TRADE OF

Industrial Insulation

PHASE 2

Module 1

Sheet Metal and Insulation Fundamentals

UNIT: 6

Marking, Cutting, Punching, Rolling, Seam Swaging & Screwing

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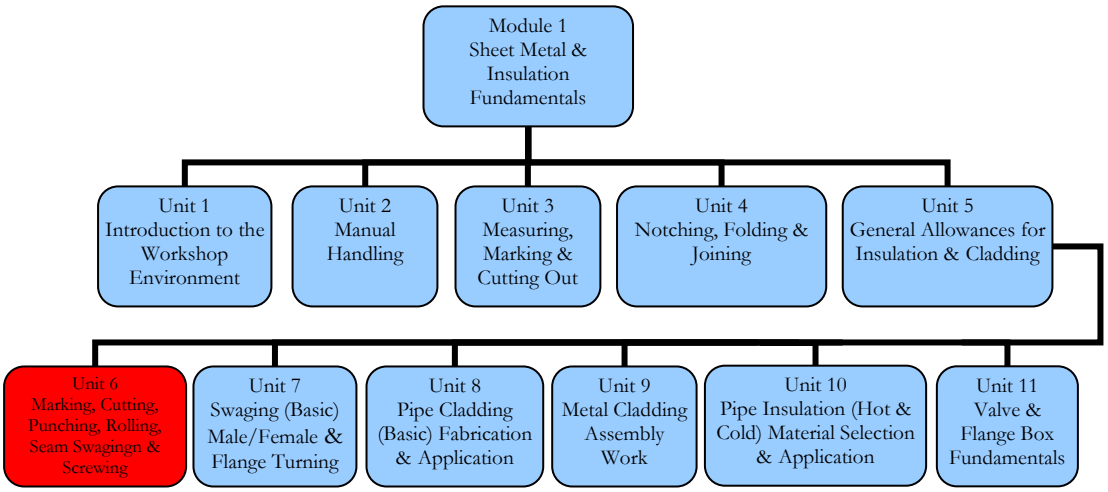
Introduction

The industrial insulator must have a good general knowledge of engineering drawing and surface developments in order to mark out patterns on sheet metal. The manufacture of a particular fitting requires a number of different steps which the apprentice needs to complete in order for the fitting to fit together correctly. Related knowledge regarding the use of similar materials in industrial cladding is very important as it reduces the risk of costly repairs later on in years.



Unit Objective

By the end of this unit ***each apprentice*** will be able to:

- Fabricate a scratch gauge.
- Mark holes centres.
- Punch Holes.
- Roll cylinderical pipes.
- Use a swager and swage pipes.
- Join pipes using self-tapping screws.

1.0 Marking Out

Key LearningPoints

- Interpretation of drawings.
- Identification and application of a scratch gauge. Scratch gauge drawing and fabrication techniques.

Marking out a pattern or development is the first step in the manufacturing of any fitting or duct section. As mentioned in ***Module 1 –Unit 3- section 1.1*** the marking out tools are generally:

- Circumference Square.
- Steel Rule.
- Scriber.
- Large and small dividers.

1.1 Working Drawings

Before the apprentice starts to mark out a particular fitting or part it is important that he/she fully understands the drawing of the job. Drawings that include all the information necessary to make an object or fitting are known as 'working drawings'. The information required usually includes: dimensions, a title, a scale, a projection symbol, and the name and finish of the materials to be used.

Working drawings are usually based on orthographic projection, but pictorial drawings can also be used. The choice depends on the complexity of the object or fitting and for whom the drawing is intended. For example, a designed might give a dimensional freehand sketch of a component to a technician to manufacture , whereas if details of the same component were being sent to a complete stranger, an orthographic working drawing would probably be used.

Refer to Module 2 – unit 2 – Orthographic Projection.

1.2 Scratch Gauge

A very handy tool that every apprentice should have in his toolbox is a scratch gauge. They can be purchased from any good tool shop or the apprentice can make one himself. The scratch gauge is a section of sheet metal with notches cut into it which represent accurate set measurements decided upon by the individual apprentice. Some common measurements would be:

- 3 to 8 mm – allowance for the male/female swage.
- 10mm – general allowance for a safety hem.
- 10.5mm – allowance for an 8mm groove joint.
- 20mm – allowance for a lap joint.

- 25mm – allowance for a mezz flange section on a duct fitting.

1.3 Fabricating a Scratch Gauge

1. Decide on which measurements are most common to the job.
2. Cut a piece of material approximately 50mm x 100mm long.
3. On one of the long sides of the blank mark each measurement with a steel rule starting with the smallest.
4. Scribe a 6mm line perpendicular to the measurement lines – this will become the depth of the scratch gauge.
5. From the start of each measurement line, notch up and across to the 6mm point.
6. Continue this process with the other measurements.
7. Using the scratch gauge scribe each measurement onto a scrap piece of material and check each measurement with a steel rule for accuracy.

2.0 Marking and Punching Holes

Key Learning Points

- Fixing hole punching using 3.3mm hand punch and hand punch techniques.
- Hand punch disassembly and tool changing.
- Multi punch setup and operation. Hazards associated with a punching machine.

The position of rivet and screw holes in a pattern development determines the strength, appearance and the overall quality of the job. A number of important considerations to take into account when marking and punching holes in a pattern are:

- Light material is usually punched while heavier material is drilled. Drilling is more accurate and tends to distort the metal less.
- The size of the hole depends on the rivet or screw size.
- Holes should be spaced accordingly to the specification of the job.
- Screws and rivets used should not corrode or contaminate the parent metal.

2.1 Spacing Rivet and Screw Holes

The apprentice should take the following considerations when spacing rivet and screw holes:

- Holes should be spaced accordingly to the job specification.
- The distance from the edge of the material to the centre of the hole should be at least twice the diameter of the hole to prevent tearing of the material.
- The minimum distance between holes should be at least three times the diameter of the hole.
- The maximum distance between holes should never be such that the material will buckle between the screws or rivets.

2.2 The Hand Lever Punch

The hand lever punch is used for punching holes in light gauge sheet metal. The operation of all hand lever punches is the same but the method of changing dies and punches can differ. In general the punches and dies are changed with the following steps:

1. Remove the die with a screwdriver or key provided.
2. Open the punch.
3. Remove the threaded collar.

4. Remove the punch from the collar.
5. Replace the correct size punch in the collar.
6. Replace the threaded collar.
7. Return the levers to the original position.
8. Replace the correct size die.
9. Adjust the die with a screwdriver until the punch just barely punches a clean hole.

2.3 Punching Holes in Sheet Metal

The following method should be used for marking and punching holes in light gauge sheet metal.

1. Space the hole centers as per the job specification and as mentioned in section 2.1.
2. Set the depth gauge on the hand lever punch to line up the die over the centerline of the hole.
3. Press down firmly on the top lever of the punch until the die punches a clean hole through the material.

2.4 Multi Punch Machine

The multi punch machine is used for simultaneous punching of several holes for screw connections to blanks for sheet metal cladding and insulation.

The multi punch machine is driven by means of a foot pedal. The punching units serve to take up the hole cuts (stamps and matrices) and are arranged on the machine table so they can be moved to suit different hole centres. The number of punching units and the diameter of the holes (2.5mm to 6mm) can be adapted to the respective needs.

The distance of the holes from the edge of the sheet (overlapping) is continuously adjustable by width stops. A variable pull out table extension guarantees stable support for the sheets to be punched.

Setup and Operation

The following procedures should be followed when setting up and operating the multi punch machine:

1. Set the punches on the machine to the required distance apart.
2. Set the back stop on the machine to the required hole centres from the edge of the sheet and clamp in place. Ensure that the overlaps on both side of the sheet are correct and that the hole centring will not interfere with the next fitting which may be attached.
3. Pull out the table extension so as to rest the sheet when punching.
4. Ensure that the work area is clear of waste materials.
5. Ensure that the operating pedal in extended out enough to allow for ease of operation.

Safety Procedures

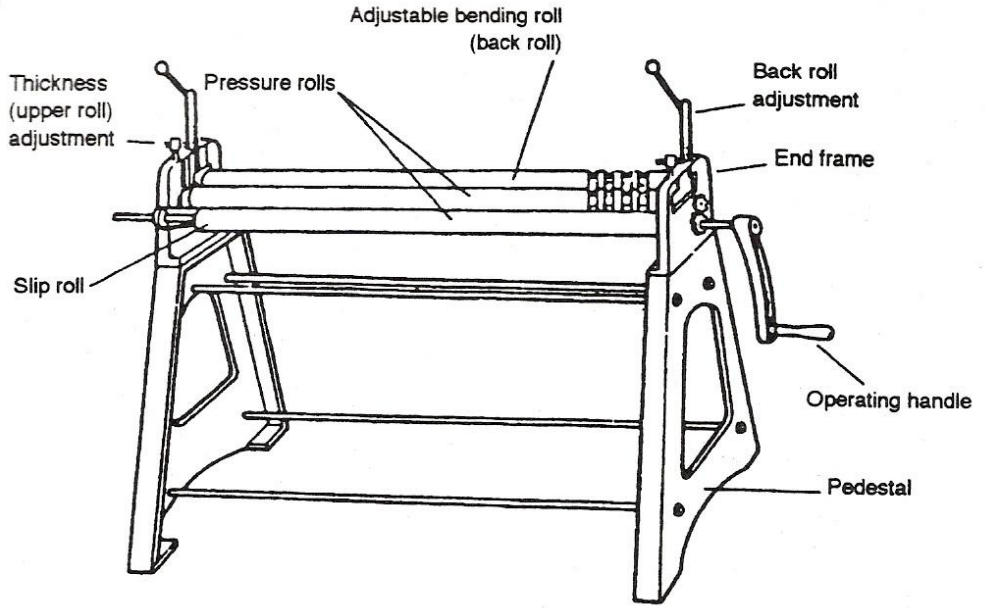
- Wear personnel protective equipment when using this machine.
- Ensure that electrical cabling on the machine is in good condition.
- Never place fingers under the individual punches.
- Use proper manual handling techniques when carrying and lifting sheets of materials .
- Keep the work area clean and tidy.
- Read the manufacturers' instructions before operating any machinery in the workshop.

3.0 Rolling

Key Learning Points

- Hand operated and power rollers set up and safety procedures.
- Rollers operation and metal rolling.
- Safe machine operation. Personal attitude to the safe use of tools.

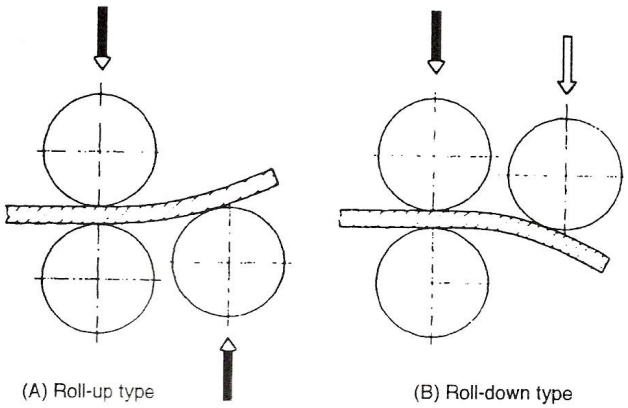
The basic types of rolls used in the sheet metal shop are known as "pinch" type rollers. These machines have two front rollers which lightly grip or "pinch" and draw the sheet through, and a free roller at the back to "set" the metal to the desired radius.



Sheet metal Bending Rolls

There are two kinds of pinch type rollers:

- The Roll-up type – These machines have adjustment in a vertical direction on the top or bottom pinch roll, and in an upward direction on the back roller. This type of machine will roll any size of curvature above the size of the top roll.
- The Roll-down type - These machines have adjustment in a vertical direction on the top or bottom pinch roll, and in an downward direction on the back roller. This type of machine will not roll more curvature than will pass beneath the pedestal frame of the machine.



Pinch-Type Rollers

3.1 Rolling a Cylinder

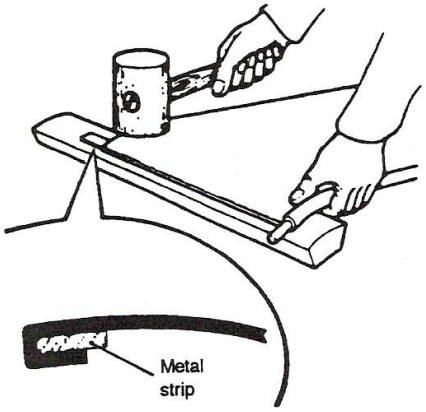
The first operation when working with light metal should be to 'break the grain' of the metal to prevent ridges forming on its surface. This consists of rolling the piece of metal backwards and forwards a few times in the rolls, reversing the bending each time. This process will ensure that the article to be formed by rolling will have a smooth surface free from kinks. If this 'breaking' operation is not carried out, a cylindrical or conical article develops ridges around the shaped body which, if not seen, may be more easily felt by passing the palm of the hand over the rolled surface.

It is good practice always to break the grain, especially on metals which have been 'cold reduced' before commencing forming operation by rolling.

Once the breaking operation is completed the pattern or blank should be rolled out flat in readiness for forming operations.

Pre-Forming

When we roll metal into a cylindrical shape the edges may not curve the same as the rest of the cylinder. We may get two flat bits either side of the joint. To prevent this we perform the metal. This can be done by tapping the edge over a round bar with a mallet as shown.



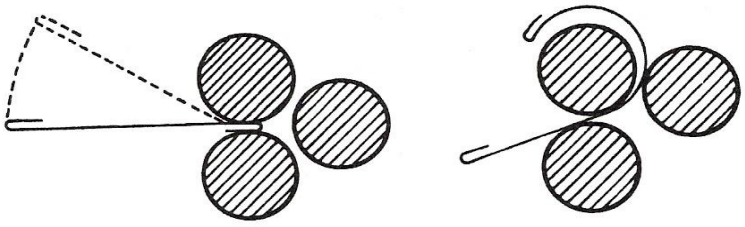
Fit metal strips in groove folds to prevent closure.

The break press is used to preform heavier metal e.g. 3 mm steel.

Preforming

Forming Cylinders

The forming process is begun by inserting the work piece between the two front rolls as shown.



The front rolls are adjusted by turning the knuckled adjusting screw on the machine. The front rolls should be adjusted to allow just enough clearance between the rolls to avoid crushing the locks.

After the work piece is inserted, it is tilted upwards as indicated by the diagram. This begins the curve and allows the work piece to pass between the upper and rear roll.

For a large radius, the rear roller is lowered and for a small radius, the rear roll is raised. The rear roll is adjusted by the two adjusting screws located at the rear of the gear housing at either end of the machine.

Safety

The following precautions should be taken when using a hand operated or power operated rolling machine.

1. Before using the rolling machine check all lubricating points, and use the recommended lubricant. Frequent lubrication is necessary to ensure long and dependable use of the machine.
2. Always wear personnel protective equipment: Boots, overalls and gloves.

3. Ensure that the work area around the machine is clean.
4. Tie up any loose clothing and jewellery so as to avoid them being caught up in the machine.
5. Ensure that the rolling machine is powered off during the setting up process so as to avoid accidental start up of the machine.
6. If a second person is required for rolling large cylinders explain clearly the procedures that will take place during the rolling process and make sure he/she fully understands the safety precautions to be undertaken.

It is important that the apprentice understands the safety precautions required when using machinery and tools in the workshop, and that he/she develops a positive attitude towards their own safety and the safety of others.

4.0 Swaging

Key Learning Points:

- Identification of swager parts and safe operation.
- Seam swaging techniques for pipes.
- Form wheel variation and effects on metals.
- Hazards associated with rollers, swagers and hand tools.

Swaging is a method used to raise a moulding or swage on the surface of sheet metal. A "swage" is produced by a pair of contour rollers. Swaging wheels are available in a large variety of contours to fit a swaging machine which can be either hand or power operated. The advantages of the swage are:

1. It stiffens the edge of a pipe or cylinder.
2. It strengthens a pipe or cylinder.
3. It acts as a stop when one pipe is slipping into another.
4. It adds a good appearance to the job.

Refer to Module 1 – Unit 7 – Section 2.0

5.0 Self tapping Screws

Key Learning Points:

- Screw types, applications and relative hole diameters.
- Fixing techniques.
- Compatibility of self tapping screws & metals.

Sheet metal fabrications are often held together by means of self tapping screws.

A range of screws are available and are supplied with a variety of head shapes. Self tapping screws with Philips heads are often preferred to those with straight screw driver slots. A self tapping screw as its name implies, cuts its own thread in holes of suitable diameters punched or drilled in sheet metal. Some precautions to be aware of when using self tapping screws:

1. Ensure the hole is the correct size before installing the screw.
2. Make sure the head of the screw driver is the correct size for the screw.
3. Do not apply too much pressure to the head of the screw as the screwdriver can slip and cause you injury.
4. Ensure that the screw been used will not corrode with the parent metal.
5. Wear appropriate personnel protective equipment i.e gloves.

5.1 Metal Screws

Since World War II, the self –tapping has in many cases taken the place of more conventional fastenings and has justified itself completely in all areas of the industrial insulation business. It is a very hard steel screw designed for joining metal sheeting and different metal components. The screw is inserted in a pre-drilled hole and cuts its own thread in the metal, thus making a very secured joint. Screws are available in stainless steel and steel in many different finishes. The types of screws available are:

- Countersunk.
- Round-head.
- Raised countersunk.
- Pan-head.
- Mushroom head.
- Hexagon head.

Most have a single slot for insertion of a screwdriver; some, known as Posidrive heads, have a star-type slot and must be placed with a special type of screw driver which can be a hand held driver or an attachment for a power drill. Where the holding power of the screwed joint is critical, torque-measuring and torque limiting screwdrivers are used to ensure sufficient but not excessive force is developed by the screw.

Cross head counter-sunk screw.

Pan head self-tapping screw.

Slotted self-tapping screw.

Slotted countersunk self-tapping screw.

5.2 Galvanic Corrosion

Bi-Metallic or galvanic corrosion is the additional corrosion that occurs when dissimilar metals are in contact in the presence of an electrolyte. The corrosion of a metal, the anode, results from the positive current flowing from the anode to the less reactive (more noble) metal, the cathode, through the electrolyte. This process is similar to the conventional corrosion of a single, uncoupled metal but generally proceeds at a higher rate depending on the difference in electrochemical reactivity of the anode and cathode metal. The requirements for bi-metallic corrosion are as follows:

- An electrolyte bridging the two metals
- Electrical contact between the two metals.
- A difference in potential between the metals to enable a significant galvanic current
- A sustained cathodic reaction on the more noble of the???

Metal Corroding \ Contact Metal	Magnesium & alloys	Zinc & alloys	Aluminium & alloys	Cadmium	Steel-carbon	Cast iron	Stainless steels	Lead, tin and alloys	Nickel	Brasses, nickel silvers	Copper	Bronzes, cupro-nickels	Nickel copper alloys	Nickel- Chrome_Mo Alloys Titanium, silver, graphite Graphite, gold,platinum
Magnesium & alloys		X	X	X	X	X	X	X	X	X	X	X	X	X
Zinc & alloys			X	X	X	X	X	X	X	X	X	X	X	X
Aluminium & alloys				X	X	X	X	X	X	X	X	X	X	X
Cadmium					X	X	X	X	X	X	X	X	X	X
Steel-carbon				X		X	X	X	X	X	X	X	X	X
Cast iron					X		X	X	X	X	X	X	X	X
Stainless steels					X	X		X	X	X	X	X	X	X
Lead, tin and alloys							X		X	X	X	X	X	X
Nickel										X	X	X	X	X
Brasses, nickel silvers						X	X	X	X		X	X	X	X
Copper							X	X	X			X	X	X
Bronzes, cupro-nickels													X	X
Nickel copper alloys														X
Nickel-Chrome-Mo Alloys Titanium, silver, graphite Graphite, gold,platinum														

X = Galvanic Corrosion Risk

Methods of Reducing Galvanic Corrosion

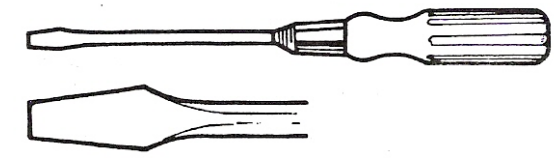
Where contact between dissimilar metals cannot be avoided the following steps should be considered:

- Select metals that are close together in the galvanic series for the relevant environment
- Avoid relatively small areas of the less noble metal and large areas of the more noble metal
- Insulate the metals from each other
- Exclude electrolyte from around the bimetallic junction e.g painting
- Paint both metals where possible: if impractical paint the most noble metal
- Provide additional corrosion allowance on the less noble metal
- Apply compatible metal or sacrificial metal coatings
- If electrical insulation is used to minimise the risk, then test for the insulation quality as part of maintenance regime

5.3 Screwdrivers

Plain Screwdriver

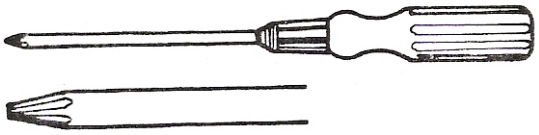
This is used primarily for tightening or loosening slotted screws. Screwdrivers are available in various lengths and with different types of handles e.g. wood, metal or plastic materials.



Plain Screwdriver

Philips Screwdriver

This screwdriver has a cross-shaped tip. This fits into the head of a screw which has a recess of the same shape. This type of screwdriver will not slip and



burr the end of the screw if the proper size is selected.

Philips Screwdriver

Summary

In this unit we have looked at a number of different processes which must be carried out in order to fabricate a cylindrical pipe fitting. Marking, cutting, punching, rolling, seam swaging and screwing are all skills which the apprentice must become proficient in, in order to be able to complete the job. He/she must also have the related knowledge when choosing different materials for a particular job. We have looked at the causes of galvanic corrosion and how different materials react and corrode each other. This type of corrosion can become a costly repair over time, but can be very easily avoided at the start of the job by taking the proper precautions.

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