7 Beaten metalwork

Introduction

Beaten metalwork is the shaping of thin sheet metals using either the mallet or the hammer. The processes are not widely used in schools, but an acquisition of knowledge and skills in this old metalwork craft will help the student greatly. The first section of this chapter covers beaten metalwork, while the second section deals with brazing and silver soldering: two processes of joining parts together to produce a number of articles in beaten metalwork.

Tools and equipment

The tools and equipment used can be found easily in other sections of the metalwork shop, but particular tools and equipment include: wooden blocks or sandbags, stakes and hammers.

The **wooden block** is a tree trunk cut and used for hollowing (Figure 7.1). In the school workshop you can use a small block of wood that can be gripped in the vice. Malleting is done on the end grain to avoid splitting the wooden block. If wooden blocks are not available, you can use sandbags.

Stakes help in shaping the metal (Figure 7.2). Some stakes can be made in the workshop. The common types include the raising stake, horse and stake heads.

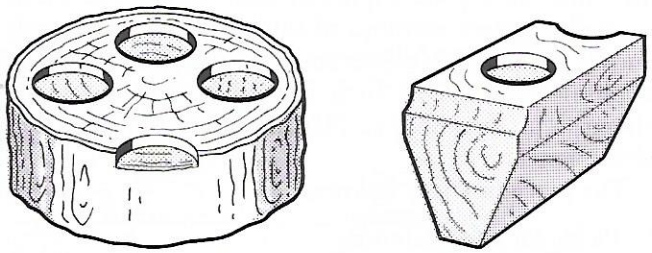

Figure 7.1 Wooden blocks.

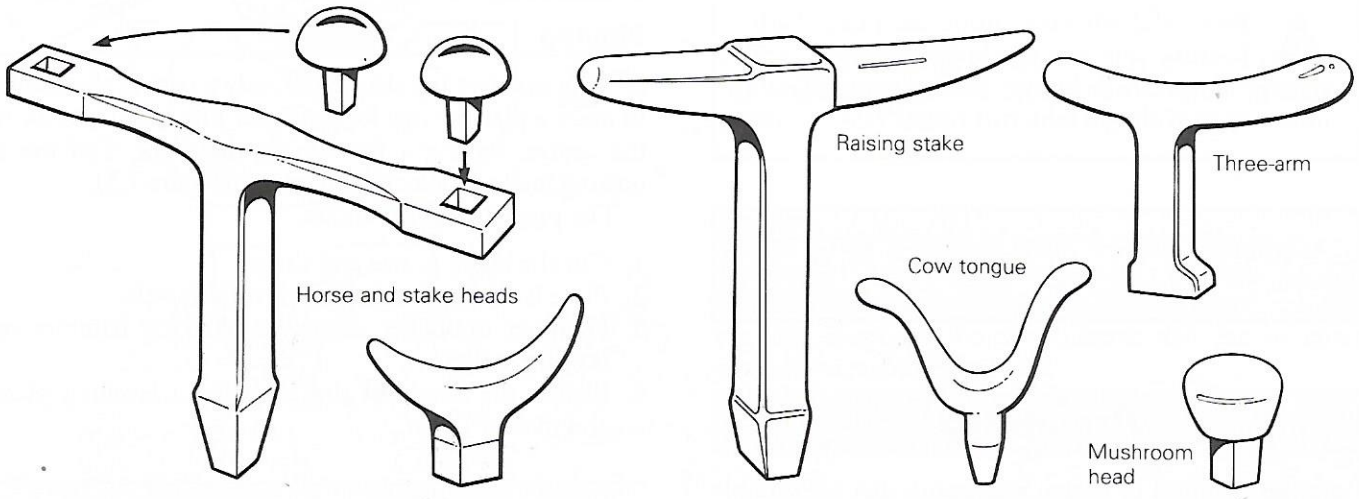

Figure 7.2 Stakes.

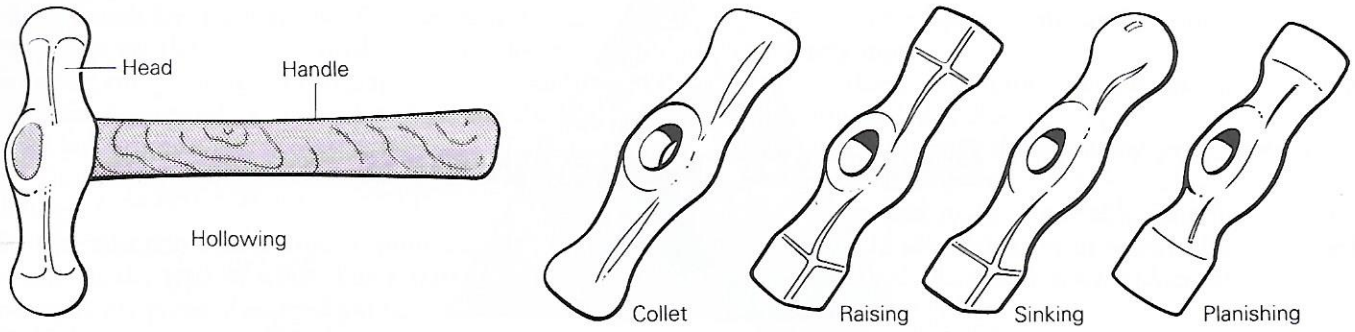

Figure 7.3 Hammers.

You must keep the faces of the stakes clean to prevent rough surfaces from damaging the work. Stakes are held either in the vice or in the hardie holes of the anvil.

Figure 7.3 shows the **hammers** that are used for the various processes discussed later in the chapter. For the best results, it is essential to choose the right hammers for the different processes.

It is advisable to clean and soften metals before and after hammering. After heating, metals are **pickled** (dipped into an acid bath). Acid baths should be near the source of a good supply of clean water. The baths normally contain mixtures of sulphuric and nitric acids but for school work we recommend that you use dilute sulphuric acid. If the bath is used hot, it should be placed in an enclosure so that the fumes produced can be extracted.

The procedure is as follows.

1. Pickle for a few minutes.
2. Remove and wash the metal.
3. Dry and clean.

▲ Be careful whenever using the pickle bath, because hot metals dipped into an acid spurt and gives off fumes. Protect yourself and others by providing a lid.

Annealing a worked metal enables it to be softened.

Processes

Processes involved in beaten metalwork that are suitable for school work are hollowing, seaming, raising, sinking, planishing and polishing.

Hollowing

Hollowing (Figure 7.4) is a simple process used to make objects such as bowls and trays. It is used for shallow shapes so that the metal is not overstretched during hammering or malleting.

The procedure for hollowing is as follows.

1. Cut the blank to shape and size.
2. Hold the piece on a wooden block or leather sandbag.
3. Hammer/mallet from the edge towards the centre.
4. Rotate the metal and continue around the circumference.
5. Repeat the process, working in concentric circles.
6. Anneal and pickle during hollowing.

You can calculate the diameter of the blank by adding the diameter and the depth of the finished bowl. For example, for a bowl 180 mm in diameter and 30 mm deep, the piece is cut from a square of side 210 mm (180 mm + 30 mm). This is only an approximation.

Sinking

Sinking involves the shaping of only a part of the blank: to make a plate or tray for example. The metal is sunk at the centre, leaving a flat rim in the work. You use a bossing mallet or blocking hammer (Figure 7.5).

The procedure is as follows.

1. Cut the blank to size and shape.
2. Place it on the forming block with dowels.
3. Hammer or mallet using the blocking hammer or bossing mallet.
4. Flatten the base and rim by using a levelling plate and mallet.

Take care to ensure that the rim and base are flat.

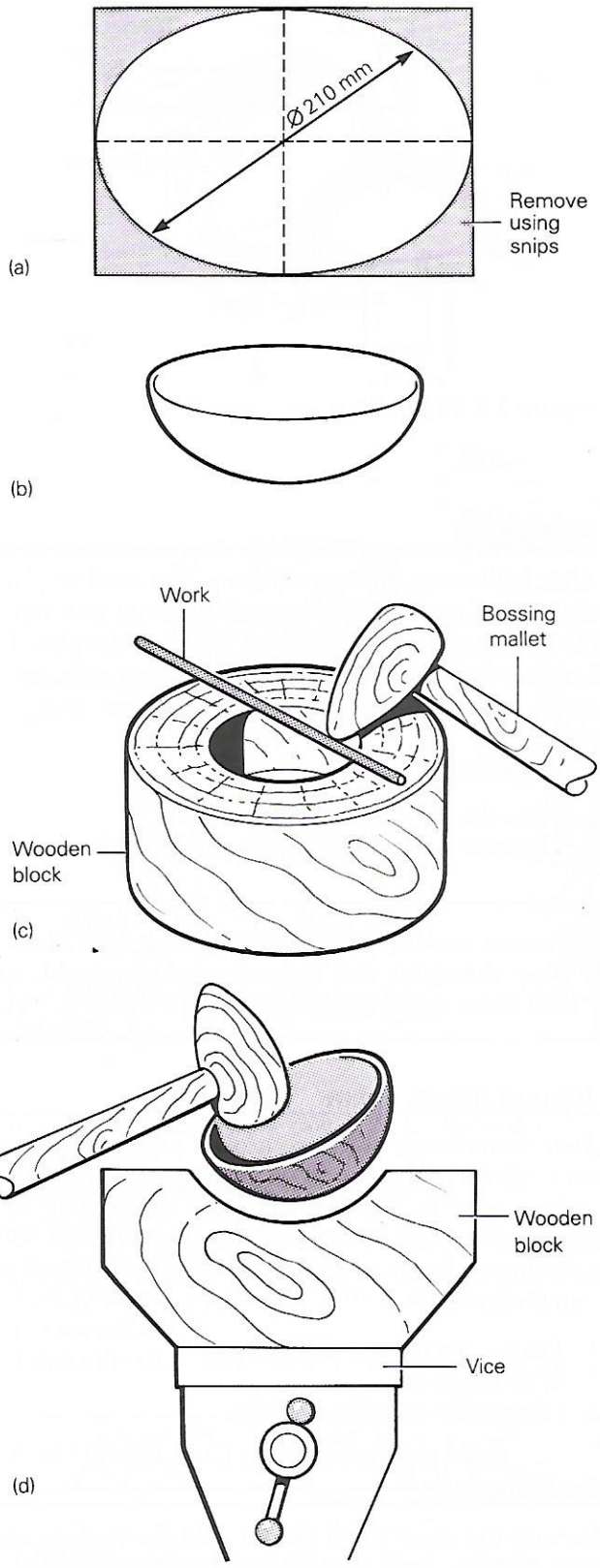

Figure 7.4 Hollowing: (a) cutting the blank piece to size; (b) shape and size of bowl; (c) malleting from an edge; (d) finishing off the hollowing.

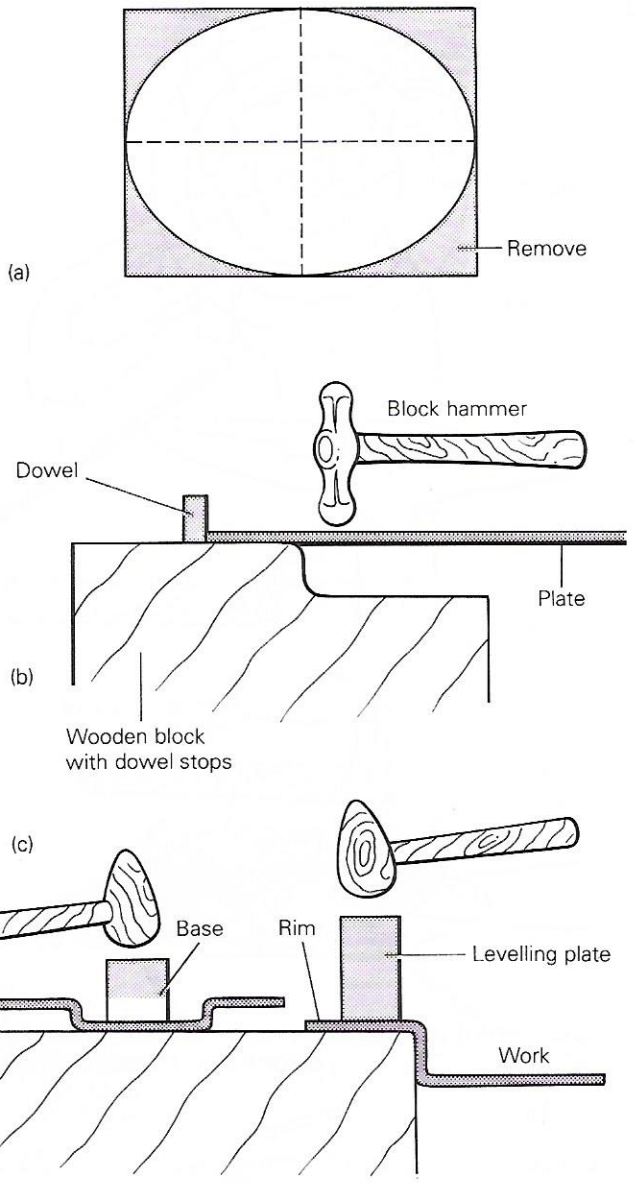

Figure 7.5 Sinking. (a) Cut to shape and size. (b) Place blank on the block; hammer using block hammer. (c) Flatten rim and base.

Raising

Raising is the forming of deep shapes (Figure 7.6). The process of raising contracts and thickens the metal. Any required shape can be raised. Items that can be raised include vases, boxes and jugs.

The procedure for raising is as follows.

1. Prepare the blank and draw concentric circles using a pencil.
2. Place the blank on the raising stake, inclined at an angle.

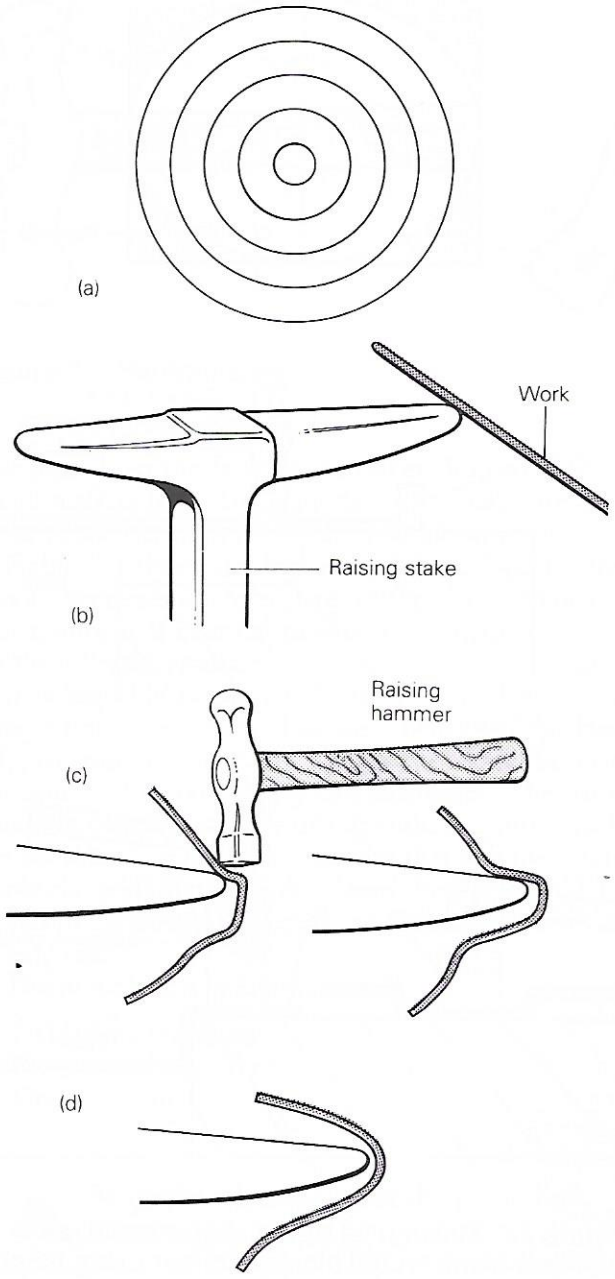

Figure 7.6 Raising: (a) blank with concentric circles; (b) work placed on the raising stake; (c) raising from the centre; (d) final stage.

3. Start from the centre and use the concentric circles as guide marks.
4. Anneal the metal after every course.
5. Planish the work (see below).

Avoid buckling and undue creasing.

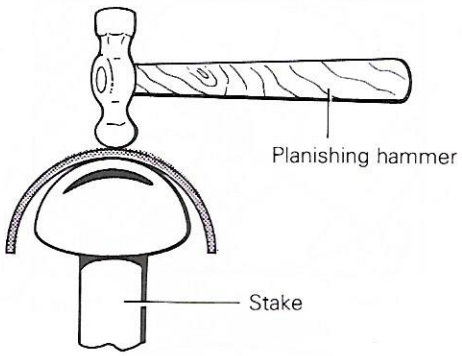

Figure 7.7 Planishing.

Planishing

After hollowing, sinking or raising, you need to planish the work (Figure 7.7), to harden the metal and improve the surface quality of the metal. You use the planishing hammer for this operation. As planishing stretches the metal, you need to take care whenever using this process.

To planish:

1. Place the work on a suitable stake.
2. Hammer it all over using the planishing hammer.

Prevent hammer marks by delivering light blows. Keep the stakes and hammers clean by polishing and greasing them regularly.

Joining a butt seam

After hammering, parts are usually joined together by hard (silver) soldering. Silver soldering and brazing are covered later in this chapter. Some seams need to be wired first (that is, bound with a piece of wire) before soldering or brazing, to avoid distortion due to expansion (Figure 7.8):

1. Prepare the joint by filing.
2. Wire the joint.
3. Silver solder or braze the joint.

Caulking

Because the sheet metal that is used for beaten metalwork is thin, it is usually thickened at the edge. In caulking, the work is given blows on the edge using the raising hammer. The advantage of caulking is that the rims become strong. The work is able to withstand distortions if other processes (such as annealing) are per-

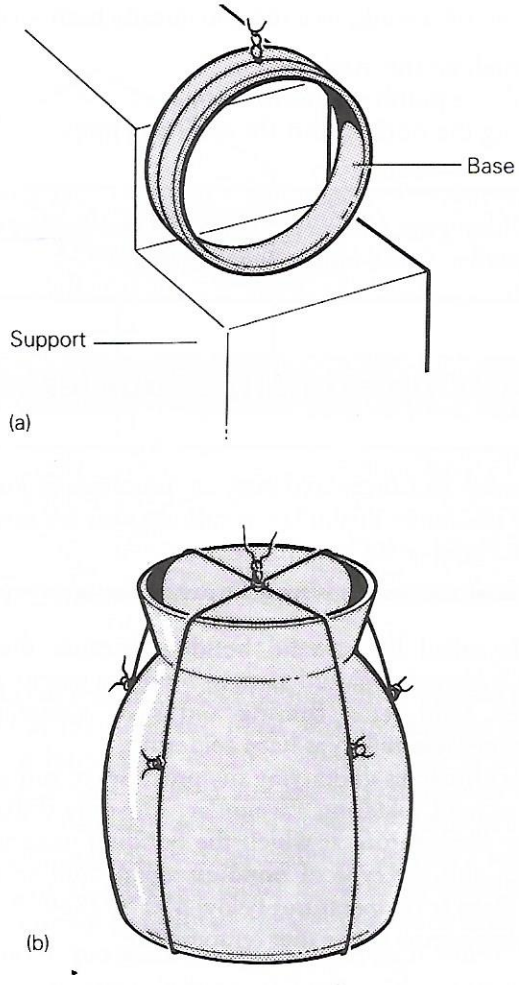

Figure 7.8 Wiring: (a) wiring the base; (b) wiring on a base.

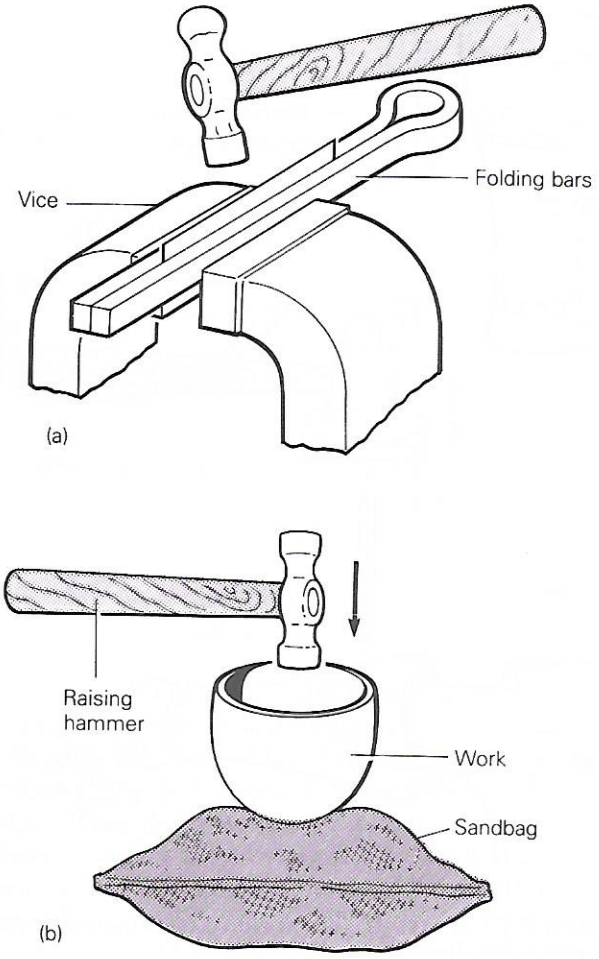

Figure 7.9 Caulking: (a) work held in folding bars; (b) work placed on sandbag.

formed on it. Raised work that is to be seamed should first be caulked.

The procedure for caulking is as follows.

1. Hold the rim in a folding bar or place the work on the sandbag (Figure 7.9).
2. Lightly hammer the edges of the work using the raising hammer.
3. Rotate the work and hammer the rims repeatedly.

> Avoid heavy hammer blows to prevent buckling.

Repoussé

In repoussé or 'chased' work, patterns are applied to the work using a number of punches. The kind of hammer used is the repoussé hammer.

The procedure is as follows.

1. Mark out the pattern or decoration to be chased or punched (Figure 7.10(a)).
2. Hold the work on a suitable stake.
3. Use a suitable chasing tool and engrave the design or pattern (Figure 7.10(b)).

> Avoid heavy hammering when chasing and punching; the tools can cut through the work.

Polishing

Any scratches or marks left on the surface of the workpiece should be carefully removed. This is not an easy exercise, so take as much care as possible. Scraping removes excess solder and scratches can be removed using water-of-Ayr stone. This is a special stone used for removing scratches from the surface of the work.

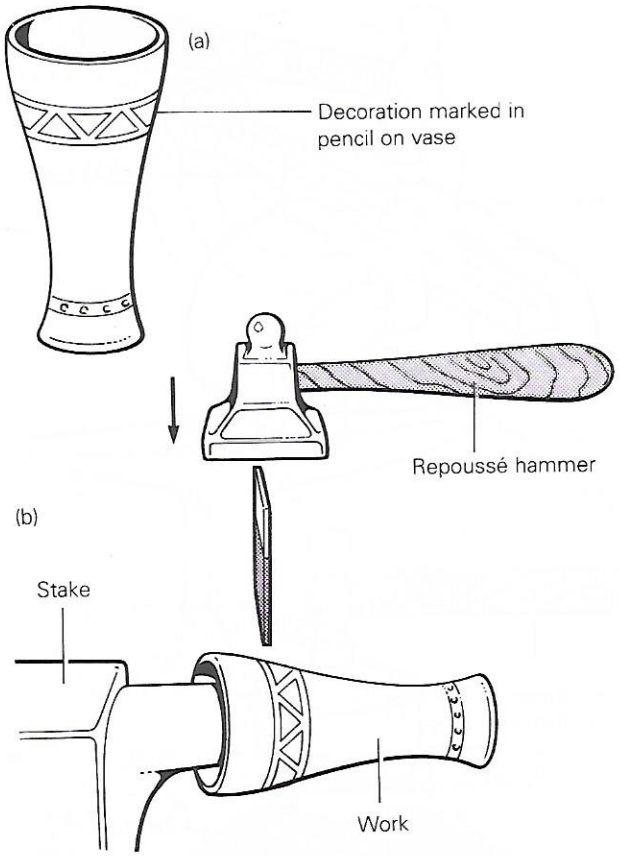

Figure 7.10 Chasing: (a) marking out decorations on vase; (b) chasing.

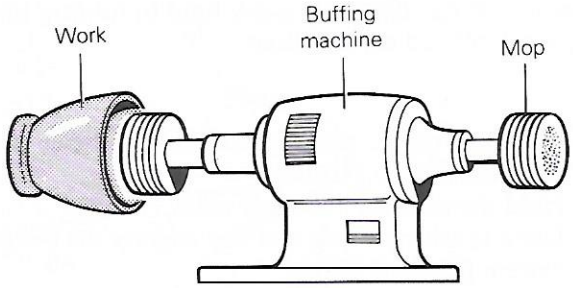

Figure 7.11 Polishing.

General polishing is, however, performed by holding the work against a revolving mop (Figure 7.11). The mops are fitted on the two revolving spindles of the buffing machine. The most common mops are made of calico and include **stitched mops** for the initial polishing, and **open mops** (unstitched) for high-class finishing.

The polish is usually supplied in bars. It consists of an abrasive material embedded in wax. The polish is forced against the mops as they rotate and is subsequently transferred to the work.

To polish a workpiece that has already been scraped:

1. Switch on the machine.
2. Rub the polish against the mop.
3. Bring the work against the revolving mop.

> Polishing the hammered work will not remove the scratches, it will only exaggerate them.

Brazing and silver soldering

> Brazing and silver soldering are processes of jointing similar or dissimilar metals together by means of a liquid–solid bonding process.

It is called liquid–solid bonding because the filler metal is heated to liquid state to bind the parent metals in their solid state. Brazing and silver soldering are sometimes referred to as **hard soldering.**

The principles underlying the processes of soft soldering and hard soldering are similar. The only differences are the temperature at which the bonding materials are melted, and the type of **bonding agent.** Soft soldering takes place at temperatures below 450 °C (840 °F); hard soldering occurs above that temperature.

Brazing

Brazing is a process in which the metals being joined are heated until they are hot enough to melt the filler metal so that it can flow into the joints.

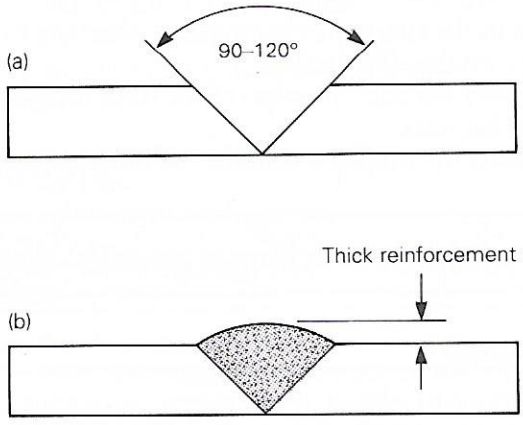

Figure 7.12 Braze welding joint: (a) preparation of vee joint: (b) completed joint.

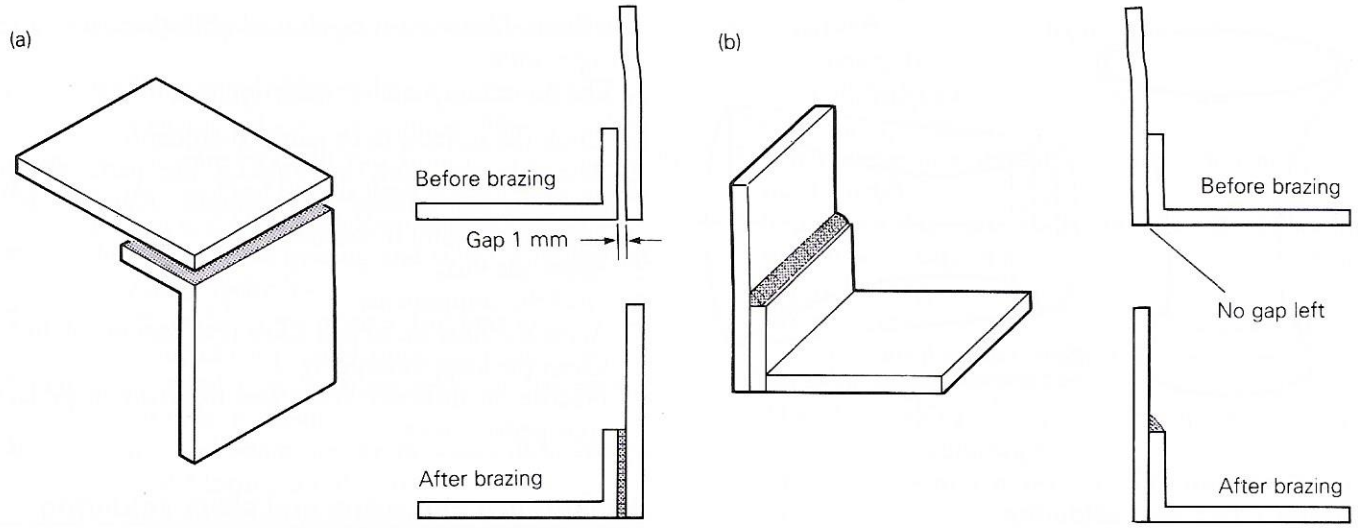

Figure 7.13 Brazing joint clearances: (a) right; (b) wrong.

In **braze welding**, a gap (groove, fillet, plug or slot) is created at the joint and filled with the molten filler to form the bond, as in welding (Figure 7.12). In **brazing**, the joint is closely fitted and the molten filler is drawn into it by **capillary action**. This is the force that pulls water up into a paper tissue or liquid up into a very fine straw. For this reason, joints for brazing must have a close clearance to facilitate the capillary attraction. If the clearance is too small or too wide the joint will be weakened. A clearance between 0.5 mm and 1 mm is ideal (Figure 7.13).

There are a variety of brazing filler metals, also called **spelters**. They are available in wire, rod, strip and powder forms. They are selected according to the material being joined, the strength required, the design of the joint, availability and cost, appearance, and the heating process used.

A brazing filler metal should: be able to 'wet' and make a strong bond on the parent metals; have a suitable melting temperature to allow the molten filler to be drawn into the joint; and be capable of producing a joint that is strong and corrosion-resistant.

The most popular brazing filler metal is **brass**, an alloy of copper and zinc. If the component is overheated, it produces a white smoke (zinc oxide). When breathed in, this can cause zinc poisoning. It is therefore dangerous to inhale the fumes. This type of brazing metal is used for brazing and braze welding of carbon steels, cast iron, galvanised iron, copper, nickel–copper alloy, and silicon bronze.

Other types of filler metal are: aluminium silicon, for aluminium; nickel alloy, for alloy steel, stainless steel, nickel and nickel–copper alloy; gold-base alloy, for stainless steel and nickel; and copper–phosphorus, for copper, silicon bronze and tungsten.

Brazing fluxes are substances used when brazing or braze welding to prevent or reduce the formation of oxides. They do not normally remove oxides that have already been formed, or remove dirt, grease and oil. The surfaces forming the joint must therefore be thoroughly cleaned.

Fluxes are sold as powder, paste, liquid, sheet or ring. Some are mixed with the filler metal, either inside it or on the outer part. A paste flux is the most popular. It adheres well to the joint when applied. The powder flux is either spread on the joint or the end of the filler metal is dipped into it in the container. A liquid flux may be added to the fuel gas so that it is deposited wherever the flame is applied.

A flux should dissolve readily, and improve the fluidity of the filler metal. It must keep the metal clear from oxides until the brazing metal flows through and adheres to the metal to be joined.

Some commonly used fluxes are borax (boric acid), borates, fluorides, fluoroborates, chlorides and alkalis. Borax is the most popular. It is used for all metals, except aluminium and its alloys and magnesium alloys.

> ▲ Most fluxes are corrosive. When you use them you must wash the joint immediately to remove all the flux residue. Do not use corrosive fluxes for brazing electrical components.

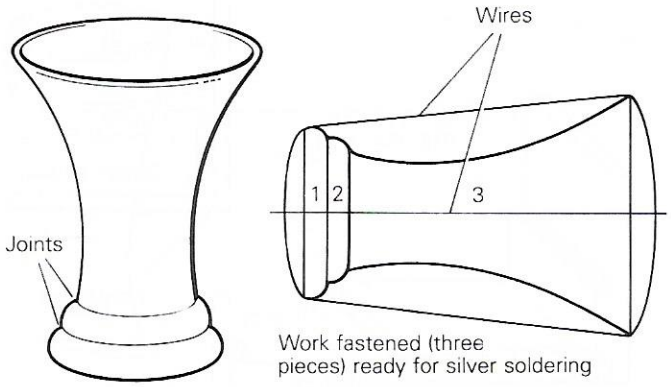

Figure 7.14 Silver soldering.

The same set of oxyacetylene equipment is used for both brazing and silver soldering. An oxidising flame is suitable for brazing (Figure 10.16). There is also a special unit called the **brazing hearth**, which can be used for brazing and silver soldering.

The procedure is as follows.

1. Clean all the surfaces to be brazed.
2. Choose the correct filler metal and the appropriate flux.
3. Arrange the workpieces carefully, ensuring that they are properly aligned and fitted together.
4. Apply the flux to the work and the filler metal.
5. Preheat the work by 'playing the flame' (not the end of the cone) over the surface. This ensures uniform temperature (heating) of the work.
6. Apply the filler metal and allow it to melt and flow completely into the joint.
7. Clean the joint and the surrounding metal to remove all the flux residue or debris.
8. Practise this operation until you become competent.

Silver soldering

The purpose and process of silver soldering are the same as for brazing. The difference between the two processes is in the filler metal used. The filler metals used for silver soldering have elements of silver in them. The two common types of silver soldering filler metal are composed of: (a) silver, cadmium and zinc – the cadmium and the zinc are able to wet or flow and alloy with iron; (b) copper, silver and phosphorus – this type is used for copper, brass and bronze components.

The **fluxes** used for silver soldering are boric acid (borax), borates, fluorides and fluoroborates. They are available in the form of powder, paste or in the molten condition. Fluxes must be cleaned off immediately after the operation.

The procedure for silver soldering is as follows.

1. Clean the surfaces to be joined thoroughly.
2. Assemble the joint by holding the parts closely together (by wiring, for example: Figure 7.14). Support the joint if necessary.
3. Apply the flux.
4. Heat the components.
5. Apply the filler metal and allow it to cool or solidify.
6. Clean the joint thoroughly.
7. Practise on different joints and materials to perfect your performance.

Advantages of brazing and silver soldering

Because the parent metals do not have to melt, a lower temperature is required than for welding. Component parts can be separated without damage by reheating, so that they can be reused. Joints are solid and strong enough to stay permanent if desired. Dissimilar materials can be joined: e.g. ceramics are easily brazed to mild steel bars as cutting tools. Jointing is quicker. Less damage is caused to component parts. Rapid temperature changes cause internal stress; this effect is reduced by the slow rate of heating and cooling. Components of varying thickness can be conveniently joined. Work that runs out of alignment can easily be realigned.

CHECK YOUR UNDERSTANDING

In beaten or hammered metalwork, thin sheet metal is shaped using the mallet or the hammer. Artefacts produced include vases, boxes and trays. Brazing and silver soldering are used to joint parts together.

- The tools and equipment used are selected based upon the kind of process or operation being undertaken.
- The wooden block or the sandbag is used for hollowing. Stakes are used to support the work.
- The common types of hammer used are collet, hollowing, raising, sinking and planishing.
- The pickle bath should be provided for metals that are to be cleaned. Take care when using the bath; the acid can be dangerous.
- Typical processes carried out using the various tools and equipment are hollowing, sinking, raising, planishing and caulking. The processes are all different; hollowing can be used to make bowls or trays: deep shapes (such as vases and boxes) are produced using raising.
- The finished work can be embossed with decorations using the chasing or punch tool. This process is known as 'repoussé'.

- Brazing and silver soldering are classified as hard soldering.
- The term 'brazing' refers to the process of joining metal components where the molten filler metal is drawn into the joint by capillary action.
- The term 'braze welding' is used when a wide gap is left in the joint and filled with a molten filler metal.
- The filler metals for brazing and silver soldering are sometimes called 'spelter'.
- The most widely used spelter for brazing is brass, which is an alloy of copper and zinc.
- The filler metal used for silver soldering has an element of silver in its make-up.
- Fluxes are used when brazing or when silver soldering, to retard the formation of oxides.
- Fluxes do not remove dirt, grease or oil from the surface of the metal components. It is therefore essential to do a thorough physical cleaning of the surfaces forming the joint.
- The most-used flux for brazing is borax.
- Brazed and silver-soldered joints must be thoroughly washed immediately to prevent corrosion.

REVISION EXERCISES AND QUESTIONS

1 What is beaten metalwork?
2 Why are aluminium, copper and brass generally used for beaten metalwork?
3 Describe how the following tools are used:
   i) wooden block
   ii) hollowing hammer
   iii) sinking hammer.
4 What precaution should be taken when using the pickle bath?
5 With the aid of sketches describe how the following processes are carried out:
   i) hollowing
   ii) sinking
   iii) raising
   iv) caulking.
6 How is polishing a workpiece in copper performed in the school workshop?
7 Describe how to wire two pieces of work before soldering.
8 Briefly explain the difference between the terms **brazing** and **silver soldering**.
9 What factors should you consider when selecting a filler metal for brazing?
10 State **five** advantages of brazing and silver soldering over oxyacetylene welding.
11 Prepare a flower vase from a plate of brass. Indicate the stages involved.
12 Using the sinking process, design and make a small tray to serve as a candle stand.
13 Prepare a two-piece work and, using the wiring process, braze the two pieces.