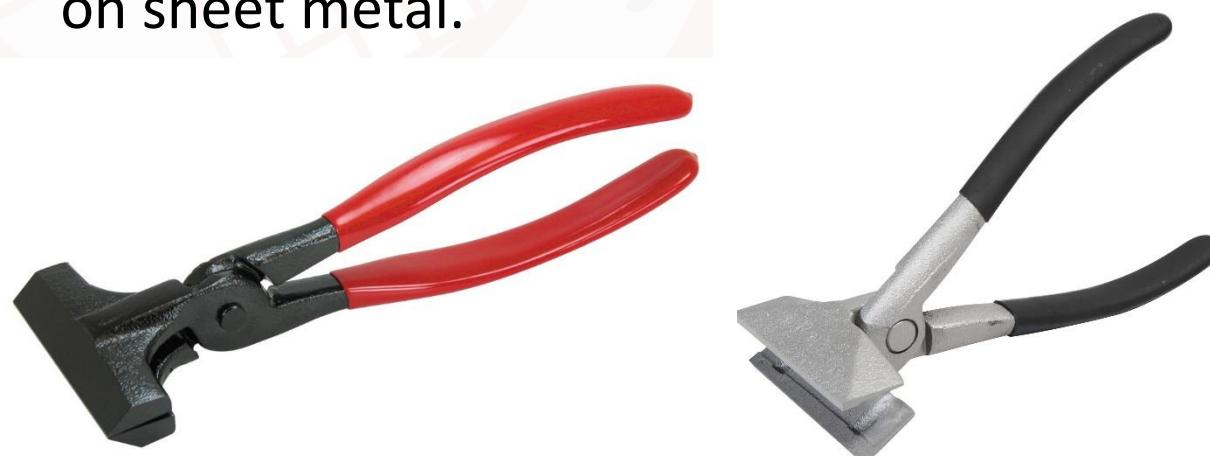
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Forming Tools



- **Hand seamers** are handheld tools that help bend or flatten sheet metal to desired shape.
- Commonly used in the HVAC industry and for custom fits in sheet metal fabrication, they make accurate, crisp angle bends, creating a finished edge on sheet metal.





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Forming Tools



- **Leather Sandbag** is a bag made out of leather and filled with fine sand
- Sandbag cradles the metal panel and allows it to be formed into a curved shape without damaging the surface.





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Assembly Tools

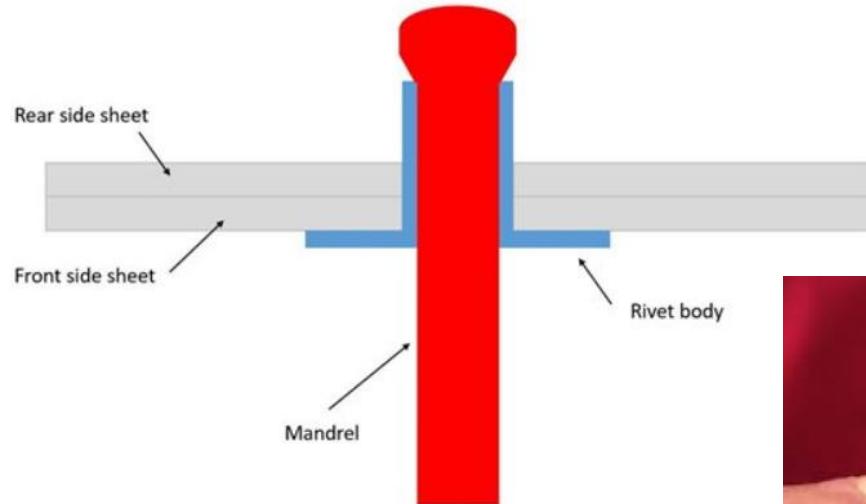


- A **pop rivet** gun is made to apply pop rivets to a workpiece and was invented in 1916 by Hamilton Wylie.
- This type of rivet gun is unique in its operation, because it does not hammer the rivet into place.

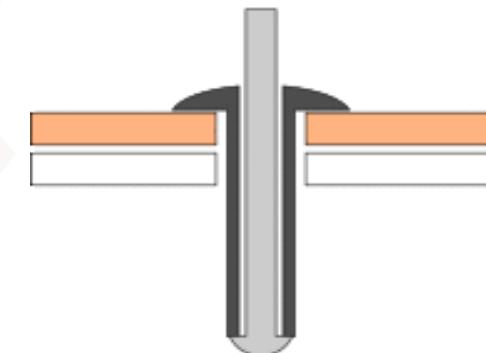




Assembly Tools



- Pop rivets consist of two parts.
- The first part is called the **rivet body** (also known as the **shell** or **hat**) and the second part is called the **mandrel** (also known as the **stem**).





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Assembly Tools



- **Spot welding** is one of the oldest welding processes whereby two or more sheets of metal are **welded** together without the use of any filler material.
- The welding heat is generated by the electric current, which is transferred to the workpiece through copper alloy electrodes.



Machines Used in Sheet Metalworks



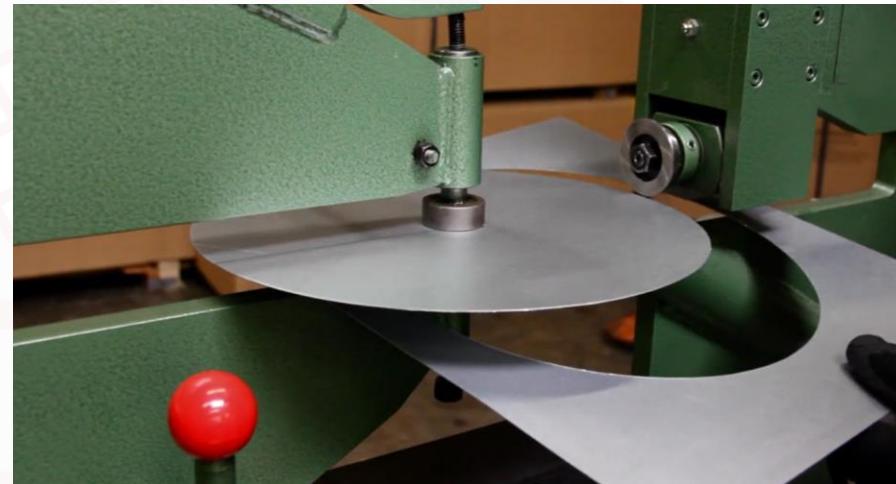
- Often called **foot shears**, kick, or stomp **shears**, these manually operated squaring **shears** are the most economical way to accurately cut large pieces of sheet metal.
- This wide selection we offer can be used for cutting steel, aluminum, stainless and more.





Machines Used in Sheet Metalworks

- **Circle shear machines** cut circles and rings from a square metal piece.





Machines Used in Sheet Metalworks



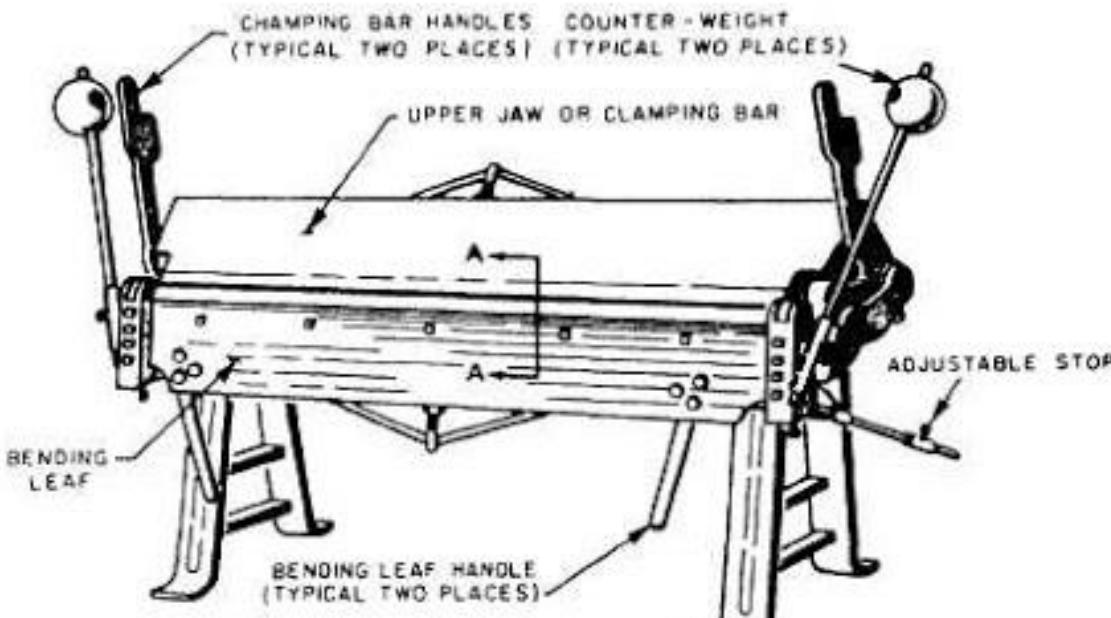
- A **stamping press** is a metalworking machine tool that can precisely shape or cut metal to your specifications.
- Typically, the process can be used for both sheet and coil forms of metal.





Machines Used in Sheet Metalworks

- A **brake** is a metalworking machine that allows the bending of sheet metal.





Machines Used in Sheet Metalworks

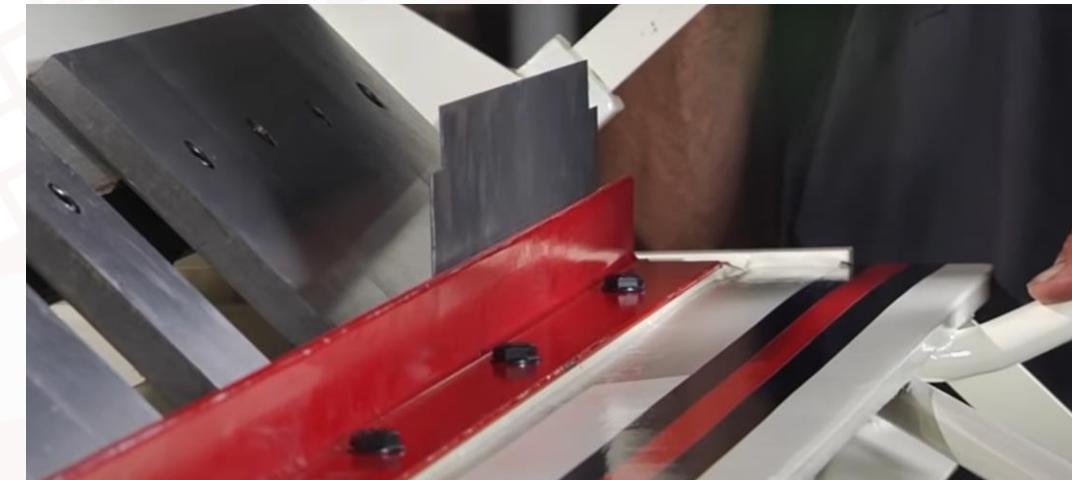
- **Cornice breaks** are press breaks that can be used to create straight bends on sheet metals
- Standard capacities of this machine are from 12- to 22-gauge sheet metal, and bending lengths are from 3 to 12 feet.





Machines Used in Sheet Metalworks

- The **box & pan brake** is often called a “**finger brake**,”
- It has a row of metal fingers across the top, which may be moved to accommodate the bending of different sizes of metal sheets.





Machines Used in Sheet Metalworks



- **Hydraulic press** brakes are used to bend and fold metal by pressing it into a die.
- These presses are designed for both specialized sheet metal work and continuous production applications.



Machines Used in Sheet Metalworks



- A **Bead Roller** is a machine tool that makes rigid lines in sheet metal to make surfaces more rugged and durable.
- The lines bead rollers add to sheet metal prevent warping and disfigurement by adding structural integrity to the metal.





Machines Used in Sheet Metalworks



- **Slip rolls** are designed to form sheet metal into curved panels or cylinders.
- These sheet metal rollers are available as manually operated or powered, and many include wire grooves for bending solid rod.





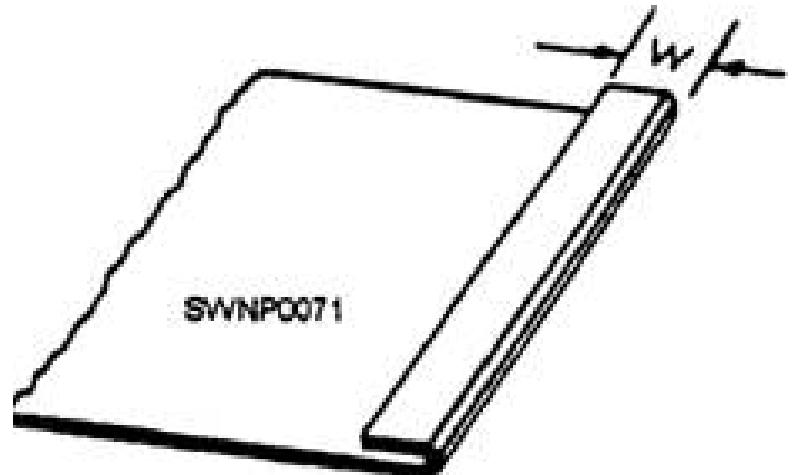
Fabrication of Edges, Joints, Seams, and Notches

- Edges are formed to enhance the appearance of the work, to strengthen the piece, and to eliminate the cutting hazard of the raw edge.
- The kind of edge that you use on any job will be determined by the purpose, by the size, and by the strength of the edge needed.



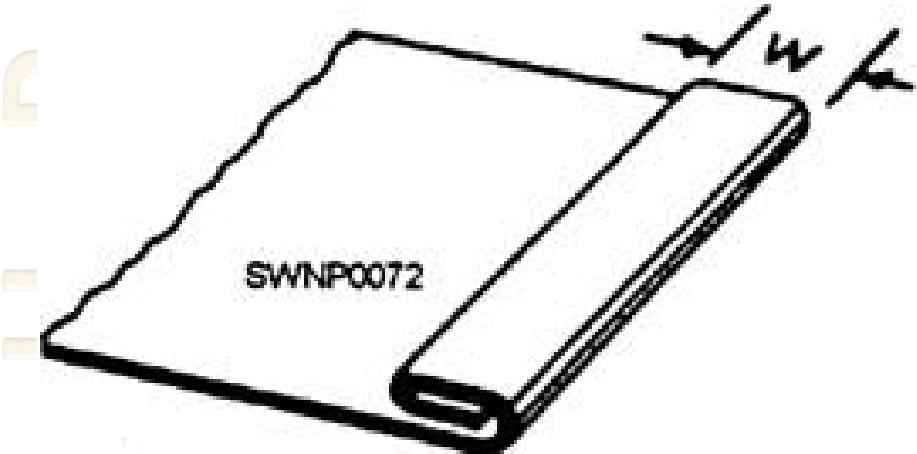
Fabrication of Edges, Joints, Seams, and Notches

- The **Single-hem Edge** can be made in any width. In general, the heavier the metal, the wider the hem is made.
- The allowance for the hem is equal to its width (W).





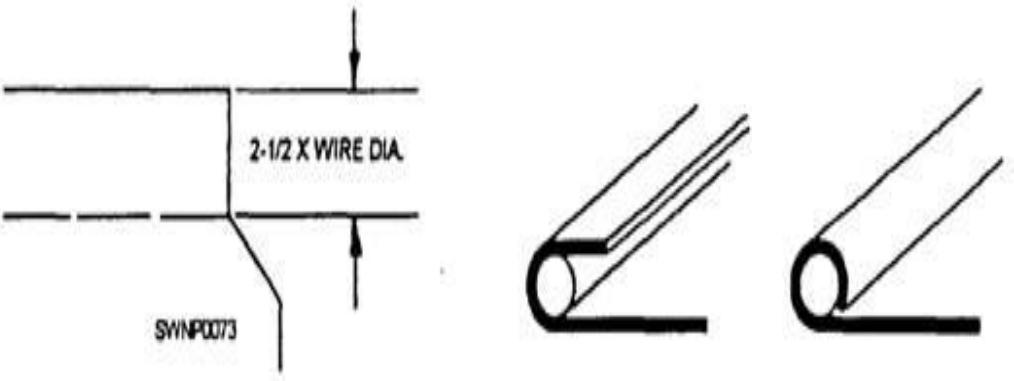
Fabrication of Edges, Joints, Seams, and Notches



- The **Double-hem Edge** is used when added strength is needed and when a smooth edge is required inside as well as outside.
- The allowance for the double-hem edge is twice the width of the hem.



Fabrication of Edges, Joints, Seams, and Notches



- A **Wire Edge** is often specified in the plans.
- Sheet metal are fabricated with wire edges to strengthen and stiffen the jobs and to eliminate sharp edges
- Ice-cube trays, funnels, garbage pails, and other articles

Example: wire $\varnothing = 1/8$ in. (0.125 in.)
Then, allowance = $5/16$ in. (0.3125 in.)



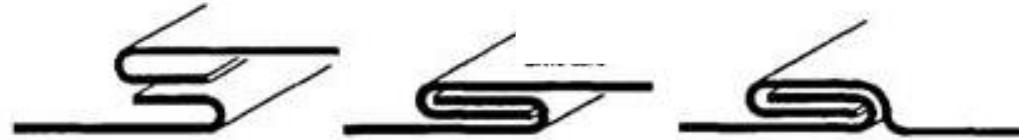
Fabrication of Edges, Joints, Seams, and Notches



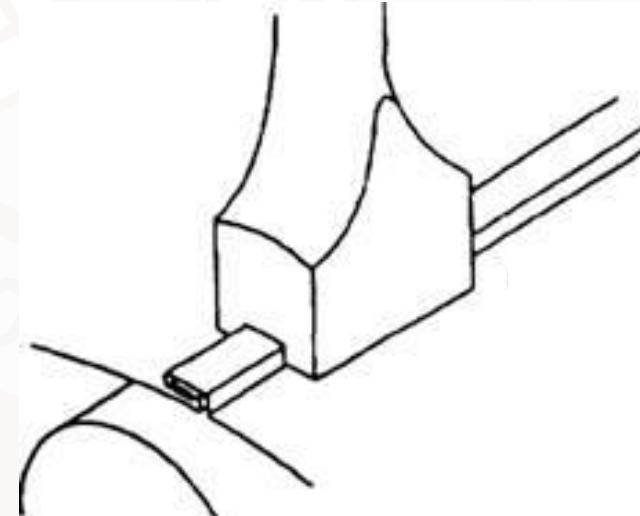
- The **Grooved Seam Joint** is one of the most widely used methods for joining light- and medium-gauge sheet metal.
- It consists of two folded edges that are locked together with a hand groover.



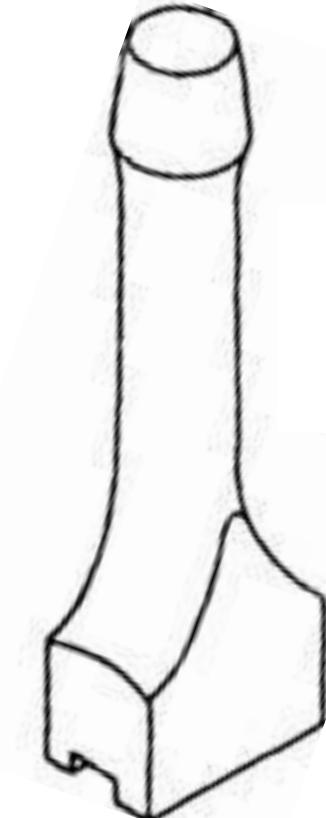
Fabrication of Edges, Joints, Seams, and Notches



Grooved Seam Joint.

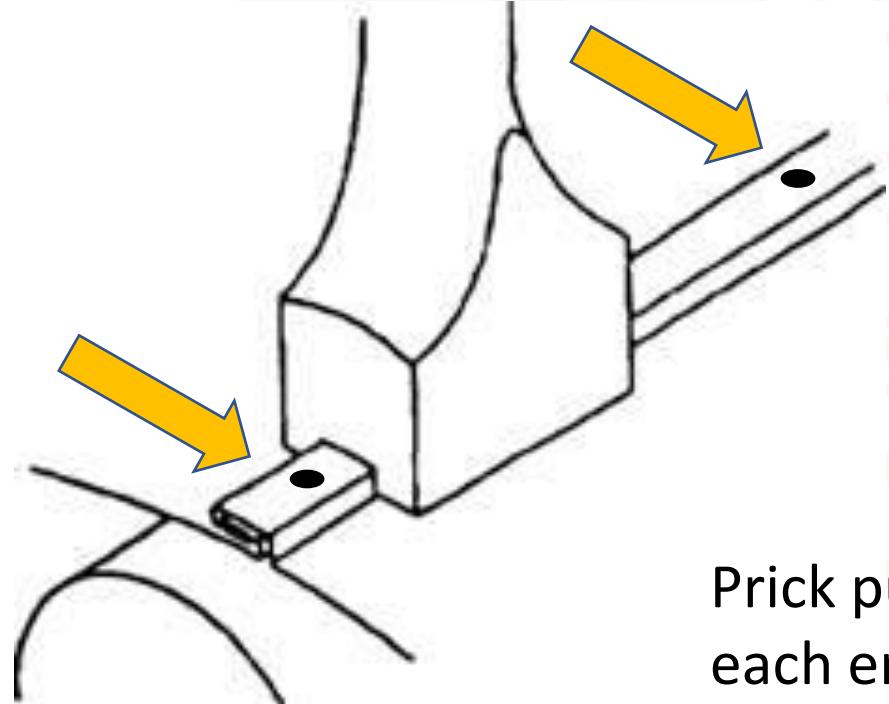


Locking a Grooved Seam Joint.





Fabrication of Edges, Joints, Seams, and Notches

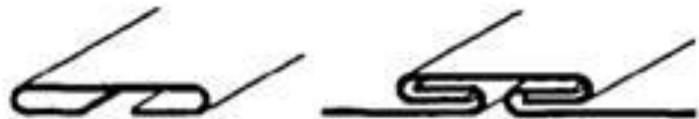


Prick punch Approximately $\frac{1}{2}$ in. from each end of the joint





Fabrication of Edges, Joints, Seams, and Notches



- The **Cap Strip Seam** is often used to assemble air-conditioning and heating ducts.
- A variation of the joint, the **Locked Corner Seam** is widely accepted for the assembly of rectangular shapes.



Fabrication of Edges, Joints, Seams, and Notches

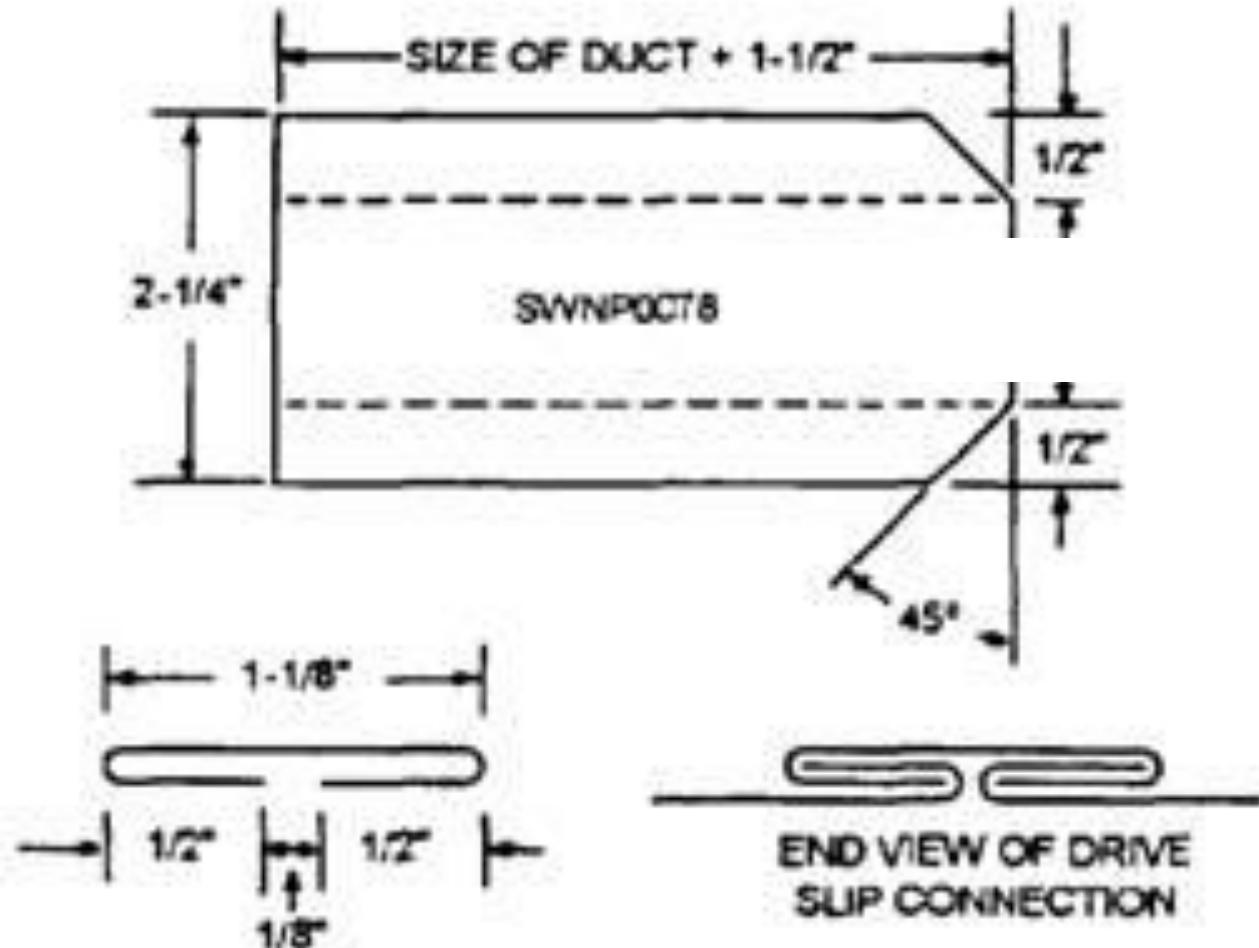


END VIEW OF DRIVE
SLIP CONNECTION

- A **Drive Slip Joint** is a method of joining two flat sections of metal.



Fabrication of Edges, Joints, Seams, and Notches



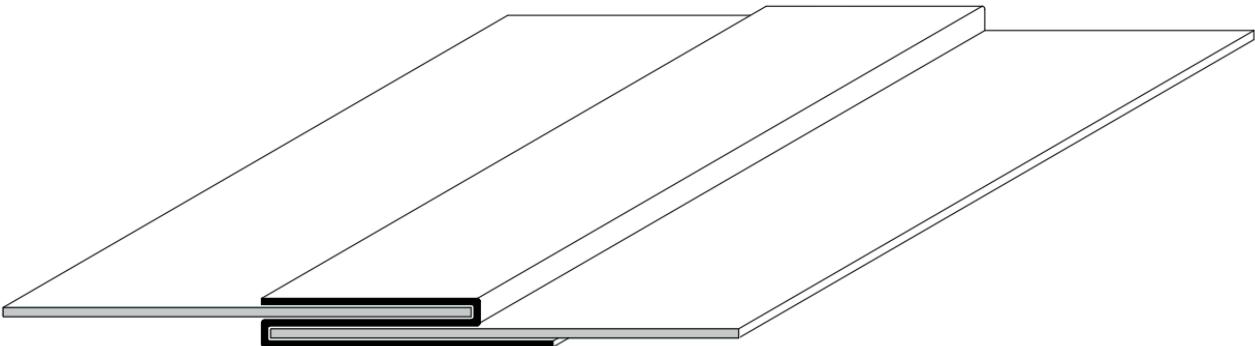
▪ **End notching** and dimensions vary with application and area practice on all locks, seams, and edges.

Drive slip pattern and connections





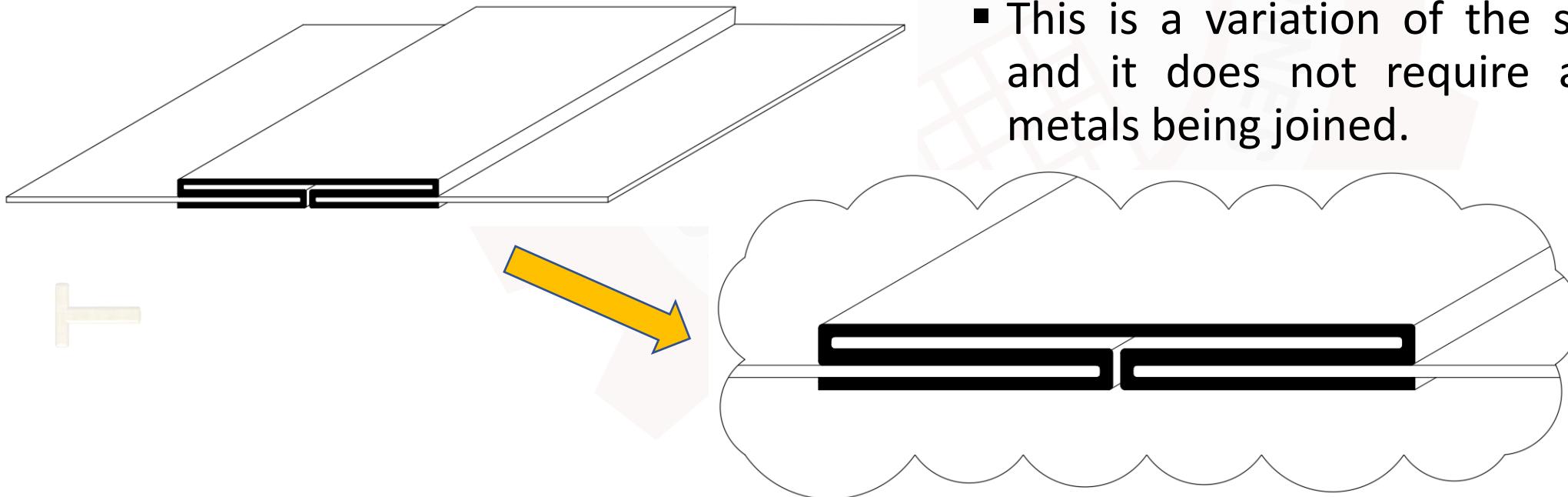
Fabrication of Edges, Joints, Seams, and Notches



- "**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.

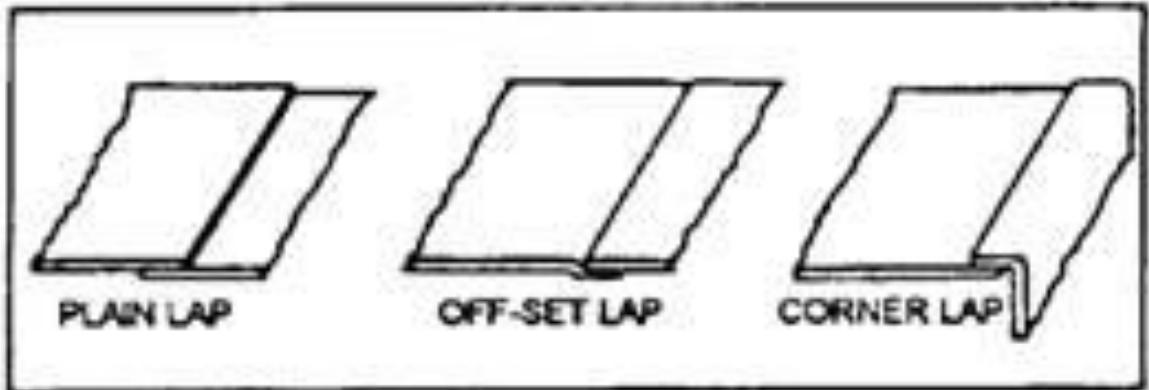


Fabrication of Edges, Joints, Seams, and Notches





Fabrication of Edges, Joints, Seams, and Notches



- Many kinds of **seams** are used to join sheet-metal sections.
- The folds can be made by hand; however, they are made much more easily on a bar folder or brake.
- The joints can be finished by soldering and/or riveting.

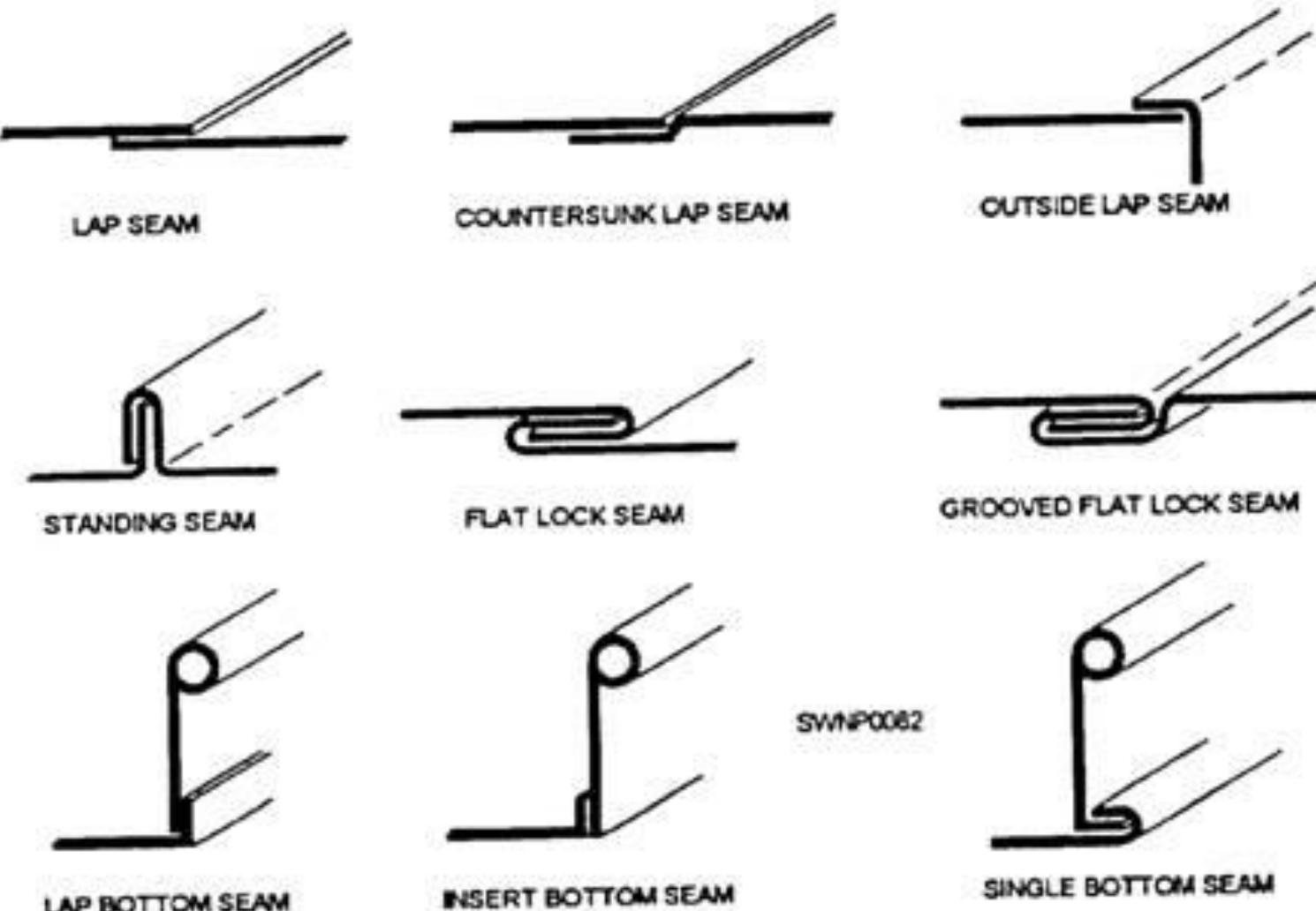


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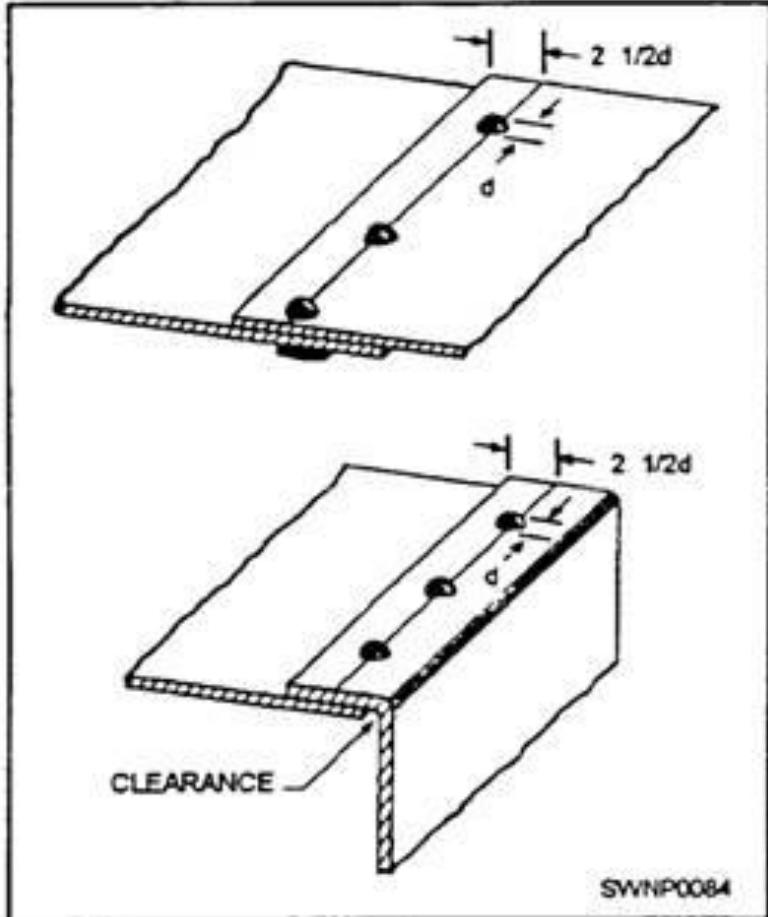


Variations of Seam





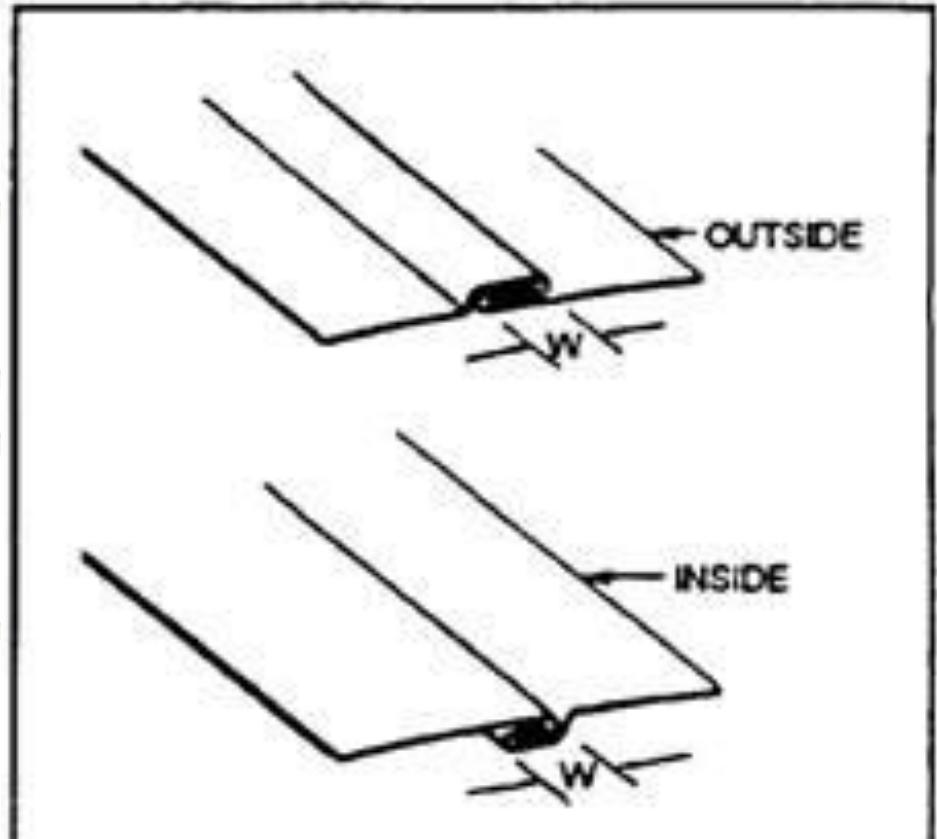
Fabrication of Edges, Joints, Seams, and Notches



- To figure the allowance for a lap seam, you must first know the diameter of the rivet that you plan to use.
- The center of the rivet must be set in from the edge a distance of $2 \frac{1}{2}$ times its diameter; therefore, the allowance must be five times the diameter of the rivet that you are using.



Fabrication of Edges, Joints, Seams, and Notches



- **Grooved Seams** are useful in the fabrication of cylindrical shapes.
- There are two types of grooved seams- the **outside** grooved seam and the **inside** grooved seam.

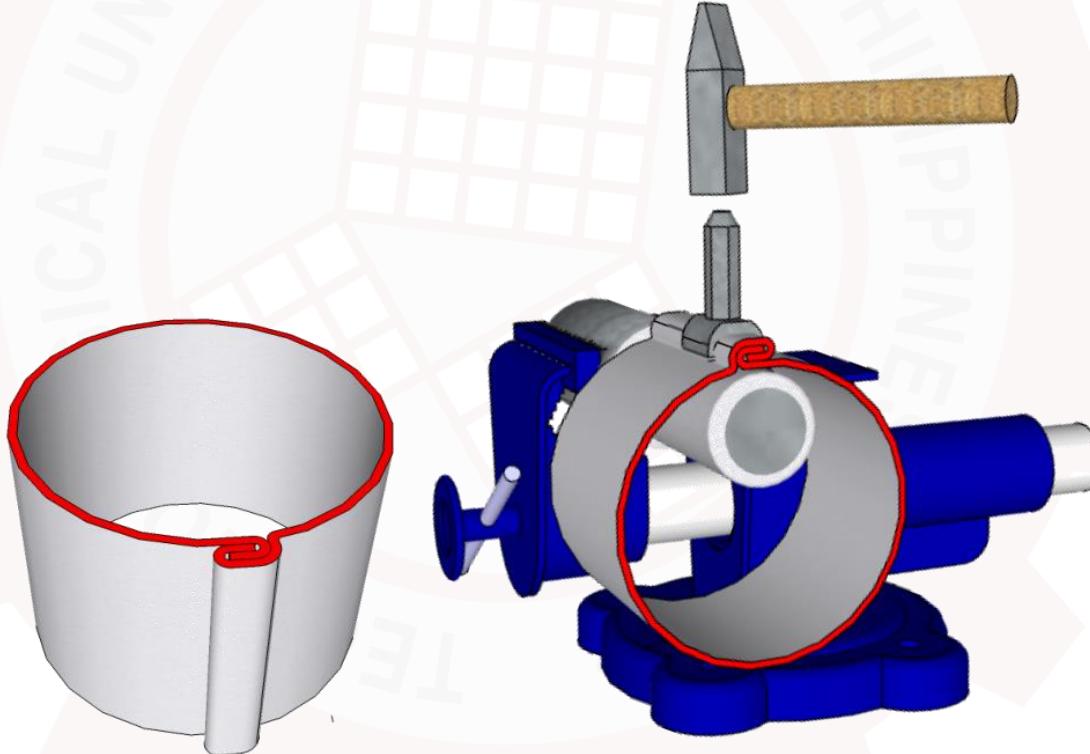


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Fabrication of Edges, Joints, Seams, and Notches



T U P





Fabrication of Edges, Joints, Seams, and Notches

- The allowance for a grooved seam is three times the width (W) of the lock, one half of this amount being added to each edge.
 - For example,
 - if you are to have a 1/4-inch grooved seam,
 - $3 \times 1/4 = 3/4$ inch, or the total allowance;
 - $1/2$ of $3/4$ inch = $3/8$ inch, or the allowance that you are to add to each edge.



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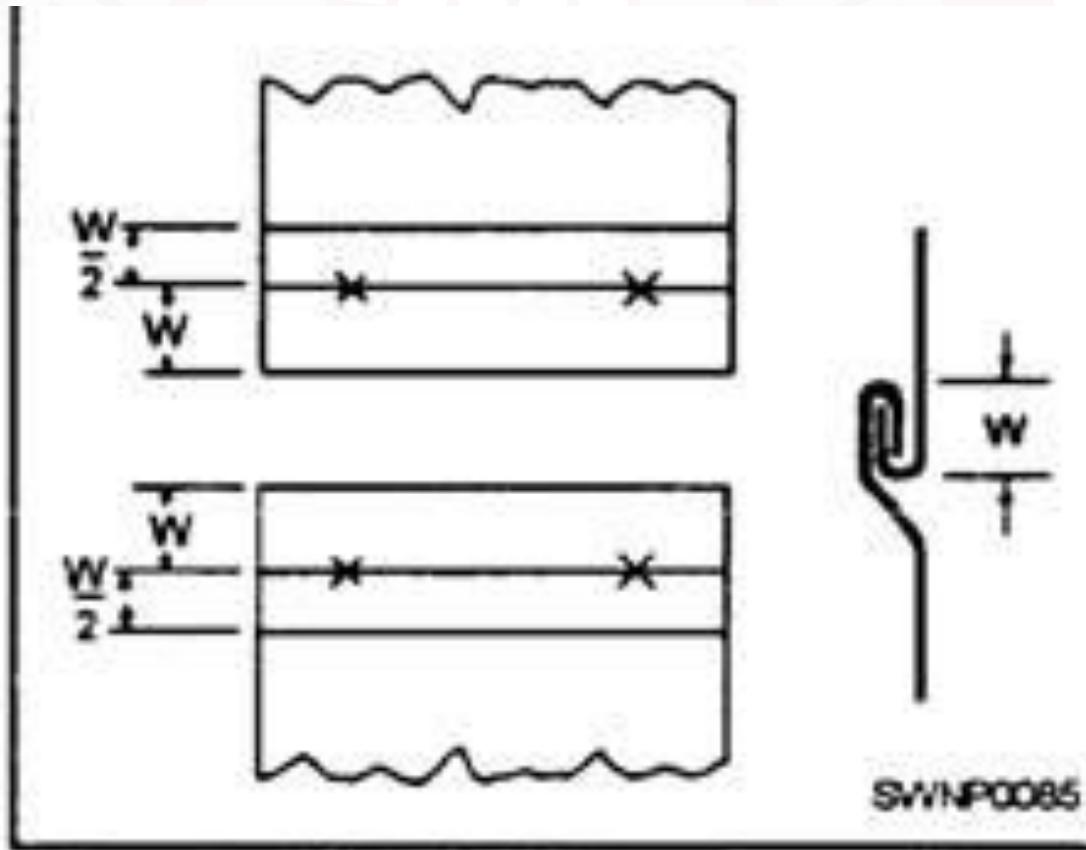
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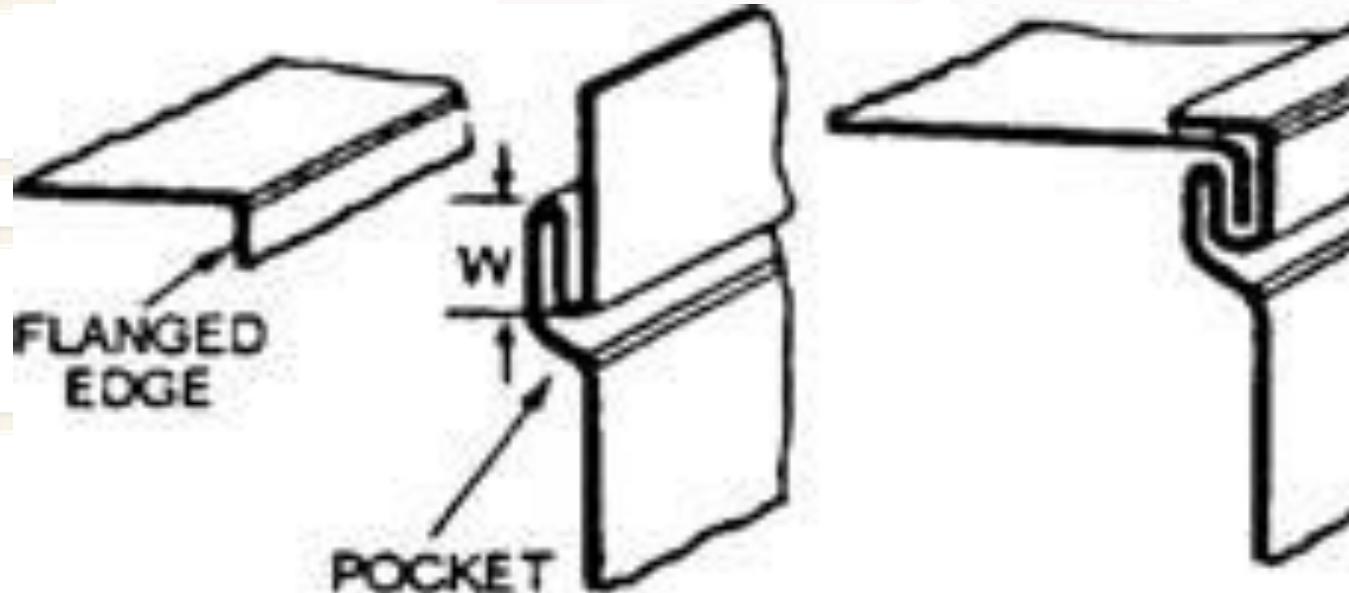
Fabrication of Edges, Joints, Seams, and Notches





Fabrication of Edges, Joints, Seams, and Notches

- The **Pittsburgh Lock Seam** is a corner lock seam.



- Used as a lengthwise seam at corners of square and rectangular pipes and elbows as well as fittings and ducts.



Fabrication of Edges, Joints, Seams, and Notches

- Notching is the last but not the least important step to be considered when you are getting ready to lay out a job.
- A **Square Notch** is likely the first you will make.
- This type of notch will result in butt corners.

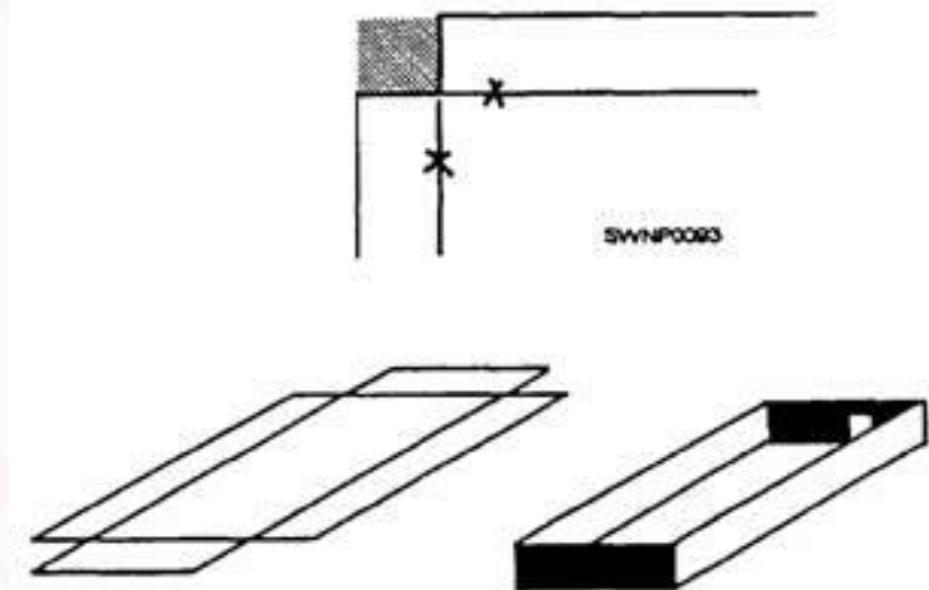
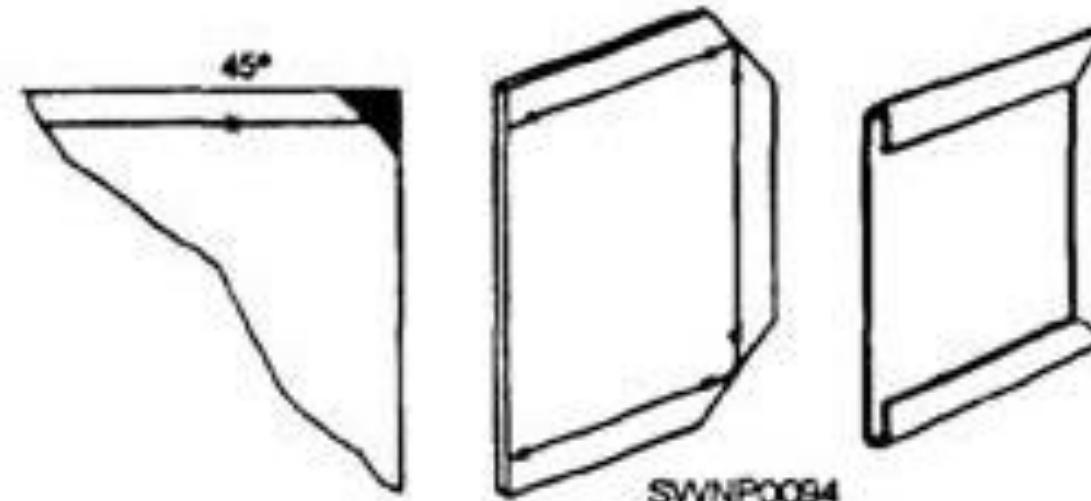


Figure 2-76.—Square notch.



Fabrication of Edges, Joints, Seams, and Notches

- **Slant Notches** are cut at a 45-degree angle across the corner when a single hem is to meet at a 90-degree angle.





Fabrication of Edges, Joints, Seams, and Notches

- A V-notch is used for seaming ends of boxes.

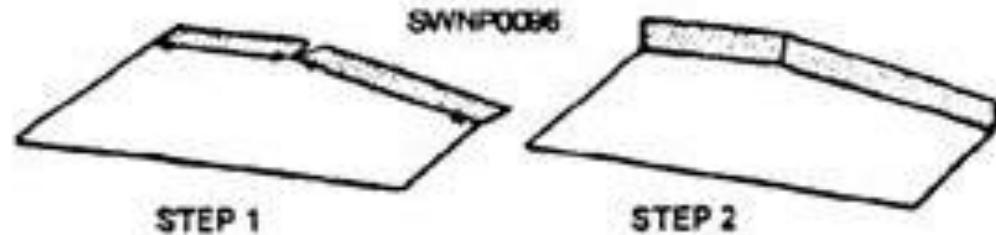


Figure 2-79.—Modified V notch.

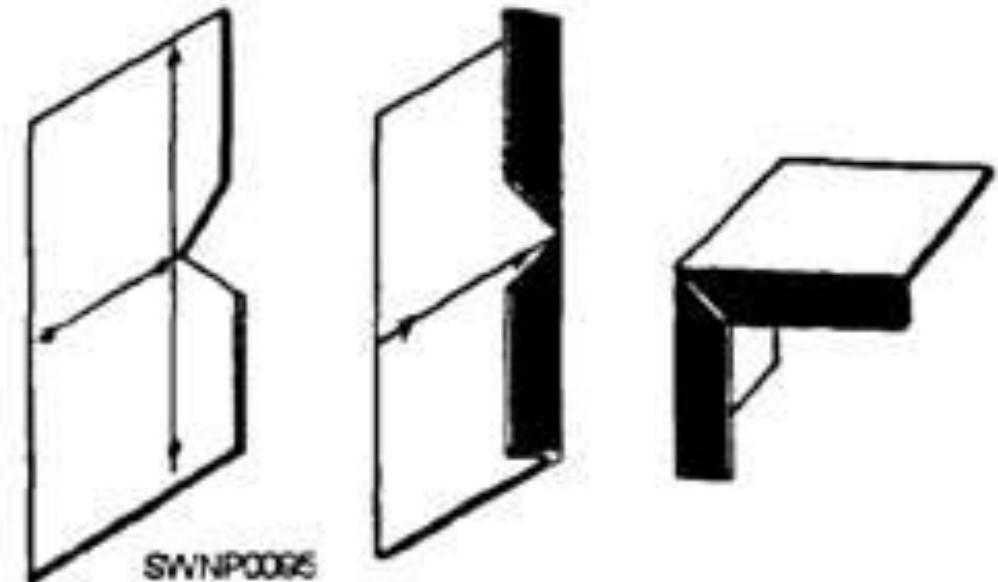


Figure 2-78.—V notch.



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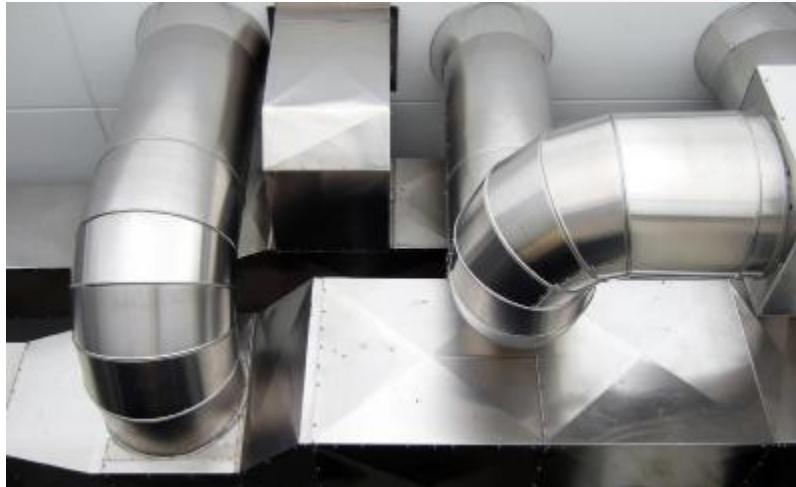


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