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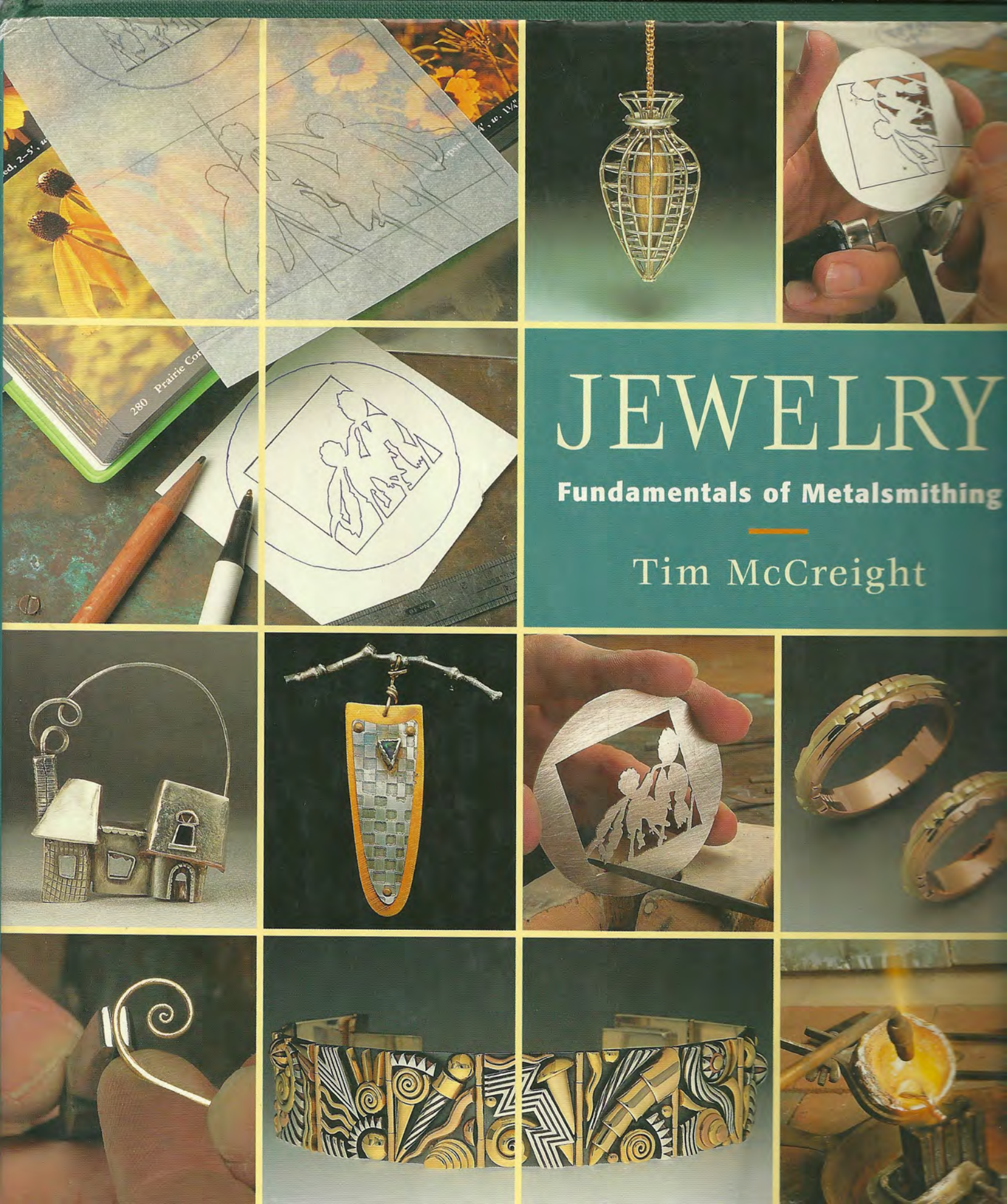
The ULTIMATE COMPILATION of REFERENCES for:

SOLDERING



JEWELRY

Fundamentals of Metalsmithing

Tim McCreight

3

Fusing & Soldering

Although it's possible to make jewelry from single units, it won't be long before you encounter the need to join elements together permanently. The ability to do this with confidence will put you a long way ahead in your jewelry making career. Fusing and soldering are among the most engaging aspects of the field; they both call for a mix of scientific understanding and intuitive response.

Fusing

Imagine two droplets of water on the kitchen counter. If these two beads of fluid come close enough to touch, they will merge together to become a single droplet. That's *fusing*. When a piece of metal approaches its melting point, the outer surface becomes liquid, a phenomenon that enables this basic joining technique.

Jenepher Burton, ring. 18K.
Photo by Robert Diamante.

FUSING

1-2 Set clean, fluxed pieces of sterling on a firebrick. Apply heat so that all pieces reach melting temperature at the same time.

3-4 You can use a steel rod to poke and prod the surface. If you wait too long, the rich textures will roll up into a blob.

5 The finished example.

Stephani Briggs, *Cloud Nine* pin/pendant. 22K, 18K, Mabe and blue baroque pearls. 3 x 2½". *Photo by Gary Sheppard.*

Some alloys fuse more easily than others, primarily because an oxide skin—if it forms—will prevent joining. And it *will* form, particularly in alloys that contain copper. This explains why pure, nonreactive metals like silver and gold fuse easily, while alloys with only a small amount of copper—such as 22K gold (with 4 percent copper) and sterling (7½ percent copper)—do not. Base metals like copper and brass are at the bottom of the list, almost impossible to fuse except in a controlled environment.

Work on a clean soldering surface, preferably in dim light, so that colors are easily read as the metal starts to melt. Clean and flux the metal, and heat the pieces evenly with a bushy flame; elements must reach the same temperature (color) at the same time. Look for the moment when the surface shimmers like mercury, which is the point where the outer skin of each piece is fluid. Pieces in contact at that moment will be joined.

Fusing is often used in conjunction with heat scarring or reticulation, surface embellishment techniques that can simultaneously weld pieces together. And therein lies the problem of fusing: It risks creating an irregular surface or worse, altering the shapes of elements being joined. If there was no alternative, I guess we'd get good at fusing and learn to make the best of its accidents. But there is a better alternative.

Soldering

In the case of fusing, increased temperatures break down the bonds between crystals, eventually causing the metal pieces to lose structural integrity. In other words, they melt into formless blobs. This process begins on the surface, which swims in a flash of molten metal. But just before that point, what happens?

As precious metals approach their melting point, the grains (clusters of crystals) of which they are made pull apart and create microscopic spaces within the structure. Soldering (more correctly called *silver brazing*) is the process of introducing an alloy (solder) that is fluid at precisely this temperature. Because the solder is fluid, capillary action draws it into these spaces in the same way water is drawn into a sponge. Because it is bonded with the parent metal at

Aaron Macsai, *Spring Bar Pin*.
18K, 14K, diamond, tanzanite.
2½ x 2½".

this internal level, the joint is very hard and almost invisible. For centuries, this is what has held jewelry together.

Soldering Overview

Soldering is as simple as heat and as complicated as physics. On the one hand, get it hot, introduce solder and hey, presto! The job is done. On the other, each assembly is unique and requires delicate adjustments in timing, flame control and observation. It's like driving. In one sense, once you've learned how to operate a car you can pretty much go anywhere. But every moment of driving requires subtle intuitive adjustments to a unique combination of circumstances.

The following guidelines are important to proper soldering, but they are only abbreviated descriptions of the process and its permutations. There is no substitute for practice.

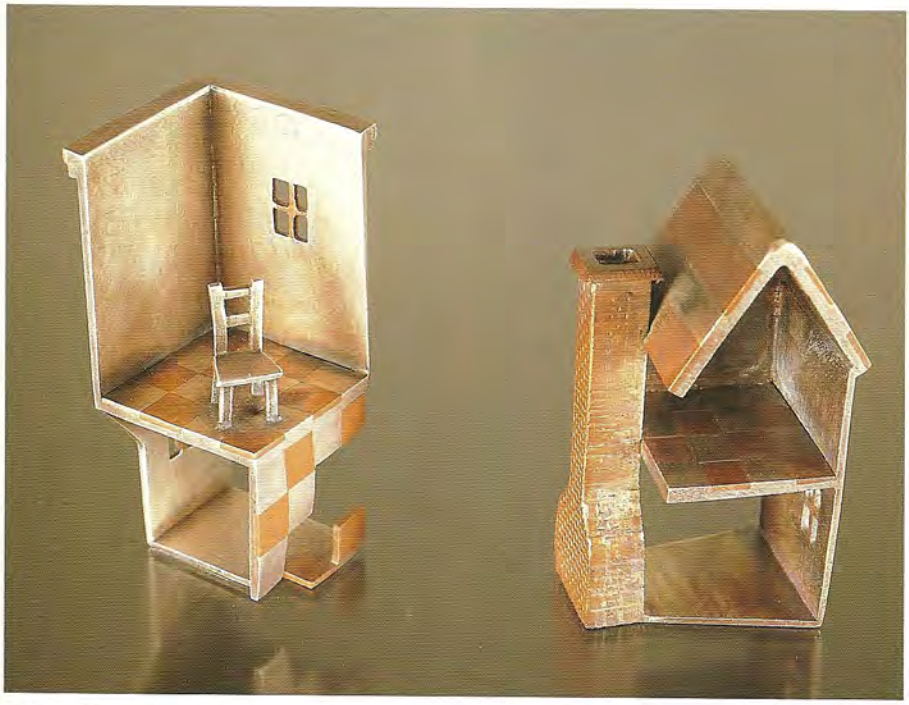
Soldering Guidelines

1. Pieces to be joined must be clean and must make a good fit.
2. Use flux.
3. Heat the area around the joint to direct the flow of heat to the seam.
4. All pieces being soldered should reach temperature simultaneously.
5. Do not overheat the metal or prolong the process. Hit and run.

Pieces to be joined must be clean and must make a good fit. Because solder will not fill a gap, you can't use it to fill in a space between elements. Remember that the solder is entering microscopic voids, not sitting on the surface. (Keep this in mind when you're thinking about how much solder to use—a little goes a long way.)

Cleanliness is critical to a good solder joint. Unseen oxides and finger oils will prevent solder from flowing into the structure. I always scrub elements with Scotch-Brite or clean surfaces with sandpaper just before soldering.

Use flux. Flux is a chemical formulated to prevent the creation of oxides during a heating operation. Very simply, we can think of flux as an air-hungry compound that absorbs oxygen before it has a chance to combine with metals to make an oxide layer (tarnish) that would inhibit soldering. There are many fluxes, each with its own ac-



Andrew Phares, *Two Stories* rings. Sterling, copper. *Photo by Tom Brown.*

tive range—the temperature window in which it will do its job. Be certain to use a jeweler's flux with a range of 1100° to 1500°F (600° to 800°C).

Jewelry fluxes fall into two broad families: fluoride-based and borax-based. As a general rule, the former (often a white paste) is messy but has a longer active range than the liquid, fluoride-based fluxes. There are many commercial brands, all of them good and each with its supporters. Try a few to determine which you prefer.

Heat the area around the joint to direct the flow of heat to the seam. Heat flows to a cooler zone. If you do what seems obvious and point the torch flame directly at a joint, the heat instantly heads away from where you want it. To outsmart the heat, start by directing the flame *around* the seam. Think of a target of concentric circles in which the bull's eye is the joint you are soldering. Heat the outer ring, perhaps an inch or two away from the seam, slowly narrowing the target as the metal warms so that when the piece approaches soldering temperature the flame is almost on the joint.

All pieces should reach temperature simultaneously. To understand the importance of this, remember that solder works by entering the structure of the metal, a situation that is only possible at high temperatures. If a piece is not hot enough, there will be no spaces between the crystals. If one piece in an assembly fails to reach the necessary temperature, the solder will not penetrate that section, and the joint will fail.

In the workshop, temperature is read through color changes. Because these are easiest to see in a dim light, most soldering areas are shielded from bright or changing light. Having your solder bench in front of a window might allow for a pretty view, but the glare of sunlight will make soldering a lot more difficult.

Do not overheat the metal or prolong the process. Solders melt at very specific temperatures. Period. It's an exact science, and one you should learn to trust. Heating the metal to temperatures above the melting point of solder is unneces-

Kiff Slemmons, *Hand Tools* box with 5 rings. Sterling. 1¾ x 3¼ x 1½". *Photo by Rod Slemmons.*

sary and will do damage. If the solder hasn't flowed when the color indicates the correct temperature, something else is wrong. More heat won't fix it.

It's also harmful to extend soldering time. As mentioned, flux is introduced to absorb oxygen before it attacks the alloy, but just like a sponge soaking up a spill, flux has a saturation point. After this is reached, oxygen will rapidly combine with copper to create stains that penetrate and can ruin a piece, while also weakening the joint. Good soldering calls for careful preparation, controlled heating, and a prompt exit. Get in, get the job done and get out.

Grades of Solder

Because you are heating everything but the joint itself, areas that have been previously soldered risk coming undone when new seams are being joined. The solution to this problem is to use solders of slightly different melting points.

Gold solder is made mostly of gold, and silver solder is mostly silver. In both cases, a small amount of base metal (usually zinc or copper) is added to lower the melting point. As the proportion increases, the melting point is lowered. In a piece with several joints, the first is made with a high-melting solder, the next with a solder that melts about 50°F lower, and the last with the lowest-melting solder. These are called hard, medium, and easy solder, respectively.

In bygone days, metalsmiths made their own solder as they needed it. Today we buy solder from suppliers of precious metals, and can rely on consistent melting temperatures. In the case of gold, there's another option. A tiny piece of gold of a lower karat can be used as solder for higher-karat gold—for example, a bit of standard 14K will work as a solder for 18K. Because this lowers the purity of the final piece significantly, it's often preferable to join gold with a solder manufactured for that specific purpose. In other words, you should usually buy 18K solder to work with 18K stock.

Stephani Briggs, *Amour* pin/pendant. 22K, 18K pearl, boulder opal, tourmalines. 4". *Photo by Robert Diamante.*

Popular Jewelry Solder Alloys

alloy	flow point	
SILVER		
Extra Easy	1200°F	652°C
Easy	1325	718
Medium	1360	737
Hard	1450	787
IT	1490	809
GOLD *		
10K	1350	732
14K	1375	746
16K	1490	810

* Each refiner sells slightly different alloys that have different melting points. Request a chart when you purchase gold solders.

The Soldering Process

Solder is sold in sheet and wire, just like precious metals themselves. The alloys are the same for both forms, so melting temperatures and rules apply equally. Why would you chose one shape over the other? Mostly it's a matter of personal choice, and relates to the process of soldering rather than the result. The effect will be the same either way.

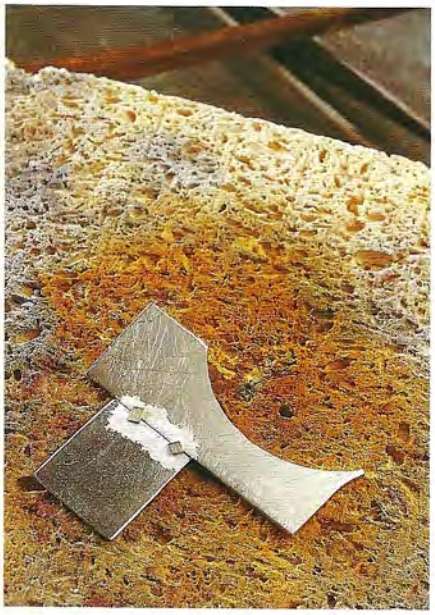
Chip Soldering

Sheet solder is used by cutting it into tiny squares or rectangles ("chips") that are set into position straddling a seam. The advantage of this approach is that the solder acts as a temperature indicator: When the metal is at the correct temperature, the solder flows. The disadvantage of chip soldering is that it's time consuming, first in positioning the solder pieces, then in the slow heating necessary to prevent the boiling action of flux from tossing the pieces aside.

Wire Soldering

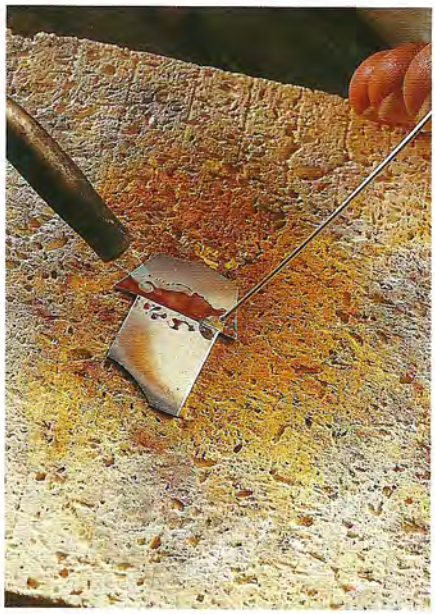
For these reasons, many jewelers prefer to use wire solder, which can be introduced into the joint at the moment of proper heat. The efficiency of this method is clear, but

CHIP SOLDERING



Chips of solder span a fluxed joint.

WIRE SOLDERING



Wire solder touches the joint just as it reaches temperature.

PICK SOLDERING

1 A needle tool is used to pick up tiny spheres of solder.

2 Solder is brought into contact just as the work reaches soldering temperature.

SWEAT SOLDERING

1 In sweat soldering, start by melting solder onto the back of one piece...

2 ...then set that piece onto another. Heat the whole assembly until the solder flows.

because it requires a precise reading of soldering temperatures, it takes a little more experience to master. The trick is to touch the tip of a solder wire to the joint at exactly the moment when the metal is ready to accept it. If the solder is brought in too soon, either the joint won't be made at all, or a blob of solder will fall onto the piece.

Pick Soldering

This useful alternative combines advantages of the first two methods by using pre-sized pieces but avoiding the need to set each chip into place. In this method, sheet solder is cut into tiny pieces that are sprinkled onto the soldering block. A piece of solder is heated with the torch, which will make it draw up into a sphere. It's then picked up with a steel rod like a potter's needle tool or a sharpened piece of coat hanger. The fluxed workpiece is heated to soldering temperature, and the solder is touched to the joint. If the temperature is correct, the solder will jump off the pick to fill the joint. The process is a delicate ballet that requires a little practice, but is very efficient once you get the rhythm. It's especially good for production situations, or multiples like chain links.

Sweat Soldering

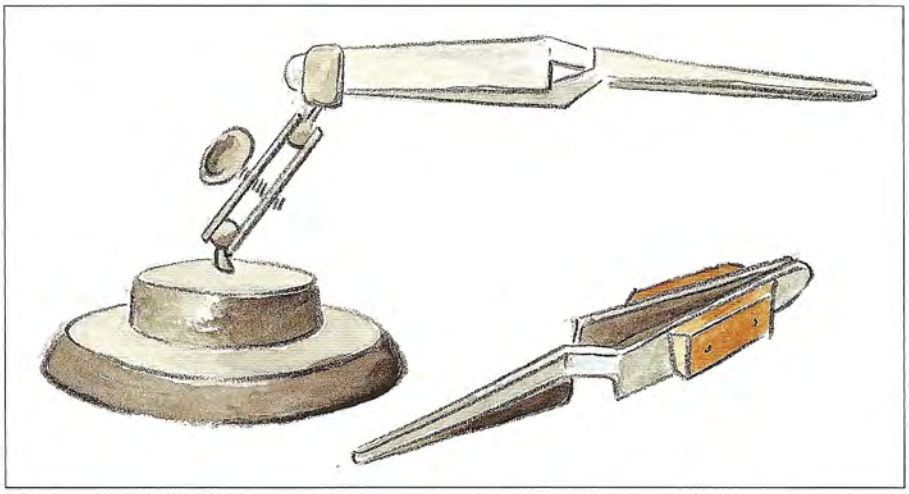
Sweat soldering is a two-step process that can be done with any grade of solder, and with either sheet or wire. The smaller unit is fluxed and solder is melted onto its surface. The piece can be allowed to cool down or you can continue directly to the next step. The metal is refluxed, laid into position, and the whole assembly is heated until the solder flows a second time. As shown, sweat solder is very useful for overlay and when attaching findings.

Soldering Aids

It's always best to keep the soldering setup as simple as possible, but sometimes elements need temporary support until the solder flows. Objects in the soldering zone will absorb (or "rob") heat from the workpiece; they're often called "heat sinks". Keep props to a minimum in both size and number, unless your intention is to protect an area from overheating.

Locking Tweezers—These are handy to hold pieces in positions that would otherwise succumb to gravity. The tweezers open when pinched, but spring closed at rest, so you can grip a piece and set it onto the block. Use large bolts or similar pieces of steel to weight the handle end of the tweezers for increased stability.

Third Hand—This device has a heavy steel base and ball-socket coupling that holds a pair of locking tweezers.



Third hand and cross-lock tweezers. It's sometimes helpful to have pieces clamped into place for soldering. Other tools that can be improvised are paper clips, straight pins and bobby pins.

Susan Silver Brown, *Spirit House Shrine* brooch. Sterling, magnet, copper, 14K, amethyst, brass, paint. 2¼ x 3¼".

Dominque Giordano, necklace & earrings. Sterling, epoxy, gold leaf, pearl. 1¾ x ⅞". *Photo by Ralph Gabriner.*

Binding Wire—Any steel wire can be used to lash pieces together for soldering. Brass or nickel silver wire will work in a pinch, but steel is preferable due to its high melting point. Wrap the pieces loosely and twist the ends of the wire together, then give the wire a half turn with flat-nose pliers to make a "Z." This will tighten the wire, but still allow it to expand during heating.

Soldering Investment—For very complicated assemblies, the pieces can be pressed into wax or glued together, then coated with a plaster-like material called *investment*. Once the investment has hardened and dried, the wax can be pulled away or the glue burned off, and the pieces soldered as usual. After soldering, the investment breaks down when the piece is quenched. It can then be scrubbed off with a toothbrush.

Pickle

Pickle is an acidic solvent that is used after soldering to remove flux residue and oxides. Most studios use a commercial product called Sparex. This is sold as dry granules and mixed with water as needed. As with any strong chemical, mark containers well and keep them safely away from children and pets.

Pickle will do its work at room temperature, but is much faster when warm, ideally about like a hot bath. An easy way to sustain this temperature is with a crock pot, which can be purchased from a housewares supplier. The pot will corrode with use, and must never be used for food again. Before using it in the studio, seal all the seams with bathtub caulking so pickle cannot spill into the interior heating element.

Though less dangerous than strong acids, pickle does irritate

Stephani Briggs, *Sunburst* pin. 22K, 18K South Sea pearls. 4". *Photo by Robert Diamante.*

Mary Hughes, bracelet. 18K, white and colored diamonds, Tahitian pearls.

LEFT: Suzanne Taetzsch, *Mourning* brooch. Sterling, 14K. 3½" high. *Photo by Allen Bryan.*

BELOW: Mary Hughes, earrings. 18K, Mabe pearls, diamonds. 2¾ x 1".

skin, especially skin that is cut or chapped. To avoid splashing pickle in your eyes, quench hot metal first in water; that way, if there's a splash it will be messy, but not dangerous. From there, the piece can be dropped into the pickle, which usually takes just a couple of minutes to dissolve oxides. Prolonged exposure to pickle will not hurt sterling or other metals, but it will corrupt soldered joints. For this reason, don't leave a fabricated piece in pickle for longer than a couple of hours.

Pickle Contamination

Pickle does its job by leaching out copper oxides, and in most studios, the same pickle is used for sterling, gold, copper and brass. After a couple of uses, pickle becomes a copper plating solution—a saturated acid with excess free copper ions. Those ions are swimming around in there, just itching for a chance to bond with something, and if an electrical charge is introduced, they jump onto every metal surface available.

Because the reaction of steel to acid will create a tiny electrical charge, never reach into the pickle with steel tweezers or introduce a steel wire or attachment into the mix. If you do, anything in the pickle at that moment will become copper plated, the effect being subtle or dramatic depending on the degree of saturation of the pickle. Once the steel object is removed, the pickle is fine again.

This plating action is usually unwanted but there are times when it can be turned to advan-

Solder Troubleshooting

It is often possible to find clues about what went wrong by examining a failed joint.

effect	possible cause
Solder never flowed.	Metal or solder was dirty, oily or tarnished. Forgot the flux. Not enough heat.
Solder all went to one piece.	That piece was much hotter than the other(s).
Solder balls up.	Solder is tarnished; scrub tarnished sheets and wires with Scotch-Brite before using them again.
Metal has roughened surface.	Too much heat.
Metal has a dark stain.	Too much heat for too long a time.
Joint seemed OK, but later broke.	Heat removed a split second too soon, just as the solder flowed. Joint was moved just as the solder was hardening. Piece left in the pickle too long.

tage, as, for instance, when coloring brass or gold. Both these metals are difficult to blacken, but copper darkens easily.

To copper plate a piece, wrap it lightly in steel wire (a couple of paper clips will do) and drop it into used pickle. The entire piece will, of course, be plated. However, during polishing the higher surfaces can be returned to their original color, so that copper is left only in the recesses.

Gems and other nonmetals should never go into the pickle. To safely dispose of old pickle, pour it into a bucket set in a sink, and sprinkle in baking soda. This will make a dramatic Captain Chemistry froth, often in a lovely aqua color. When the mix stops bubbling, the acid has been neutralized and the solution can be safely flushed down the drain.

JEWELRY

CONCEPTS AND TECHNOLOGY

OPPI UNTRACHT

AUTHOR OF "METAL TECHNIQUES FOR CRAFTSMEN"

BASIC TYPES OF JOINTS

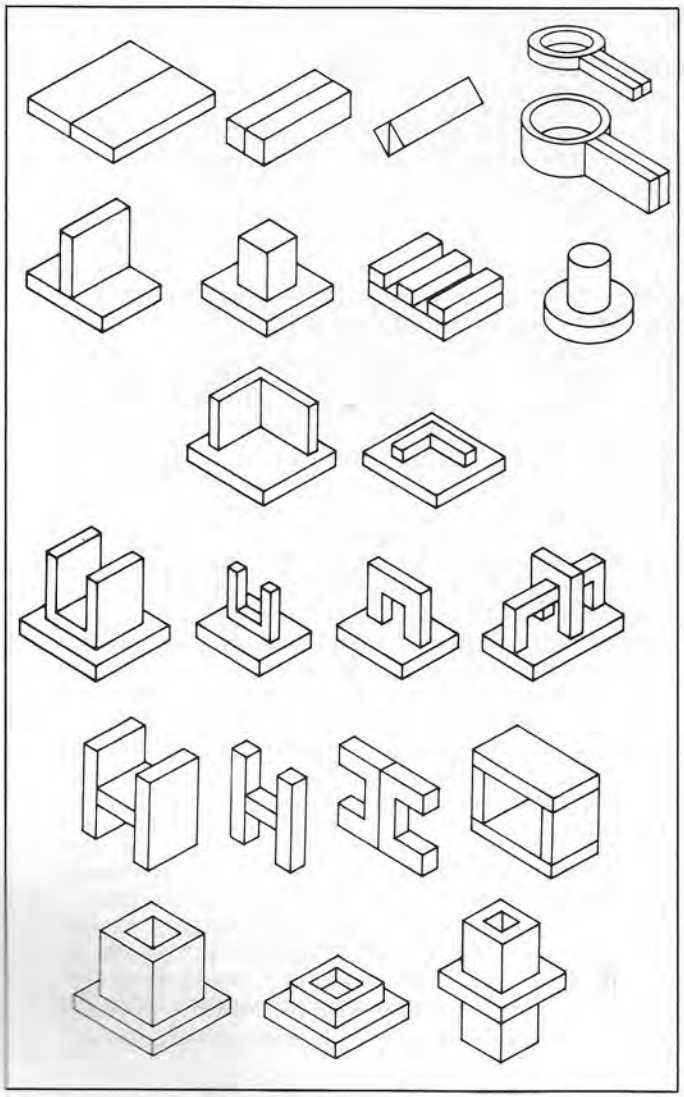
A *joint* is a place where two or more parts are united or made to fit together. The union can be permanent as when soldering, riveting, or welding, or movable as in other joining methods such as certain kinds of riveting, screwing, flanging, folding, and bending.

BUTT JOINTS In a butt joint, two ends come together squarely at their extremity without scarfing or chamfering.

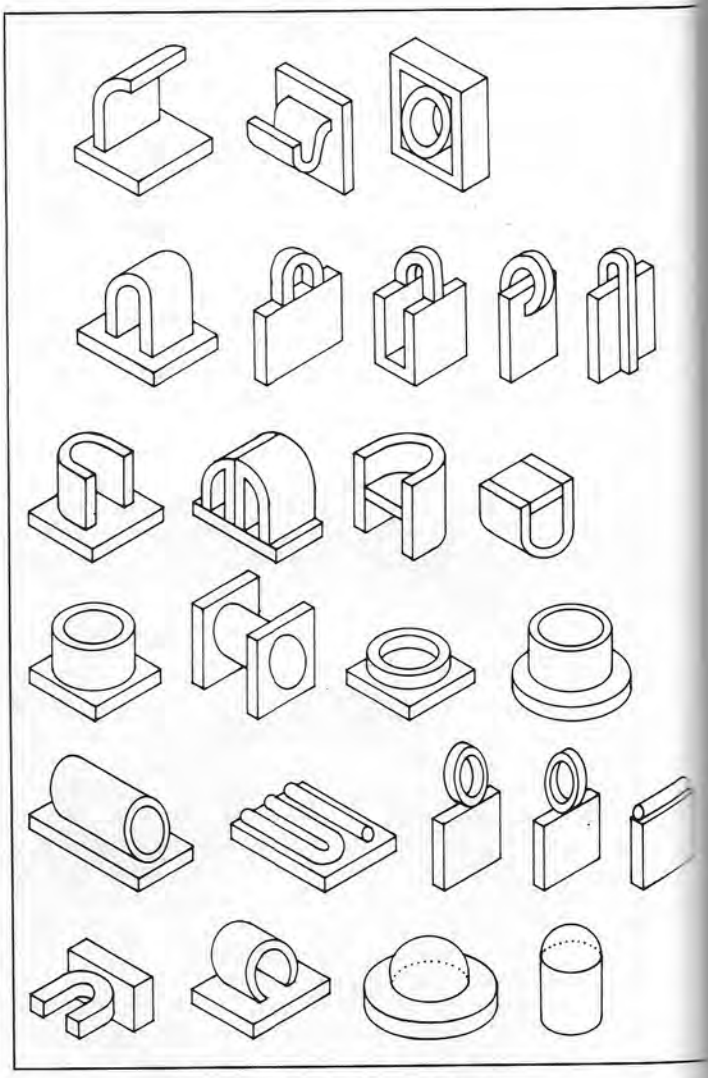
LAP JOINTS In a lap joint, one part or layer overlaps another. A special type is a *sleeve joint* in which one tube fits inside another.

SCARF JOINTS In a scarf joint, the join is made by chamfering, beveling, notching, halving, or otherwise cutting the two parts so that they correspond with each other where they overlap. Such joints can also be made by the use of a *plate* that overlaps the joint and is secured by rivets.

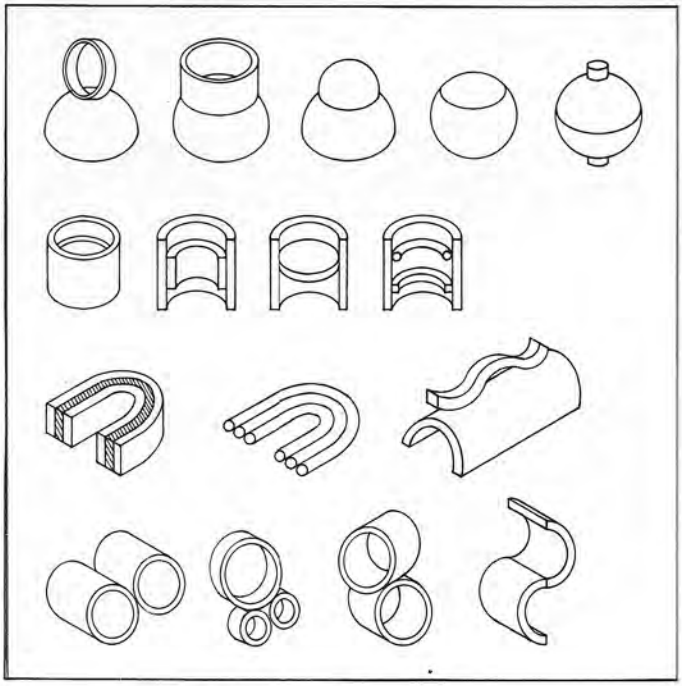
All the joints shown here are made with the basic forms of metal used by the jeweler: sheet, wire, and tubing. Many of the situations illustrated can also be used when joining or assembling cast sections, or when combining cast and fabricated parts. In some cases, solder would not be needed, though it could be used. We do not include all conceivable combinations, as this is obviously impossible.



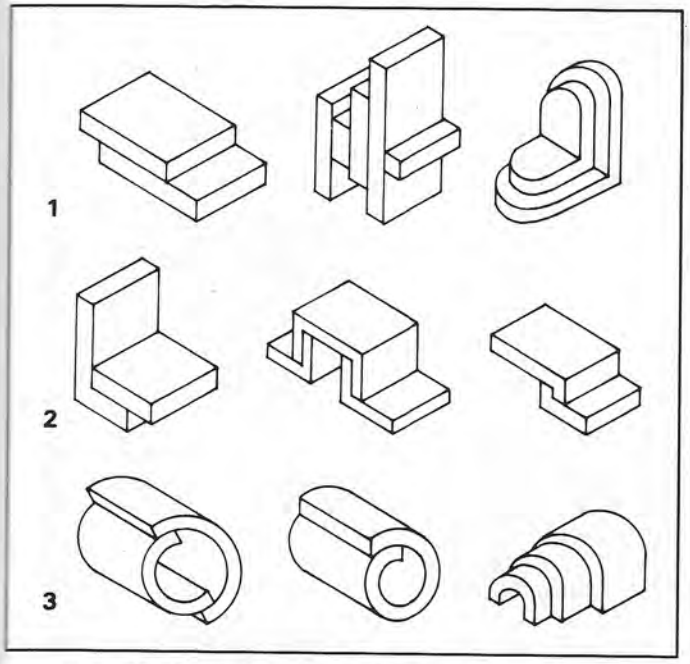
10–3 *BUTT JOINTS, FLAT TO FLAT.*



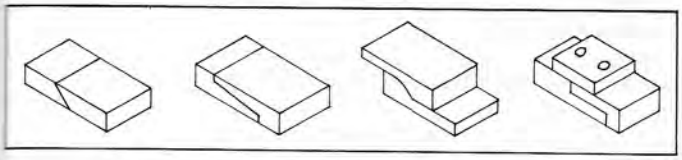
10–4 *BUTT JOINTS, CURVE TO FLAT.*



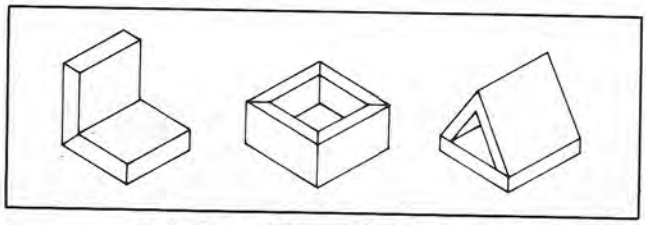
10–5 *BUTT JOINTS, CURVE TO CURVE.*



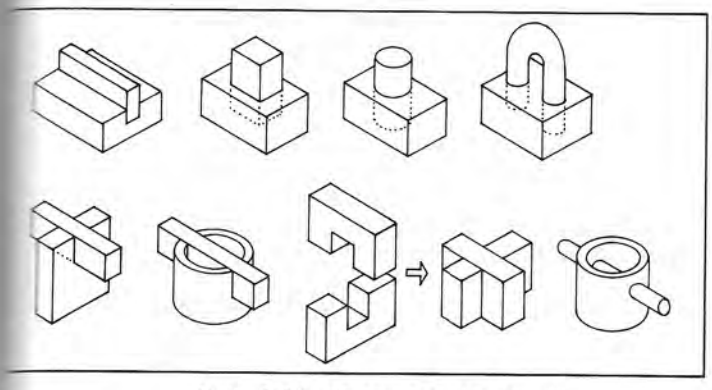
10–6 *LAP JOINTS*: 1. Flat to flat; 2. Corner lap; 3. Curve to curve.



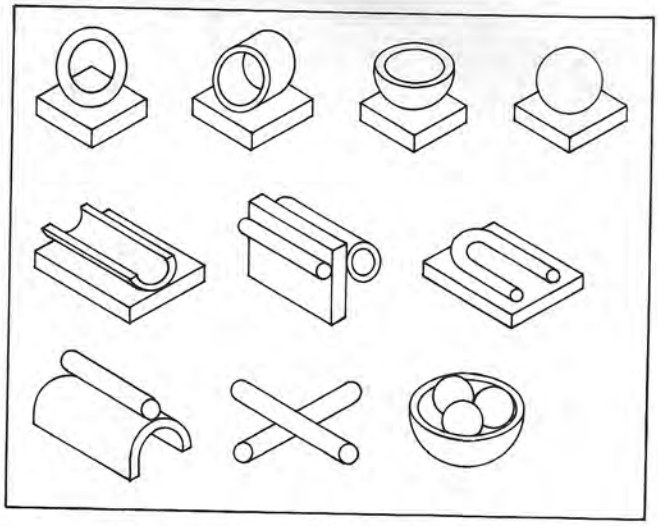
10–7 *SCARF JOINTS.*



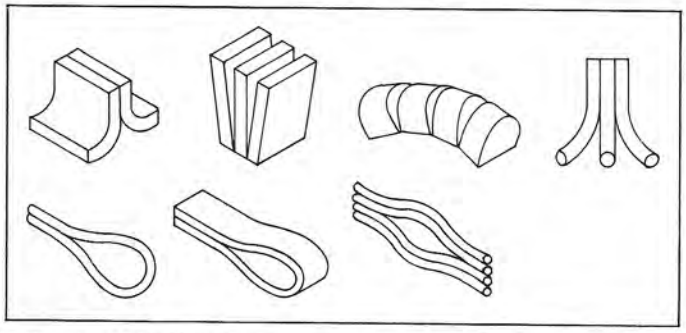
10–8 *CHAMFERED OR BEVELED JOINTS.*



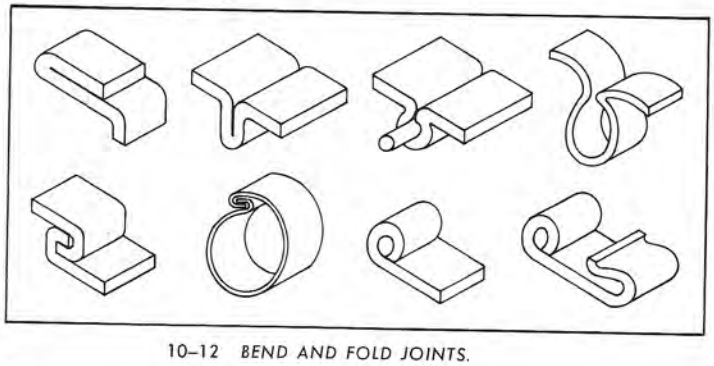
10–9 *SLOT AND PENETRATION JOINTS.*



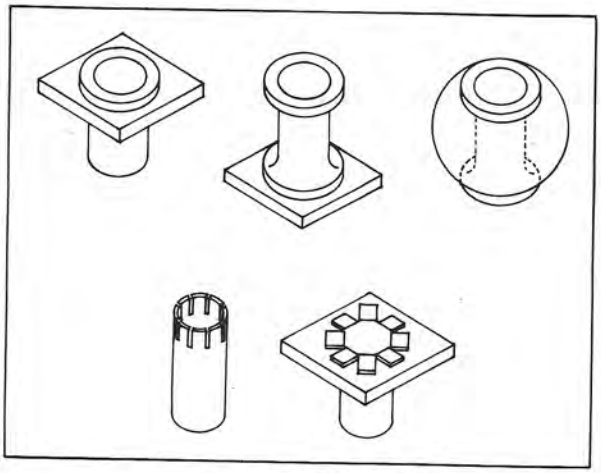
10–10 *POINT- OR LINE-OF-CONTACT JOINTS.*



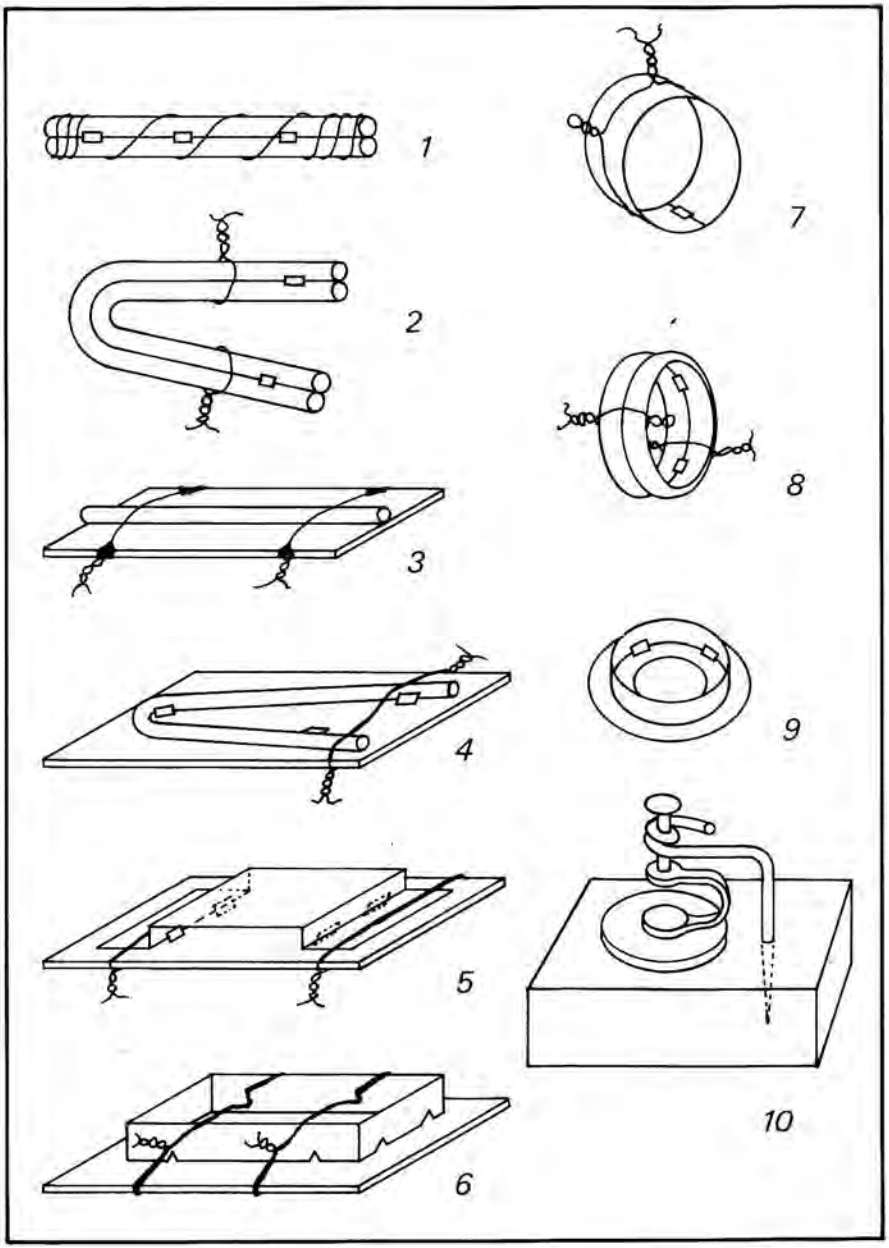
10–11 *SPREAD GAP JOINTS*
This consists of the joining of two forms only by their contacting edges or surfaces, their physical shape making larger surface contact impossible.



10–12 *BEND AND FOLD JOINTS.*



10–13 *FLANGED JOINTS.*



10–19 *TYPICAL SOLDERING SITUATION JIGS AND SOLDER PLACEMENT*

1. Iron binding wire wrapped the full length of a wire-to-wire joint.
2. Binding wire used in separate ties at intervals.
3. Binding wire used in conjunction with nicks made in the edges.
4. Binding wire to hold down wire ends.
5. Binding wire to hold down sheet, solder placed internally.
6. Edge soldering with graver-raised "stitches" to hold a part in position. The wire is bent or kinked to allow for expansion of the metal during soldering heat.
7. Binding wire given a twist to allow for expansion when soldering a cylindrical form.
8. Soldering two wires together with binding wire tied at opposite sides, solder placed within.
9. Soldering a bezel edgewise, with solder placed inside.
10. Soldering an ear wire finding supported by a heavy-gauge, bent iron binding wire pin forced into the soldering surface.

The Theory and Practice of Goldsmithing

Prof. Dr. Erhard Brepohl

TRANSLATED BY Charles Lewton-Brain

EDITED BY Tim McCreight

Brynmorgen Press

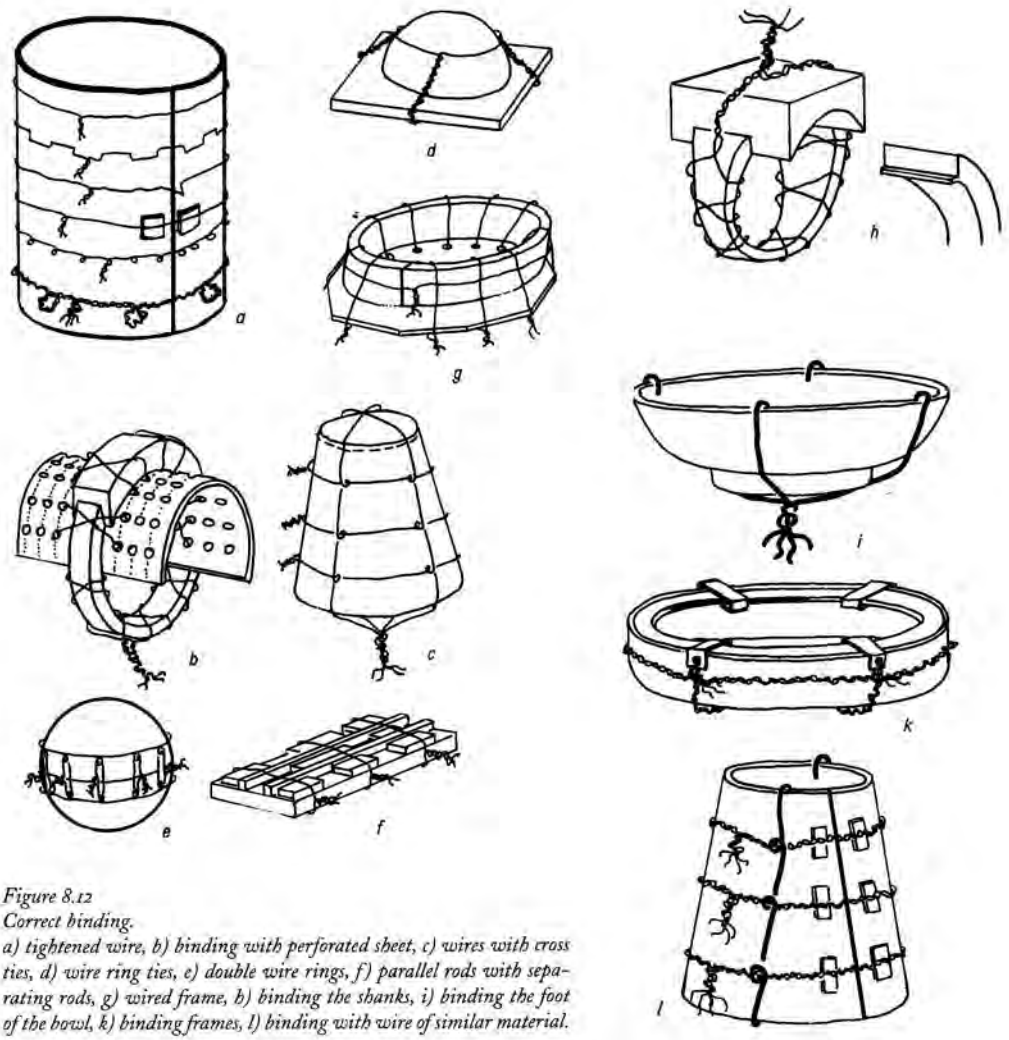


Figure 8.12
Correct binding.
a) tightened wire, b) binding with perforated sheet, c) wires with cross ties, d) wire ring ties, e) double wire rings, f) parallel rods with separating rods, g) wired frame, h) binding the shanks, i) binding the foot of the bowl, k) binding frames, l) binding with wire of similar material.

scratching a silver object. If possible, fine silver should be used; its higher melting point and softness make it ideal.

A useful holding device is illustrated in figure 8.12b. Small holes are drilled into a thin steel plate that is then curved to fit inside a ring. This arrangement provides many options for placement of wire to tie the pieces together. Figure 8.12f shows how a bezel can be tied onto a base plate if the opening is to be later sawn out

In exceptional cases where no other method of fastening can be devised, it is possible to drill into the workpiece and bind pieces with wire of the working material, for instance, using sterling wire when working on a sterling object. After soldering the excess wire is removed and the binding wire, which has been soldered in place, is filed smooth.

CLAMPS

Small, hair pin-shaped devices called clamps have several advantages. They are easy to make and apply, often reusable, and avoid the shrinkage problems mentioned above. In many cases these are made from whatever wire is close at hand. Heavy binding wire and nickel silver are preferred. Figure 8.13 illustrates a variety of shapes and their application. Of course, each situation might require special modifications.

PINNING INTO THE SOLDERING SURFACE

An alternate way to join pieces for soldering is to anchor them onto the soldering block. Charcoal or firebrick blocks work particularly well for this. Figure 8.14 illustrates the use of pins to hold delicate parts in specific arrangements. In figure 8.14d, the ends of two pins are bent into loops which hold onto a wire securely. Pins are also useful when soldering chains. As seen in figure 8.14e, a chain can be stretched taut with pins for soldering.

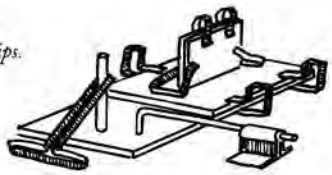


Figure 8.13
Different clips.

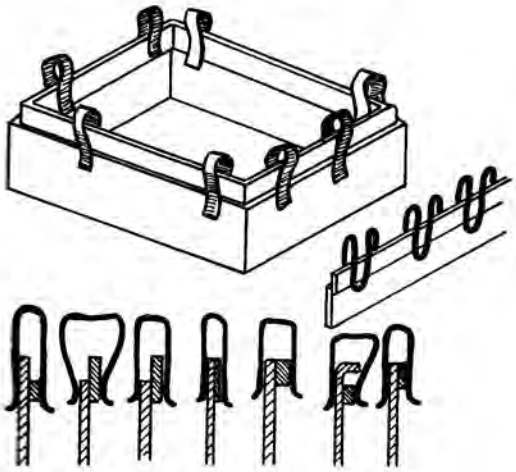
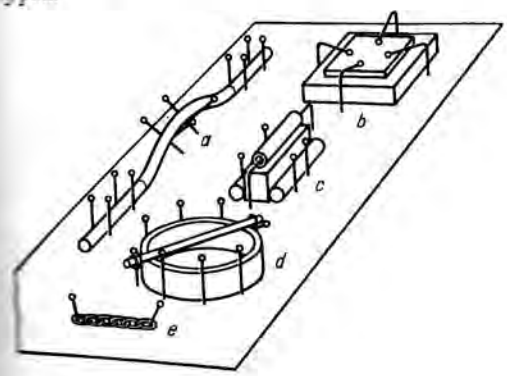


Figure 8.14
Use of pins.



Soldering investment

This specialized method (figure 8.15) is especially recommended when joining many small pieces. Rather than wires, a plaster-like material called investment is used to secure the pieces during soldering.

First the individual parts are painted with flux then heated until they are left with a layer of glaze. The pieces are then assembled by pressing them into wax or modeling clay. Of course, it is necessary that the pieces touch each other. A temporary wall of cardboard, plastic, or tape is laid around this construction and sealed with modeling clay. Conventional casting investment can be used but a special formula, called soldering investment, is preferred because it dries faster. Mix the investment with water according to the manufacturer's instructions and pour it over the work. A thin layer of investment is sufficient; too much material only extends the drying time required.

Allow the investment to dry, removing the wall after about 10 minutes to speed up this process. Invert the piece and use a fine blade to scrape away wax and/or investment from solder seams. Pre-heat the entire unit (either with a bushy flame or in a kiln) to ensure that all moisture has been removed. Add flux and solder at each point of contact and heat with the entire unit with a torch until the solder flows. After checking to be certain all the joints are solid, quench in water and the investment will fall off.

ASSEMBLY ON ACID SOLUBLE FORMS

In some extreme situations this unusual method is indispensable. The example here, shown in figure 8.16, demonstrates the fabrication of a sphere made of a lattice of wires. The concept is to create a form in a metal that can later be removed with acid. In this example we'll imagine a copper sphere and Au 750 (18k) gold wires. First, two hemispheres are made from thin copper sheet and soldered together. The lattice work is constructed on the copper sphere and soldered in sections (8.16b).

When the fabrication is complete, drill holes in the copper wherever possible to reduce the amount of metal present. The remaining copper is removed by etching the entire unit in a strong solution of nitric acid. Adequate ventilation will of course be required. Because the gold is impervious to this acid it will

Practical jewelry making

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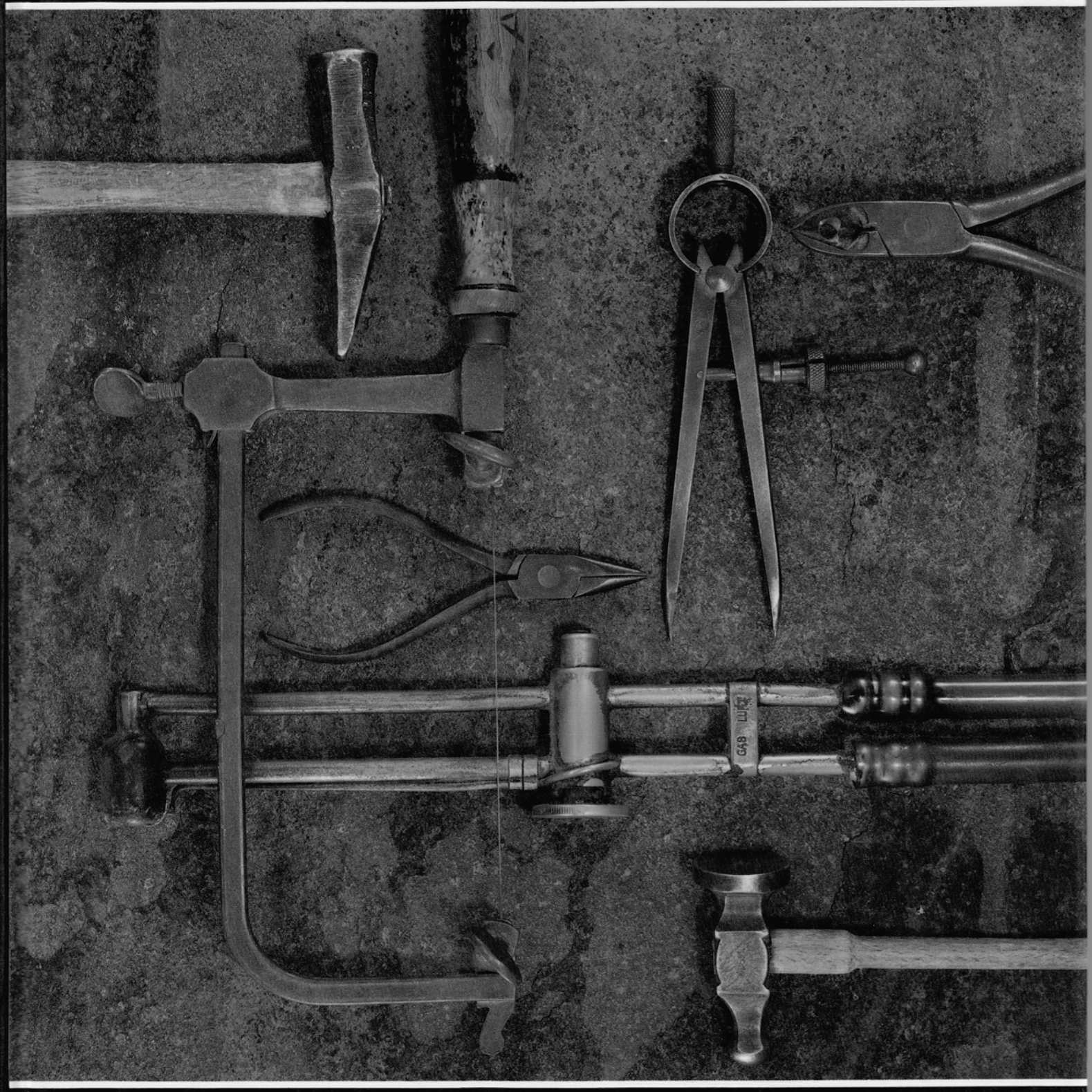
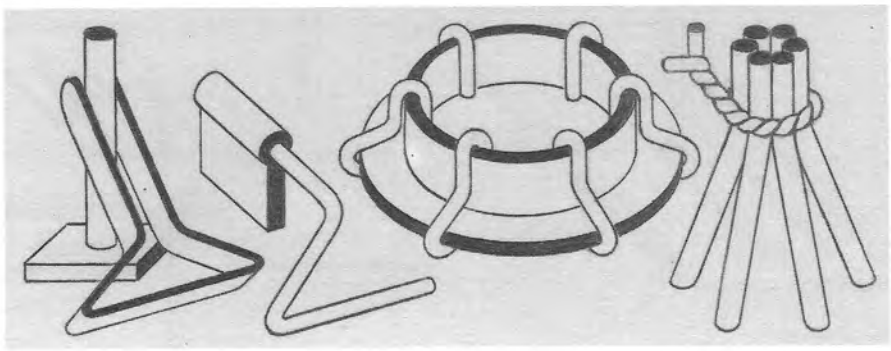


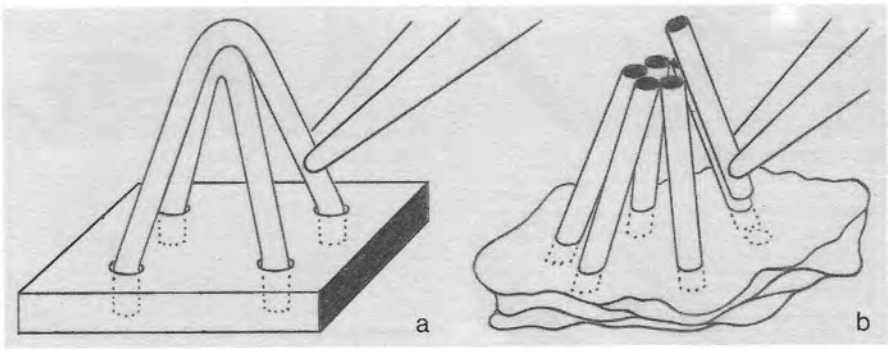
UBOS/SCRIPTAR

18 Brazing

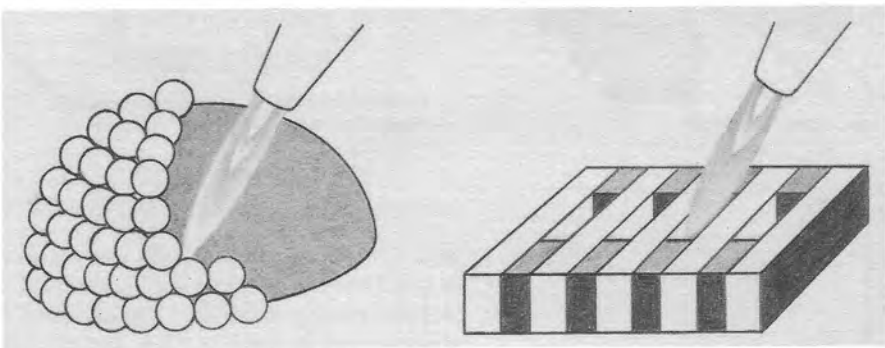
Clamping and fixing



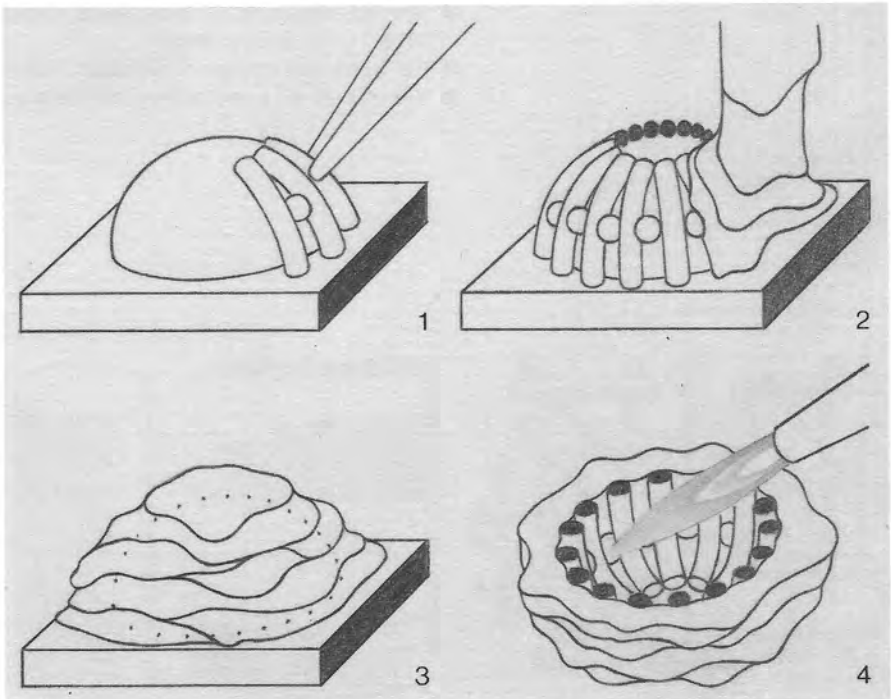
a) Fitting into a jig
b) Fitting into paste



Brazing on a copper or brass jig, followed by removal of the jig by dissolving with aqua fortis.

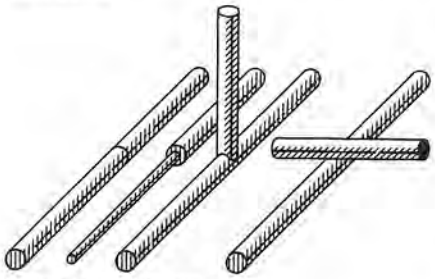


Building up on paste and fixing with plaster followed by brazing in the plaster.

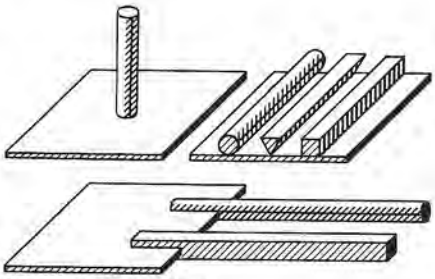


18 Brazing

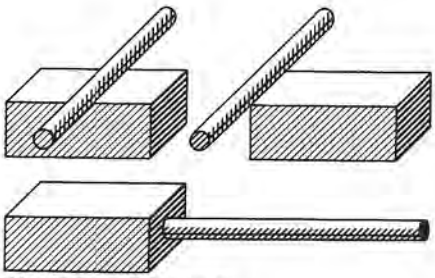
Wires/bars



Wires/bars on wires/bars

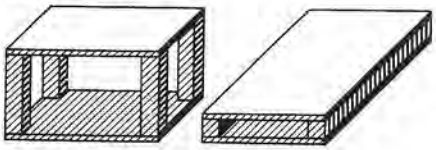


Wires/bars on strips/sheets

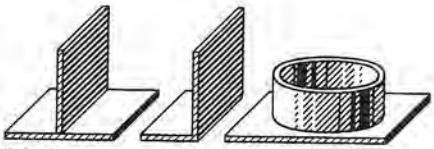


Wires/bars on plates/volumes

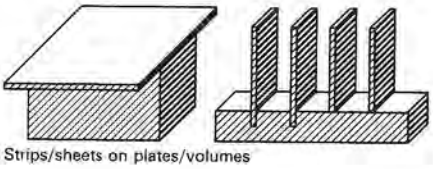
Strips/sheets



Strips/sheets on wires/bars

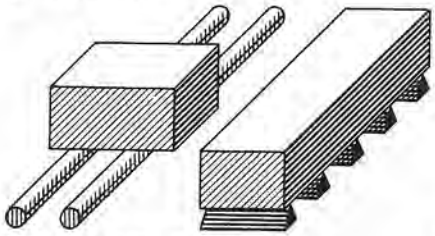


Strips/sheets on strips/sheets

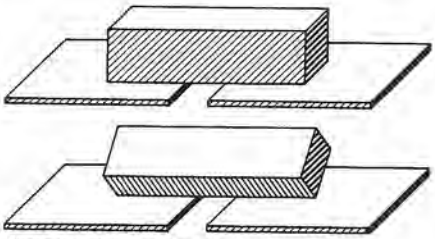


Strips/sheets on plates/volumes

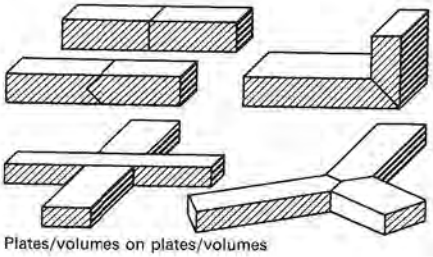
Plates/volumes



Plates/volumes on wires/bars



Plates/volumes on strips/sheets

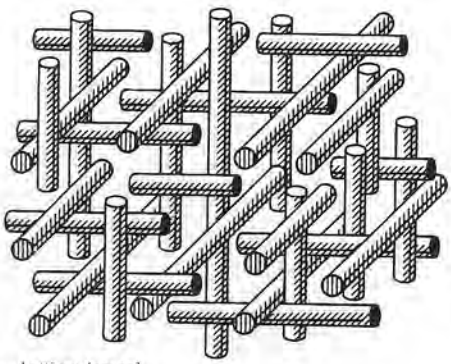


Plates/volumes on plates/volumes

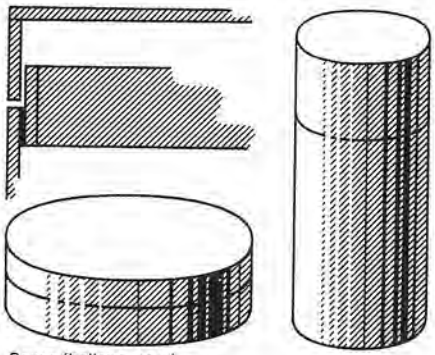
Observe:

- the effect of brazing with too much or too little solder
- the effect of brazing with too much or too little flux
- color changes through the effect of heat
- variations in stability after and during the glowing process (annealing)
- the expansion of various metal thicknesses and of various materials (copper, silver, gold, brass, steel)
- the heat absorption of different volumes
- the effects of overheating on metals and solders

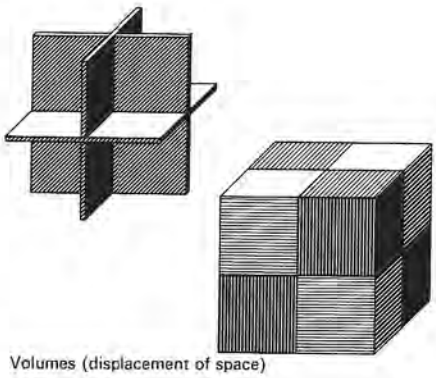
Possibilities of creation



Lattices (space)



Boxes (hollow space)



Volumes (displacement of space)