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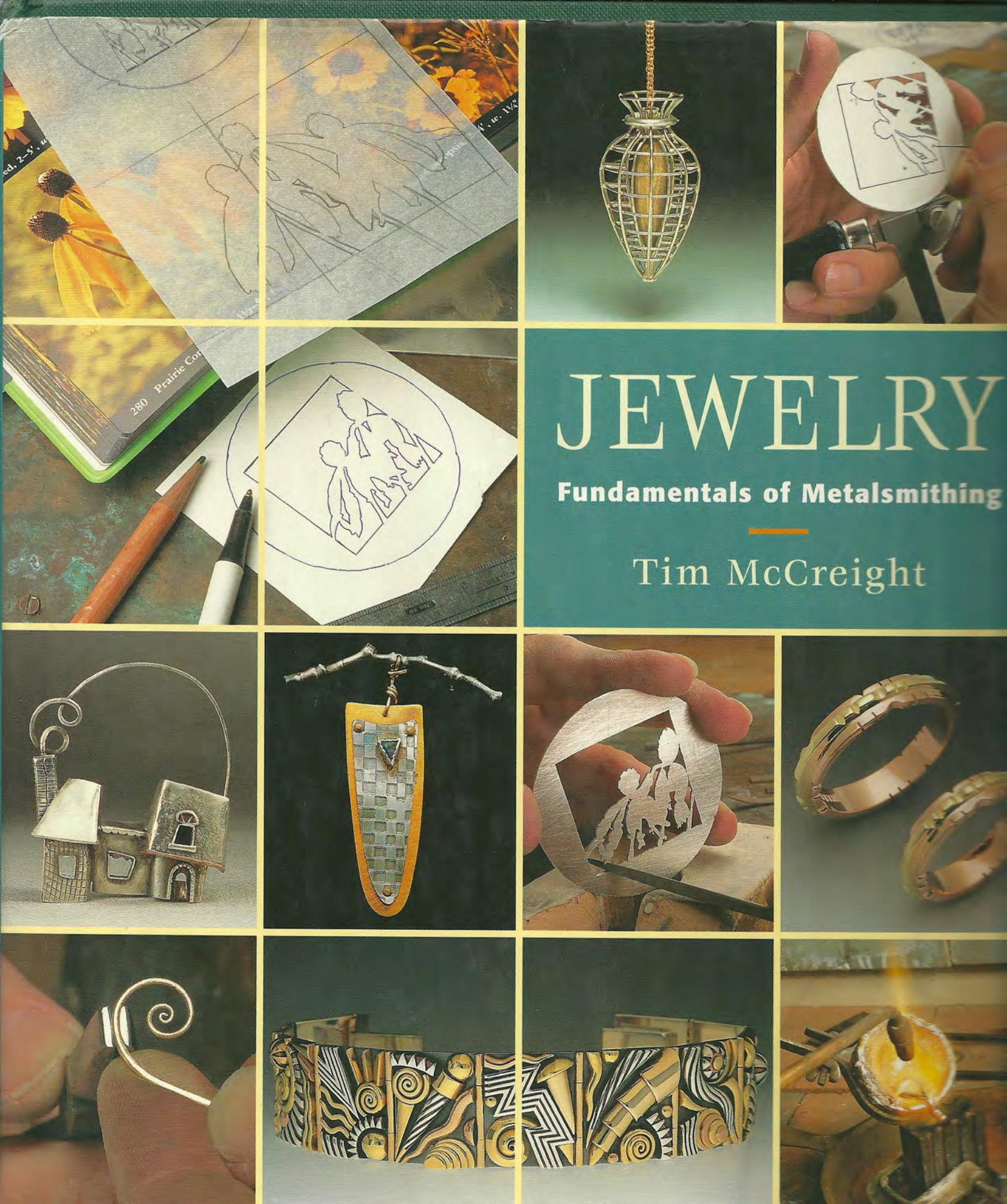
The ULTIMATE COMPILATION of REFERENCES for:

COLD JOINING



JEWELRY

Fundamentals of Metalsmithing

Tim McCreight

4

Cold Joining

The term "cold joining" means a wide range of devices and techniques that secure two or more pieces together with a mechanical—rather than a heat-induced—connection. Though the term may be unfamiliar, we all use cold connections every day. Paper clips are an example, as are staples, rubber bands, buttons, shoelaces and Velcro. This chapter describes some of the most popular cold connections for metals, but they are merely points of departure. There is nothing here that can't be modified to suit your particular needs. Look around you, not just at jewelry, but at hardware, automobiles, housewares and, well, look at everything!

Despite the thousands of uses for fusing and soldering, there are occasions when the heat of soldering will damage a piece. In these cases, a mechanical (cold) connection is needed. Generally, the reasons to use a non-soldered joint falls into one of these categories.

Use cold connections when:

- The material being connected—stones, plastic, and so on—would be damaged by heat.
- The parts will be easier to polish, patina or set before final assembly.
- The heat of soldering would damage a desired temper.

Jung-Hoo Kim, *Humanbeing-Tree* brooch. Sterling, fossilized ivory, sugelite, 24K foil. 3½ x 2½".

Cleo (Claire Dinsmore), *Autumnal Vestige* neckpiece. Bronze, copper, sterling, steel, 18K, leather, secrets (contents), Colorcore. 3" diameter.

Thomas Mann, *Japanese Stone Fetish*. Steel, stone, brass. 2 x 3¾". *Photo by Will Crocker.*

Staples and Tabs

We commonly think of staples as squarish bits of fine wire that pop out of a dispenser we keep in a desk drawer. More broadly, you might consider a staple a simple device that relies on two (or more) legs that penetrate layers of material and are bent over to secure the elements. There is nothing in that definition that limits size, shape, height or complexity. The demonstration photos in this chapter show a simple, fabricated staple, but your imagination should guide you as you explore the wealth of possibilities.

Tabs are a lot like staples, except they usually wrap around a piece rather than pass through it. Because of this, tabs can be sawn to interesting shapes that contribute to the design.

Process for Staples

1. Lay out the design carefully, paying close attention to measurements. If in doubt, experiment with a cardboard model.
2. Saw out the pieces and file the edges smooth. Solder elements into place if needed.
3. Bend the legs to 90° to get them ready for the final assembly.
4. Finish the piece as called for by the design, using patinas, polishing, etc.
5. Lay the pieces together and begin to press the legs into place. Start by getting everything halfway pressed over to ensure the proper fit. When you are sure everything is in order, press the legs down with a blunt tool or pliers.

Rivets

A rivet is nothing more than a piece of metal—usually a rod or wire—that penetrates all the layers of an assembly and is bulged out on each end to create a head, like the head on a nail. We see rivets in bridges and machinery, and attaching handles on our kitchen utensils. They also reinforce our blue jeans. Ready-made copper and aluminum rivets can be purchased from a hardware store, but most jewelers create copper, sterling or gold rivets as needed for a specific project.

Julie Flanigan Hill, *Cuff Link Series: Contains Recycled Materials.*
Sterling, recycled materials. 2/3" diameter.
Photo by Bobby Hansson.

Riveting Guidelines

1. The rivet material should be annealed.
2. Location of holes is critical; don't hurry.
3. The rivet must make a tight fit in the hole.
4. Provide enough material, but not more.

The rivet material should be annealed. The holding power of a rivet comes from the head, which is formed by tapping directly down on the vertical axis of the rod. This is a process called *upsetting*, and it will be more effective and easier if the metal is as malleable as possible.

Location of the holes is critical. Riveting often comes toward the end of a process, after time has been spent creating, ornamenting and finishing a shape. Don't risk sacrificing that work by rushing through the vital step of locating holes for rivets. When several rivets are being used, as is often the case, avoid

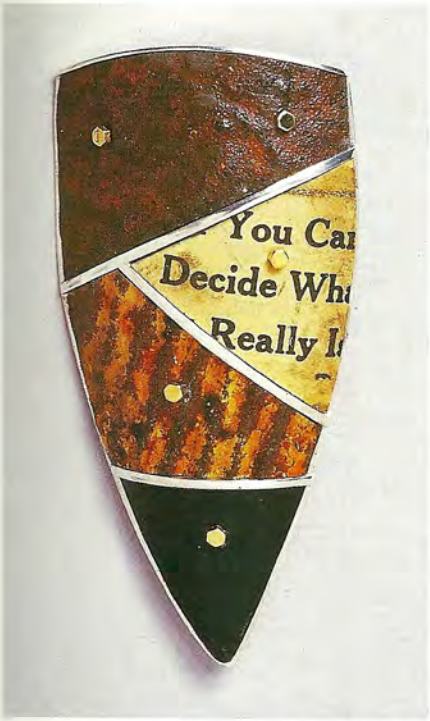
MAKING A STAPLE

1 To solder the legs of the staple, attach an inverted "U," then cut the curved section.

2 Mark the location carefully, then drill holes.

3 Use pliers or a blunt rod to press the legs of the staple over.

4 The finished piece. Sterling elements secure black vinyl (record) to copper base.



Julie Flanigan Hill, *Fortune Series: If You Can Decide What Really Is.* Sterling, rusted tin, rusted steel, lacquered tin, answer from a fortune telling machine. 3½ x 1½".
Photo by Bobby Hansson.

Judith Hoffman, *Bird Goddess* brooch. Sterling, 18K, copper, enamels. 4 x 3¼ x ¾".
Photo by Patrick Sumner.

the temptation to simply hold the units together and start drilling; almost inevitably, pieces shift just enough to ruin the alignment. Instead, use the following process.

Mark, centerpunch and drill all the holes in the top piece. Then set it into position and use a needle or similar tiny point to mark the location of *one* hole in the next lower piece. Separate the pieces, centerpunch the mark, and drill. Repeat the process for each layer. Now, make the first rivet, which will start to lock the pieces together. Note that although they can no longer slide left and right, the pieces can still pivot.

Hold the assembly tightly and mark a second hole, then carefully drill through all layers. Make the second rivet, which will clasp the assembly together so it can neither shift nor rotate. Now it's safe to drill all the remaining holes at once, and complete the riveting.

The rivet must make a tight fit in the hole. Riveting depends on the ability of metal to upset, or compress down onto itself. This only happens when the metal has no other choice, like bending off to the side. To force this situation, the rivet wire must be snugly confined by the hole that contains it. One way to accomplish this is to use drill bits that match conventional wire sizes or are even a touch small. It's easy enough to enlarge a hole with a round needle file.

Another strategy is to drill the holes smaller than the wire you

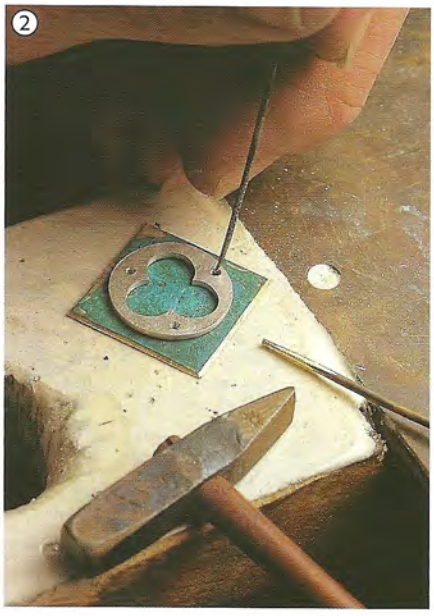
Jenepher Burton, pins. Sterling, tin and escutcheon nails. 3" diameter.
Photo by Robert Diamante.

have on hand and file a gradual taper in the wire. This wire can be inserted into the hole until it makes a tight grip, and then cut off at the correct length. If the hole is too large, planish the area around the hole in order to push the metal inward.

Provide enough material, but not more. A rivet holds because of its head, the lump that sits on top of the assembly. No head, no rivet. It's clearly possible to cut a rivet too short, but it's also possible to cut it too long. Too much material here will allow the wire to curl rather than mushroom to create a head. If you notice this starting to happen, use pliers to straighten the wire, and file it. The rule of thumb calls for half the diameter of the wire to extend above the surface to become the rivet head. If a rivet wire is 2 millimeters in diameter,

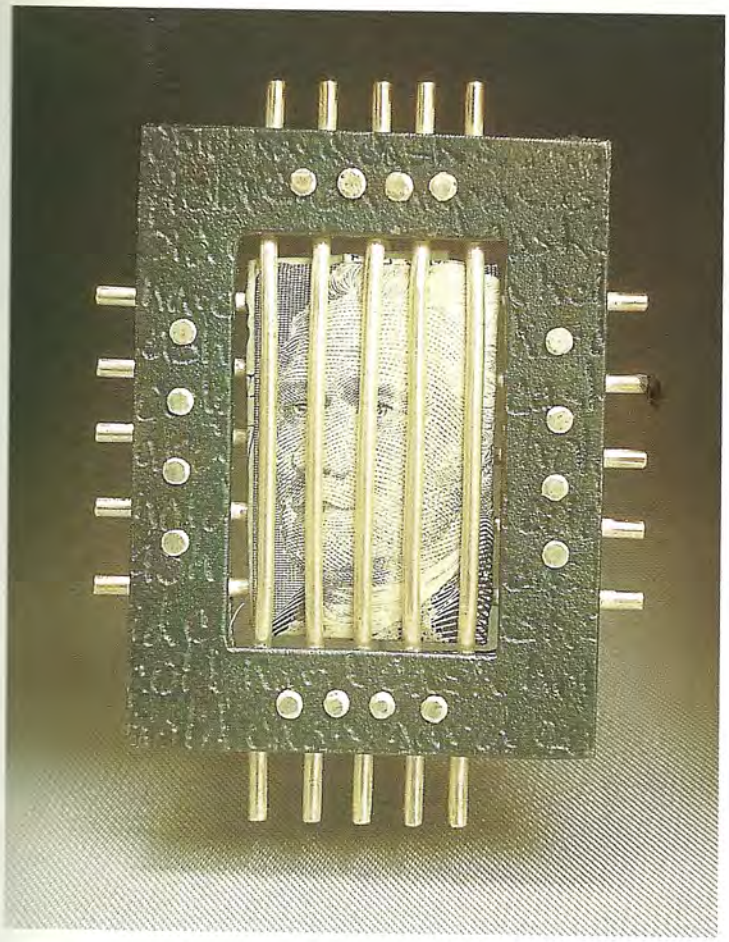
RIVETING

1 Riveting starts with careful layout. Centerpunch and drill holes in the top piece.



2 Use a needle to carefully locate a hole; then centerpunch and drill.

3 Insert a snug-fitting wire and trim it to the proper height.



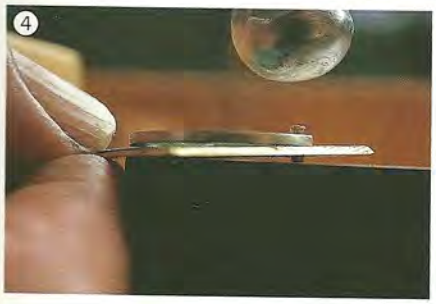
Steve Midgett, *Cold Hard Cash, Hold Cash Hard.* Steel, sterling, $10 bill. 1½ x 1¼".

about 1 millimeter should extend from the top and bottom at the beginning of the riveting process.

The top of the rivet should have a flat surface so it will not deflect the hammer blows that give it its shape. If snipping with wire cutters, remember to file the wire's tips enough to remove the pointed ends always left by that tool.

The Riveting Process

1. Prepare the pieces following the guidelines above, then slide a piece of annealed wire into the first rivet hole. Snip the wire to the correct length and file it to flatten both ends.
2. Set the assembly on a sturdy steel surface. The tool for this is called a *bench block*, but any handy piece of steel will work; a square hammerhead or a small vise are good substitutes.
3. Hold the work so the tip of the rivet wire on the underside is the only thing touching the bench block. Using a small ball peen or cross peen hammer, strike several light blows against the exposed tip of the rivet.
4. Flip the piece over and repeat the process. It won't take long before the upsetting of the rivet is enough to hold it in place. Continue flipping the piece, working on both sides as the rivet head grows. If using a cross peen hammer, alter the position of the hammer so the marks are at right angles to each other. That is, make the form of a "+" on the top of the wire. This will push the metal outward symmetrically and result in a large, even rivet.
5. As the rivet nears completion, use a small, flat, polished hammer to smooth and shape it. Further shaping can be done with a *beading punch*, a *cup bur* or sandpaper.



4 Elevate the piece slightly so the wire projects from both sides; tap lightly.

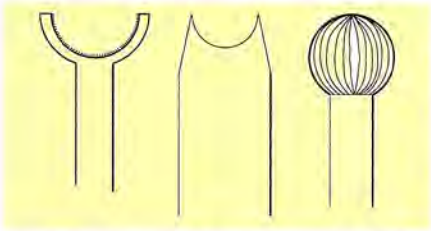
5 Drill the second hole, taking care that the elements have not pivoted.

6 Rivets can be shaped with a cup bur (right) or beading tool (here, made from a nail).

Finishing Rivet Heads

Because rivets are formed with a hammer, it stands to reason they will show hammer marks. In some cases, these random marks contribute to a design, and may even be exaggerated with stamping tools. Another alternative is to shape the rivet heads into delicate symmetrical domes. This can be done with careful use of files and sandpaper, but when more than a couple of rivets need finishing, use a cup bur or beading punch, or both.

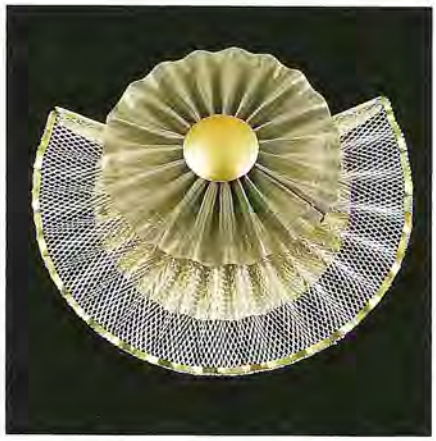
Beading punches are short steel rods, usually only a couple of inches long, with a polished hemispherical depression in one end. They are used primarily to harden and shape the tips of prongs in stone setting and are, unfortunately, too small for some rivets. To make a larger beading tool, saw the point off a steel carpenter's nail and use a drill bit or a *ball bur* to create a depression in the sawn end.



Left to right: cup bur, beading punch, ball bur.

Beading tools can be used manually or with a drill press or electric drill. Either way, rotate the tool aggressively while rocking it back and forth. Use a tool that is slightly smaller than the rivet head: in this way it will not scratch the jewelry even when it is rocked side to side. Many people recommend lubricating the action with a tiny bit of wax or oil.

A cup bur is a steel tool with teeth that remove metal. Unlike beading tools, these are almost impossible to make yourself. They work by cutting away excess metal to leave a uniform dome, which can then be polished with a beading punch, sandpaper or buff.

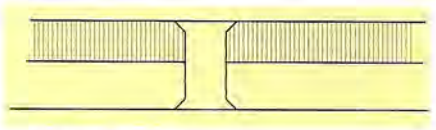


Arline Fisch, *Pleated Mesh*. Sterling, 18K, stainless mesh. 4½ x 4".

Specialty Rivets

Disappearing (Invisible) Rivets

This variation is made just like a standard rivet, but the material being joined is prepared differently. Holes are drilled in the usual way, but before riveting, the edge of the hole is beveled with a file or bur to create a funnel-shaped opening. Riveting proceeds as usual, but in this case the lump of metal that is upset fills the opening, so that the rivet head is formed flush with the surface. Any excess material can be filed away without danger of weakening the rivet. If the rivet wire is of a contrasting color, say, a copper rivet in a sterling sheet, the result is a dot of inlaid color. If the rivet is made of the same material as the top piece, the rivet will blend into the sheet with the usual finishing steps. Hence the name: disappearing. Amaze your friends!

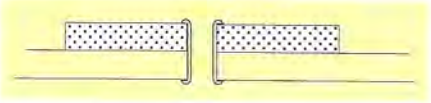


Invisible rivet.

Tube Rivets

This variation is recommended when joining a fragile material such as enamel, shell or ceramic, because it involves less tapping than a conventional rivet. It also has the advantage of leaving an opening in a piece that can be used for either ornamentation or for a functional requirement like hanging a pendant.

The idea is simple: Instead of a solid wire, a section of tubing is used to make the rivet. Copper and brass tubes can be purchased at a hobby shop, and most suppliers of sterling and gold sheet also sell a few sizes of tubing. If you have a drawplate, it's not difficult to make your own tubing, as explained in Chapter 7.



Tube rivet.

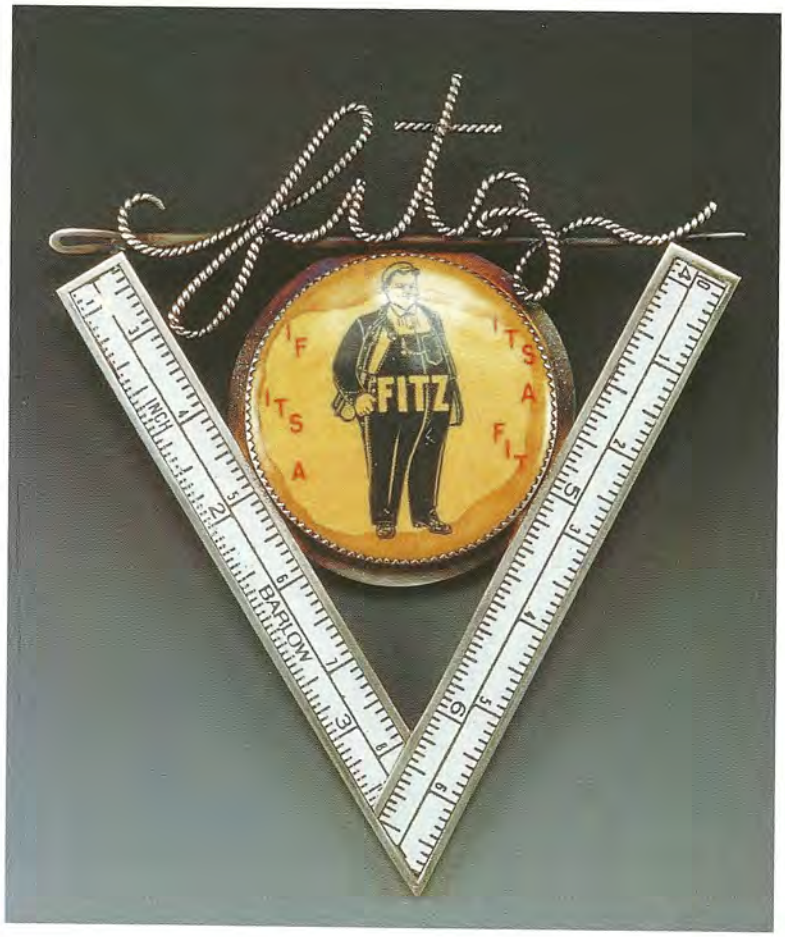
As before, holes are drilled carefully and must be a snug fit. The tube is annealed and slipped into position, then trimmed at the same length as a standard rivet. Here's where the similarity ends. With the rivet in position, insert a scribe or similar pointed steel object into the neck of the tube and twirl it around to curl the lip of the tube outward. Flip the work over and repeat the process on the reverse side, continuing until the tube starts to flare out like the bell of a trumpet.

Grasp a dapping punch vertically in the jaws of a vise. Sandwich the rivet between this and another, similar, punch on top. This process is easiest if someone holds the work for you as you manipulate

the tools and a hammer. Tap lightly to curl the rivet outward and cinch it tight. If you don't have the correct size dapping punch, it's easy enough to file a chamfer or bevel on a steel rod (e.g., a nail), which will do the same thing. Tap on the rivet just until it seats against the workpiece, to avoid stressing the pieces being joined.

Nailhead Rivets

This variation calls for an extra step as the rivet is prepared, and results in a rivet head that is either larger than usual, or requires no hammering, or both. Start by selecting a wire as before, and drill a hole that makes a snug fit. Draw a bead on the wire by holding it vertically into a flame, taking care to withdraw the flame slowly so as to ensure a smooth surface. Quench the wire in water and dry it off.



David and Roberta Williamson, *Fitz* pin. Sterling, found objects. 3 x 2½".

TUBE RIVET

1 Rotate a scribe in the mouth of the tube to bend it outward.

2 Gentle tapping with a rounded punch will curl the lip out and down.

The next step typically uses a drawplate, but you can also make the tool you need by drilling a hole the same diameter as the wire in an eighth-inch or thicker piece of steel. Rest this jig, or a drawplate facing right side up, on the slightly opened jaws of a vise, and slide the wire into the hole until the balled-up end sits against the plate. Use a light hammer to flatten the bead, and you'll have what looks like a nail. This rivet is finished in the conventional way, but has the advantage of having one end preformed. This makes it useful for situations when access to one end of a rivet is difficult. Because the head is larger than usual, a nailhead rivet lends itself to being textured, shaped or ornamented.

Square Rivets

A single rivet allows elements to pivot, which is, of course, sometimes desirable. In those cases where the pieces must remain stable, the usual solution is to use at least two rivets. An alternate method is to make the rivet from square or rectangular wire. Everything proceeds as described above, except that the hole is pierced with a saw and refined with a file to make a snug fit on the rivet.

Washers

When joining two rigid materials—say metal and shell—a couple of rivets are enough to make a solid connection. But when attaching a soft material such as leather, use washers to increase holding power.

Stacey Lane, bracelet. Sterling, pearls. 2½ x 2¾". *Photo by Gregory Staley.*

We all know what washers look like: disks of steel with a round hole in the center. Well, when it comes to jewelry, forget that. They can be steel, but they can also be gold. They can be smooth, round and symmetrical, or they can be highly integrated ornamental elements. Once the washer is in place, the process is exactly the same as above, and the decorative potential is enormous.

Threaded Connections

The easiest kinds of threaded connections to buy and use are small nuts and bolts from your local hardware store. You'll find them in brass, steel and stainless steel, all of which can be used for jewelry. Smaller bolts are often available through hobby shops, especially those that supply model train enthusiasts. Any of these metals can be soldered using the same flux and solders mentioned in the last chapter, but if you use steel, do not put the piece in pickle. It can be rinsed in very hot water to dissolve the flux, then cleaned with Scotch-Brite.

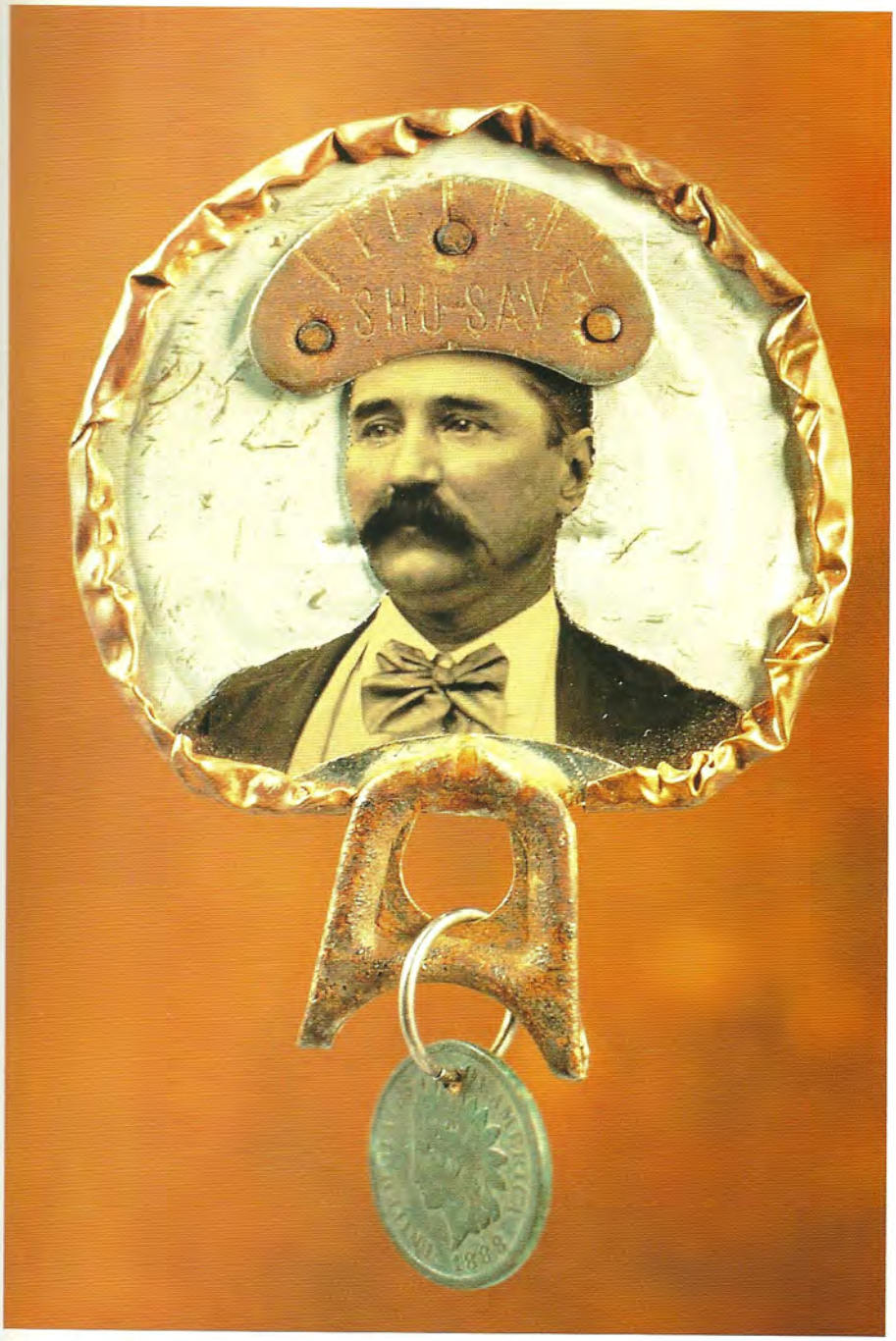
The advantage of using bolts to hold pieces together is that the elements can be removed—handy if repairs or cleaning are necessary. The disadvantage is the possibility that the nut might wiggle loose as a piece is worn. One way to guard against this is to put a tiny drop of glue into the nut after assembly. The bond can be broken with a sharp twist if the nut needs to be unscrewed. Alternately, strike the nut with a steel hammer while it sits on an anvil or similar support—this will crimp it slightly, making it more difficult to turn, both going on and coming off.

To cut your own threads you'll need a *tap* and *die*. These tools cut internal and external threads respectively, and can be purchased individually or in sets. Hardware stores carry sizes down to 1/16" (1.5 mm); jewelry suppliers can provide much smaller sizes. Taps and dies are sold with special handles that are worth buying if you plan to use them often.

The first step in using a tap is to drill exactly the correct size hole. Charts provided with the tap will tell you which drill bit to use. Once the hole is drilled, grip the metal firmly (e.g., in a vise) and screw the tap into the hole, using a forward-and-reverse motion; this will clear the tiny chips being cut as you go. Turn clockwise a half turn, then counter clockwise a quarter turn, always keeping the tap perpendicular to the sheet. Don't rush it, and don't use much force. Just guide the tool along until it spins easily in your hand.

When threading a rod, it's again important to start with raw material of a correct size. Dies are brittle and will break if you try to thread an oversized rod. Use a file if nec-

j.e. Paterak, pendant. Sterling, 14K engagement ring, mica, moonstone, printed paper. 1¼ x 1¼".



Robert Ebendorf, pin. Tin, tintype, tap, coin. 2 x 3".

essary to make the diameter equal to the largest diameter of the screw, which you can determine by measuring the tap. Grip the rod either vertically or horizontally and use the same screw-unscrew motion to guide the die down the rod. Again, make an effort to keep the die perpendicular to the axis of the rod.

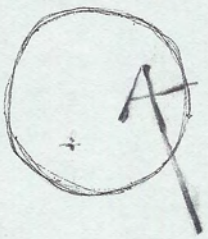
Adhesives

It's traditionally considered a sign of poor craftsmanship to use glue—and sometimes it is. If solder or a mechanical connection can be used, that's probably the route to go. But there are cases where adhesives are acceptable, and many instances when adhesives can be used to supplement mechanical joints. Perhaps the best rule of thumb is this: Whatever technique you use, the same high standards of craftsmanship should apply.

Glues are only as strong as the bond they make on the materials you're joining. Clean metal surfaces, with either sandpaper or a solvent like nail polish remover, to ensure an oxide-free surface. Follow manufacturers' directions carefully to guarantee good results. In the case of epoxies, this includes thorough mixing of the two components. Use a tool you can actually grip (not a broken toothpick) and massage the epoxy from several directions for a couple of minutes.

With the cyanoacrylates (Super Glue), bonding is achieved not by drying, but when air is excluded. That's why this glue is not recommended for porous materials, but works so quickly when you pinch your fingers together. Here again the rules of cleanliness apply.

Metals Technic



COLLECTION OF TECHNIQUES FOR METALSMITHS

Edited by Tim McCreight

David LaPlantz

Cold Connections

elcome to a new, exciting and perhaps unlimited way to speed up the construction of your art! Cold connections are mechanical or chemical devices that allow you to join elements without the heat of soldering. In addition to the possibilities of incorporating materials that cannot be soldered such as plastic or paper, cold connections make it possible to assemble prepolished and work hardened units. The best cold connections are not seen simply as necessary compromises to make assembly possible or easier but as a vital element in the design and logic of making art. For me they are a primary creative avenue down which I travel as I make my art.

Perhaps the best way to begin is to discover the many obvious and not-so-obvious cold connections around us. Be prepared to liberate your mind and your materials as we explore the fascinating world of cold connections! I'll bet that after you start using these fastening schemes you'll notice a multitude of connections in everyday life that have applications to your jewelrymaking. Be careful to look closely. It's funny and sad how we overlook basic things in our lives, failing to see relationships and their connection to our work. As I type this into my portable computer I recall slipping the disk into its slot with a click – the cold connection. They are absolutely everywhere!

To assist in your examination of everyday cold connections check out an incredible book called *The Handbook of Fastening and Joining Metal Parts* by Vallory H. Laughner and Augustus D. Hargan (McGraw-Hill. 1956, LCCN: 54-8801). If this 620 page book with its amazing illustrations doesn't give you at least a few ideas, nothing will!

With editing assistance from Shereen LaPlantz, to whom I am forever grateful!

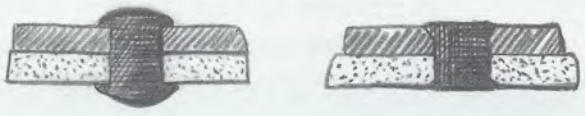
Thinking in Tangents

Before we get into the specifics of making these devices a few general observations might be in order. Thinking (or how we were taught to think) unfortunately often involves moving ideas in straight lines. Personally I prefer to think tangentially. A tangent, as you may recall from geometry, is the turning aside from a straight line or digressing. By thinking in a straight line, life and its solutions are generally boring and less creative than they might be. By thinking in tangents you are liberated, permitted to break off suddenly from one line of thought to pursue another direction. Obviously you can and will return to the straight line as often as required.

With all cold connections consider placement, spacing, the number and size of connecting units, their color, shape and height. Ask yourself if washers are needed for functional or aesthetic reasons and whether special tools or sequences of operation will be required.

Types of Cold Connections

Later I'll talk about adhesives but for now we'll focus our attention on mechanical connections. These fall into two categories; the type you make in the studio and commercially manufactured units that await your personal interpretation.



In a standard rivet, a bulge sits on top of the sheet as at the left. In a flush rivet, a counterbore, or flared opening accommodates this bulge. If the rivet is of the same material as the sheeet, this is called a 'disappearing' rivet.

Rivets

The theory behind rivets is simple: a rod, bar or tube passes snugly through the materials being joined and extends a little further on each side. A hammer is used to tap the metal back onto itself in a process called upsetting. It is this bulge that holds the stack together.

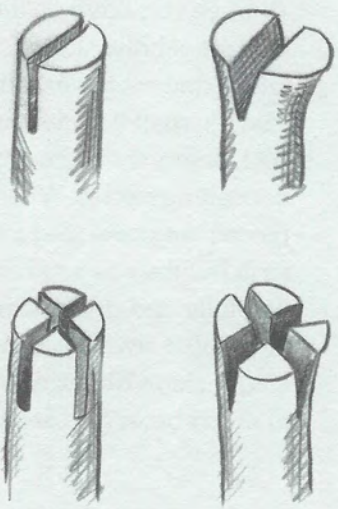
Though they are usually round, rivets can be any shape you want as long as you don't mind the time required to file appropriately shaped holes. This is true of tube rivets as well as the conventional wire rivet, though you'll need special tapered punches to facilitate the spreading of the rivet head.

Rivets can be set with a head either above the surface of the metal or flush with it. Standard rivets give an added dimension to a piece that might otherwise be boringly flat, while flush rivets are visual treats because they appear to float on the surface. If different colors of metal are used the effect glows. On the other hand if the rivet stock is the same color as the metal being joined the rivets will totally disappear.

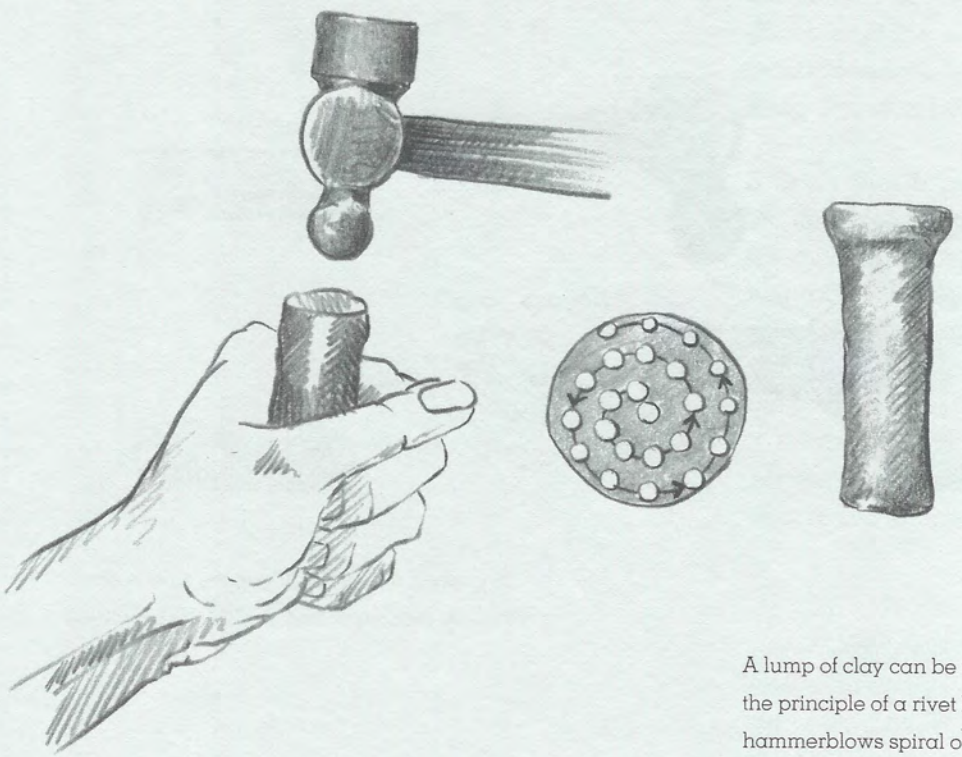
There are literally dozens of variations on this description, not counting the ones you have yet to dream up. For instance wire rivets can be cut with a fine jewelers sawblade and spread like a cotter pin. A double cut in the shape of an X will give a further variation. In either case the tip of the wire is simply spread with a knife blade or small screwdriver.

I usually use a small ball peen hammer for upsetting. Each blow from the hammer drives the metal out in 360 degrees. By starting in the middle of the wire and working outward in concentric circles the metal flows quickly and evenly. An easy and effective method to demonstrate the action of the hammer blows is to roll a rod of plasticine clay about the size of your little finger, making sure that both ends are flat. Hold the rod snugly in your fist as shown on the next page and use the ball peen hammer as described above.

Notice the relationship between the diameter of the rivet stock, the drill bit required to make a hole that fits and the drawplate hole that yields wire of this diameter. There are three parts to this relationship and when one part is established the other two are dictated by that one. For instance if you only had one size drill bit, that would dictate the wire gauge you need for rivet stock. Which, if you need to draw down the wire, corresponds to a specific drawplate hole. For example a number 53 drill bit equals about a 14 gauge wire which in turn equals hole #25 in my Joubert "E" drawplate. It's comforting to see how easy the relationships fall into place.



For delicate rivets, the wire can be split with a fine sawblade, making either one or two cuts. The grip is made by forcing the sides apart with a knifeblade.



A lump of clay can be used to illustrate the principle of a rivet head. As shown, the hammerblows spiral outward.

Simple Upsetting

1. Grasp the wire in pliers close to the hinge area, allowing about ⅛ inch (2-3 mm) to be exposed.

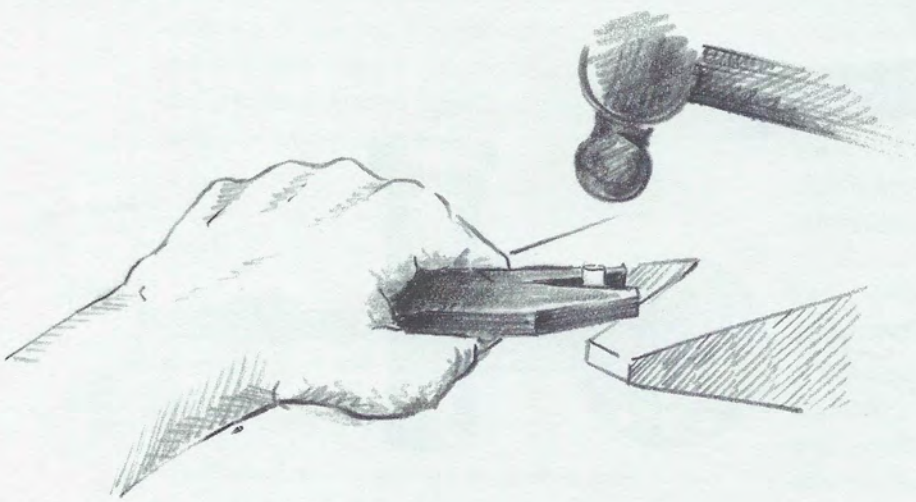
2. Rest the pliers on the bench pin and strike the wire with a small ball peen hammer, working from the center outward in concentric circles.

3. Keep checking to see that the upsetting is even, both from the top and in profile. Turn the wire completely around to be certain you check it from all angles.

4. Continue upsetting until the head is the desired diameter. Slip it into the hole in your piece for visual reference. Remember that in addition to aesthetic concerns, the rivet head must be large enough to satisfactorily secure the pieces being joined.

5. If many rivets are required, make them all now when you're into the rhythm of the operation. In this way they are more likely to all look the same.

6. Once you have all the rivets made and the first set of holes drilled, slide a rivet into place and set the assembly over a steel block. File the rivet if necessary to achieve the correct length, then upset it with light taps in concentric circles. When the first rivet is set the pieces are prevented from sliding back and forth but they can still rotate. Line the pieces up carefully and drill one more hole, then secure that with a rivet. Now the pieces can no longer move about, so it's safe to drill all the remaining holes and set the rest of the rivets.



To preform a rivet head, grip the wire in pliers that are then supported against the benchpin.

Some Do's:

1. Know whether your specific rivet material requires annealing before riveting.

2. If you question your design or rivet positioning make a matte board model first. This kind of rehearsal pays big dividends for first time experiences in life or art!

3. Always cut rivet stock longer than needed then adjust length by filing. Cutting new rivets is frustrating and a waste of time and materials.

4. Make a rivet sampler in various materials before assembling your final piece. I'm a believer in spontaneity, but in a controlled spontaneity!

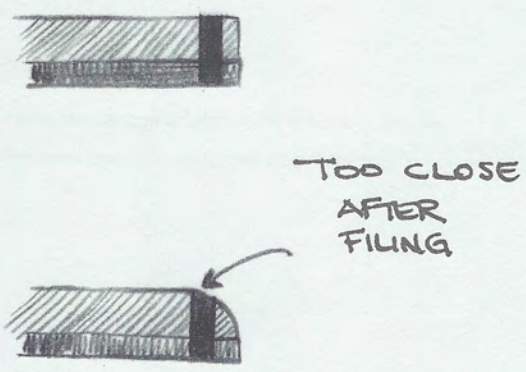
Some Don't's

1. Don't cut rivet stock too short!

2. Don't rivet too close to the edge of your materials. The minimum space is equal to the diameter of the rivet stock. More space is recommended. Remember to take into account filing that may take place after riveting.

3. Don't rivet through layers of material that are too thin. Use thicker metal or add washers to the outside of the pieces. Washers are especially important when joining leather or similarly soft materials that might allow the rivet head to pull through. Of course washers need a hole the same size as the rivet but they do not have to be round or flat. In fact this practical necessity can sometimes provide exactly the decorative element that a piece needs.

In planning the location of rivets, remember to account for subsequent finishing.



Tube Rivets

1. Drill or punch holes for the tube rivet. A tight fit is important.

2. Anneal the tubing then slide it into place and mark the correct length, allowing half a diameter to project on each side.

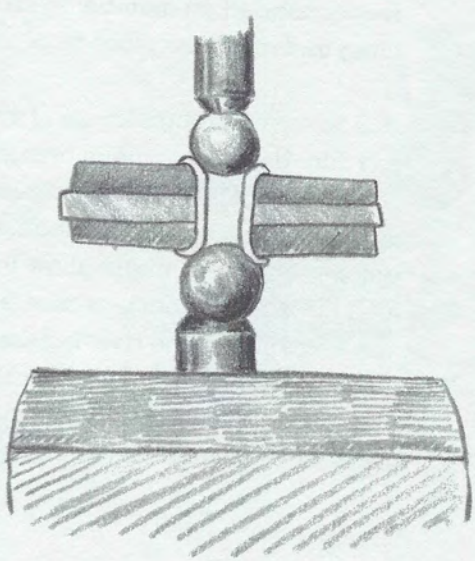
3. Saw the desired length, using a tube cutting jig if available.

4. File both ends of the tube smooth and square and slide it into position.

5. Rotate a scribe or similar tapered rod on an angle to flare each end of the tube as shown.

6. Continue the flaring, alternating between the ends of the rivet until it is locked into place. The final spreading of the rivet is done by striking the tube between two dapping punches. Secure one punch vertically in a vise and strike the other with a rawhide mallet.

To start forming a tube rivet head, insert a scribe and rotate it gently. Repeat the process from the other side, alternating back and forth as the rim rolls over.



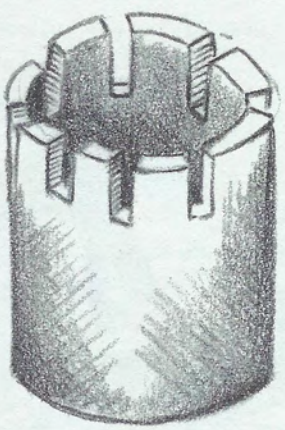
A tube rivet can be further secured by setting it between two dapping punches and striking lightly.

7. A tapered punch with a blunt end is then used to finish the flaring. The other end of the tube is supported on a steel block during this operation and then of course the piece is flipped over and the process is repeated on the other side.

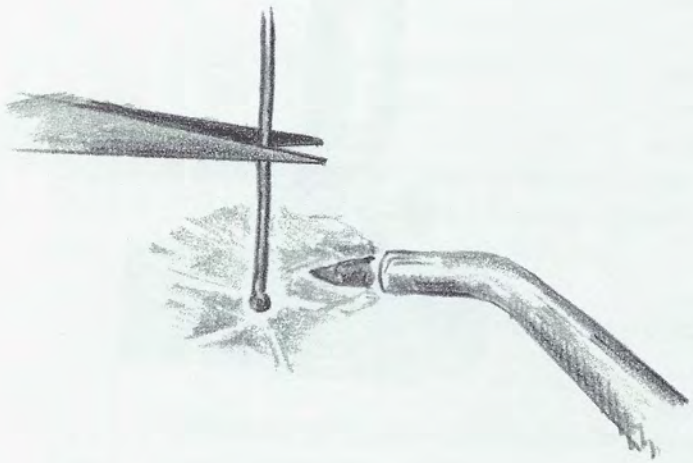
8. Finish the flared surface on each end as needed with files, sandpaper, polishing, engraving, etc.

In an alternate method the end of the tube is slit with a fine sawblade. I recommend making 3 or 4 saw cuts across the tubing to a depth of at least half the amount of the rivet that projects. When the tubing is spread with the tapered tool the saw cuts will facilitate spreading, making the flaring almost instant.

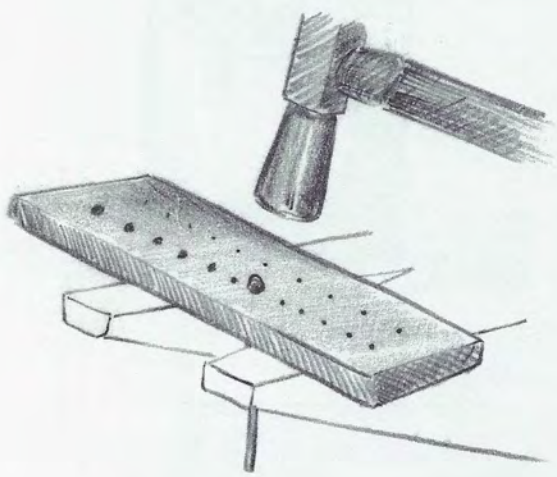
For small tube rivets, make a punch like this to complete the setting. It will leave a tight and neat looking head.



An interesting and especially gentle tube rivet can be made by slicing into the tube with a fine sawblade.



To draw a bead on a wire, hold it vertically in a torch flame. Allow the bead to crawl upward, then remove the flame gradually to insure a smooth surface.



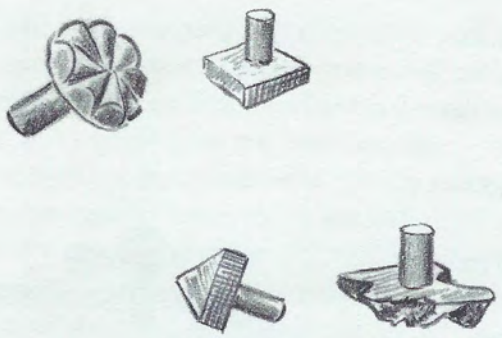
Slide the wire with its bead into a drawplate and planish it to create a nailhead.

Ball Head Rivet

In this variation a larger than usual head is made on the rivet through the use of heat. Clearly this is done before the rivet is in place. Any jewelry torch can be used to create a small ball on the end of a wire in a process called "drawing a bead." Start with about 5" of wire in the appropriate gauge. Hold the wire vertically 3 or 4" below the plier's jaws and heat the end with a sharp intense flame. As the end of the wire melts, it will draw itself into a sphere and crawl up the wire, getting bigger as it goes. If you try to melt too large a sphere, mean ole Mr. or Ms. Gravity will invite the ball to drop off the end of the wire so I always work over an annealing pan just in case. If the ball is going to drop off it's better that it land in your pan than in your shoe!

The new rivet can be positioned on the piece and riveted as usual with one exception. Having gone to all the work of creating a ball-headed rivet it would be a shame to flatten that head by mashing it on a steel block. Instead, use the endgrain of a piece of hardwood to support the rivet on the underside. An alternative is to use the steel block and hammer with moderate or light blows. The top of the ball will flatten out, leaving the sides nice and round.

To create a nailhead rivet, start by drawing a bead as described above. Insert the wire into the appropriate sized hole in the watchmaker's rivet block or from the front of a drawplate. With this steel support resting on the bench pin, flatten the ball to the desired 'squish' using any flat-faced hammer.



Nailheads can be shaped with files, fabricated from sheet and wire, and cast.

Exotic Rivet Heads

Consider sawing flat sheets from 16 gauge or thicker metal sheet, then soldering rivet wires to the back. Suddenly the choice of rivet heads is expanded many fold! Cast forms can also have rivet wires soldered to their backs. Remember that when working with these decorative forms, the support block beneath the rivet should be of wood rather than steel to minimize the damage to the design.

Nails and Commercial Rivets

Brass and iron nails are available in many shapes and sizes. They work well as rivets and are quick to set because one end already has a preformed head, which can be used as is or customized. Commercially made rivets are available in several sizes and materials including copper and anodized aluminum. One end is already flared, usually with a flush head. I am intrigued with the shape of these rivets but they do not lend much creatively to my work. You decide for yourself.

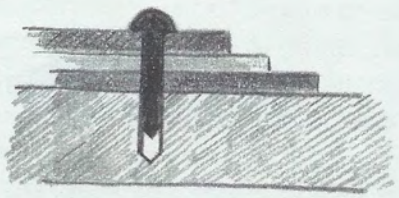
Grommets

Commercially made eyelets or grommets can be used as rivets, assuming they are tall enough to go through all the materials. Your local sewing center should have eyelets in aluminum that are silver colored along with some painted colors such as black, green, white, etc. A simple but effective setting tool can usually be purchased at the same store. One such tool is a pair of pliers with a die built into the jaws. Another is a single male punch that requires a hammer to cinch the grommet. Simple instructions supplied with each rivet setting tool provide gratifying results.

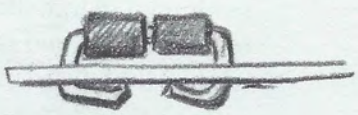
NAILS

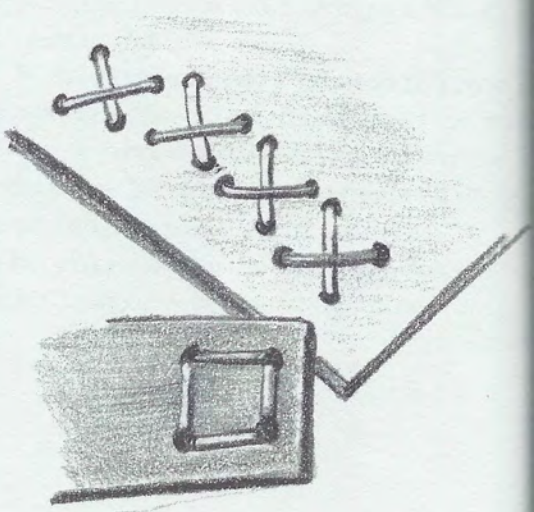
A nail can be as strong as a rivet but it must be driven into metal at least ¼ inch thick to provide a solid grip. In my work I like to use HO train scale iron nails but brass nails will work just as well. I have had splendid results using the HO nails to connect 24 gauge aluminum to anodized aluminum rods.

I drill holes the width of the nails through the thin pieces first. Using the drilled sheet as a template I mark the thicker metal and drill pilot holes into the rods. The diameter of these pilot holes needs to be 75–80% the size of the nails to insure a positive grip. They should penetrate only to about two-thirds of the metal's depth. The pilot hole allows the nail to be driven into the metal with ease without it jamming or bending over. Shorten the nail as needed to eliminate the telltale bump that will otherwise appear on the top side of the piece. Cut off nails will need to have new points filed on their ends.



When using small nails, pre-drill a hole that is longer but smaller in diameter than the nail. This will create a friction fit along the shaft of the nail and insure that you can drive it down tight.





Staple shapes can be used in many creative ways.

STAPLES

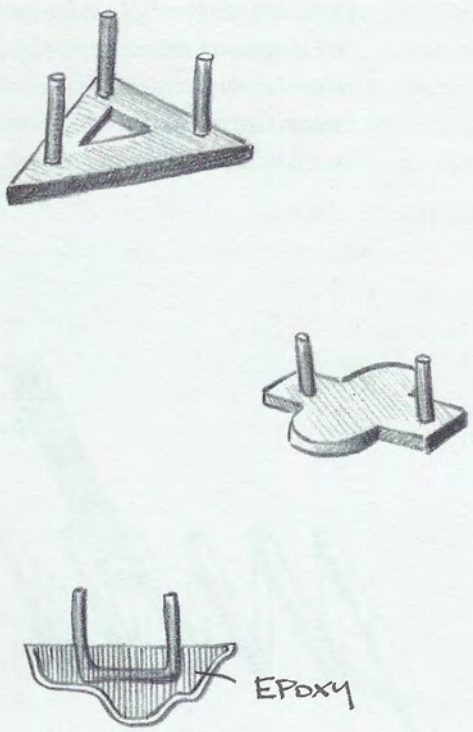
The staple is amazing for its simplicity and versatility. Staples, of course, are a one piece construction consisting of a flat top (head) and two legs. Staples are commercially available but in the context of jewelrymaking they are usually made in the studio from either wire or sheet.

If staples are made individually for specific pieces, holes are marked and drilled as each staple is applied. If commercial staples are used or if you have contrived a jig to produce a quantity of identical pieces, make a plastic template to facilitate the placement of holes.

When assembling units, the staple is slid into position and pliers or a bezel pusher are used to bend the legs down. They can be bent either inward or outward. If the materials being joined are not too fragile the staple can be tightened by striking it with a mallet.

If you find your staple connection designs becoming boring, think about overlapping one staple on top of another in an X pattern or perhaps stringing beads on the staple. Staples can be fabricated by soldering wires to sheet metal shapes and cast units, or by epoxying a leg into a hollow form, as shown in the illustrations on this page.

To mark drill holes for unusually shaped staples, trim the ends of the staple legs flat and press them into an ink pad like those used for rubber stamps. Carefully position the staple and lower it against the object, where the ink will leave clear marks to be center-punched and drilled.



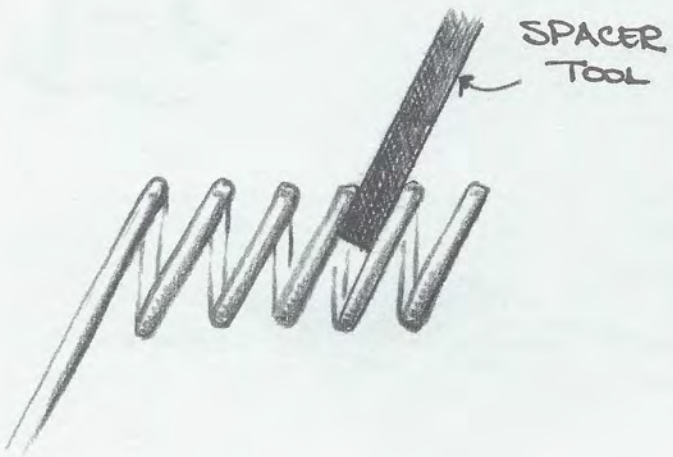
The staple concept can also be applied to fabricated or cast elements.

Coil Connections

The familiar student's notebook presents an excellent example of a spiral connection. Examine one and you'll quickly see a simple theory to add to your cold connection Catalog of Solutions.

To calculate the diameter and length of the spiral, measure the thickness of the material being joined and add about 30%. This is the coil diameter. Obviously this dimension may vary depending on your personal design needs and the degree of movement you want to achieve.

The space between the coil holes and the distance from the edge of the metal should be at least equal to the size of the hole itself. Be sure that the hole is large enough to allow the elements to move freely. A hole that is twice as wide as the coil wire would be typical. Experiment with a cardboard model and you'll soon see the relationships.



How to Make a Coil Connection

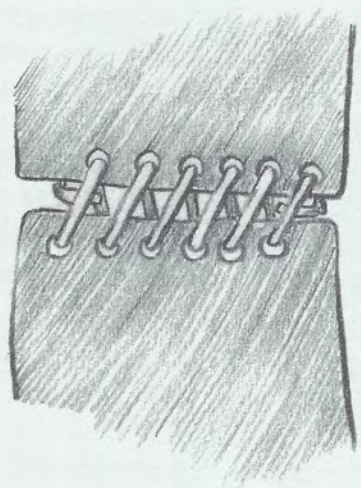
To determine the length of wire for your coil, first decide on the intended diameter. Because the wire needed to make a loop is about three times its diameter ($C=\pi D$), multiply the diameter by 3 to determine the length of wire needed for each loop. Multiply this figure by the number of holes in the pieces being joined and you'll know the length of the wire you should start with. Of course it's wise to add a little more to be on the safe side.

The coil is made by wrapping the wire around a metal mandrel of the correct diameter. Wooden mandrels can compress during winding, making an uneven coil. Grip the mandrel horizontally in a vise so it sticks out about an inch longer than the length of the coil you wish to make. Rather than start from the very end of the wire, allow about an inch to overhang the mandrel when you lay the wire perpendicularly across it. While holding this section, use your other hand to wrap the wire as tightly as you can. Be certain each new turn of the coil is pressed against the last link. With the coil still on the mandrel, grasp each end and gently pull them outward. To guarantee that each wrap is even, make a tool from a strip of wood or stout cardboard. This should be a square about 2" on each side and exactly as thick as the space you want between each turn of the coil. Note that this is also the distance between the holes on the metal plates. Use masking tape if needed, to thicken the tool.

Remove the coil from the mandrel and insert the cardboard tool between the first and second turn of the coil. Rotate the coil, "screwing" it along the tool from one end to the other until the coil spacing is uniform. To assemble the pieces, thread or rotate the coil through the holes, almost as if you were driving a large screw. Bend the wire in a 90° angle at each end of the coil to keep it in place.

Sewing and Stitching

Just as you can sew cloth to cloth with thread, you can also sew metal to metal with wire, thread, or any other kind of fiber. Consider that wire can be drawn to any thickness and comes in many colors and you'll agree that the solutions are limitless. I recommend examining everything you can find that is sewn together. Once you have all this visual information in your gray matter, the solutions will pop out when needed! For more examples look into Oppi Untracht's book, *Jewelry Concepts and Technology* (Doubleday, New York, 1985). He has a great section of stitching examples. Embroidery, basketry and macrame books will also offer interesting ideas.

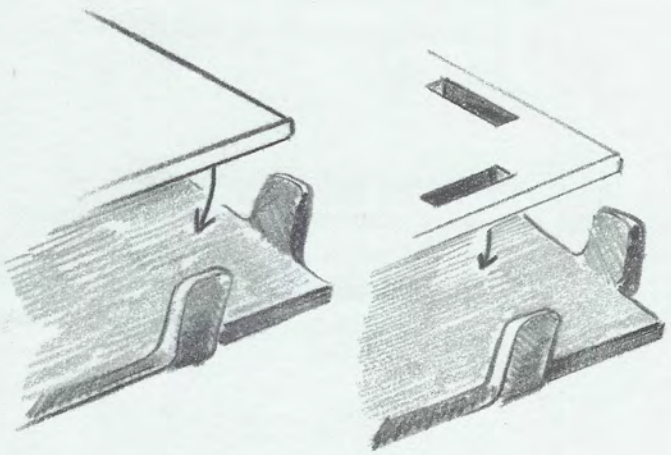


Tabs and Slots

Remember the tongue-like shapes that hold clothes on paper dolls? Tabs like those and variations on them can offer dozens of possible cold connection options. An examination of toys, appliances and household items will probably reveal many possibilities.

The most familiar use of tabs is to bend them over an edge or through a slot. If the tab has passed through a slot a simple twist will hold the metal pieces together nicely. As mentioned before, a light tap with a mallet can be used to tighten the joint as long as it won't hurt the materials.

Consider making the tabs as decorative as possible, opting for nifty shapes rather than simply staying with the expected tongue shape. Similarly, the relationship between the shape of the slot and its location on the piece can create a sense of drama and personal artistic judgement.



Tabs can be wrapped around the outside of a piece, or can slide into slots.

Adhesives

Though there are contexts in which the use of glue is seen as poor craftsmanship, it would be closedminded to disregard this branch of cold connections out of hand. Sophisticated adhesives are available today that were science fiction less than a decade ago. For a broad-minded person, the addition of adhesives to the jeweler's arsenal is as logical as accepting a new torch or hammer design.

When using any adhesive it is vital that the metal surfaces be chemically clean. I use a Scotch-Brite pad which has the advantage of creating a tooth, or roughened surface, as it scrapes off any oxide or grease film. If the object has a finish you'd rather not damage, clean it with denatured alcohol then rinse the piece and allow it to dry before applying the adhesive.

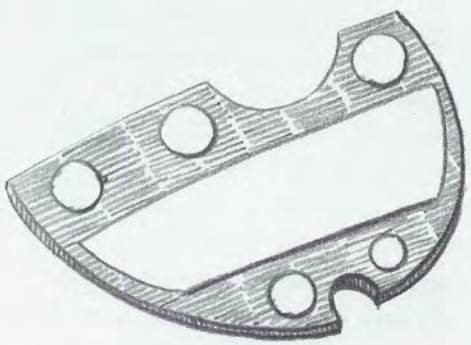
Follow the manufacturer's instructions meticulously! Especially in the case of high-tech epoxies and adhesives, the success of the joint can be dramatically affected by relatively minor infractions. For comprehensive information on adhesives and suppliers, look into *The Adhesives Red Book* in your local library.

Double Stick Adhesive Tape

Double stick or self-adhesive tapes are fast, fun and easy to use for instant and durable connections. These adhesive tapes come in a variety of forms such as rolls, squares, rectangles and dots in 8, 10, 12 and 14 mm sizes. All adhesive tapes come with a thin protective paper liner on each side. This should of course be left in place until the very moment when the pieces are being assembled.

I recommend using adhesive tapes of different colors and thicknesses to add variety to your laminations. Most adhesive tapes are either black or white but I color the edge with a permanent felt marker to meet my needs.

The Scotch brand 3M #4016 Scotchmount-Natural D.C. 1/16 inch urethane foam tape is superb for holding power as is SE-LIN from Gaylord. The latter is incredibly aggressive, paper thin (36 gauge) double stick and is available from Aardvark Adventures, P.O. Box 2449, Livermore, CA 94551–2449. Write to the Industrial Specialties Division of 3M at Building 220-7E-01, M Center, St. Paul, MN 55144–1000 for information about the Scotch Joining Systems, A-20 Acrylic Adhesive Family Products.



Combinations of dots and rectangles of adhesive are a simple way to secure a complicated shape.

Using Tape

Use a sharp pair of scissors or an X-Acto knife to cut the tape slightly smaller than the object being adhered. If the blade gets gummed up with adhesive, clean it off with Q-tips and acetone. Be careful that you don't accidently cut yourself.

As mentioned, be certain that the metal to be joined is clean and grease-free. Because oxides form quickly, the metal should be cleaned within a few minutes of the construction. I always place the tape on the back side of the top or overlay piece first because it's usually easier to position the element from the top down. I use my knife blade to remove the protective liner and to help in the placing of small pieces. In fact I find that I rarely cut odd shapes of tape, but rather cut a square or rectangle for the body of the piece and rely on precut dots to take care of the odd shaped extensions.

Screws

Small taps and dies are available to the goldsmith who wants to make his own threaded units but I use commercially available brass screws and nuts. These are sold at hobby stores that cater to model railroad enthusiasts and come in a range of sizes and lengths. The same source will also sell socket tools that will make the tightening of these tiny elements relatively easy. It's a worthwhile investment if you plan on using this type of cold connection a lot. If not you'll be able to get by with pliers or tweezers.

To use the screw, drill a hole that is large enough to allow the threaded rod to pass through without having to be forced. This could damage the threads. Make certain that the screw is long enough to allow 4 or 5 threads to stand proud of the surface. If washers are to be used, remember to calculate them into the overall length. Brass washers are usually sold along with the screws but of course you may want to make your own.

Assemble the pieces and tighten the nuts. Excess screw material can be snipped and filed away, which has the added advantage of creating a bur that will lock the nut in place and minimize the chance of its vibrating loose. Of all the cold connections mentioned, this has the unique advantage of ease of removal. For this reason it is recommended when there is the likelihood that the jewelry piece will need to be disassembled in the future.

Conclusion

The cold connection should not be seen as a secondary method for constructing your art. Think of it as the primary creative avenue down which you may travel to partially or completely assemble your art. The time required to construct your pieces with cold connections might allow you to have more free time to enjoy your life. And to make more art! Hallelujah!

David LaPlantz is a designer and jewelrymaker whose work can be found in numerous collections and galleries across the United States. He is the author of *Artists Anodizing Aluminum* and a professor at Humboldt State University in northern California.

JEWELRY

CONCEPTS AND TECHNOLOGY

OPPI UNTRACHT

AUTHOR OF "METAL TECHNIQUES FOR CRAFTSMEN"

RIVETS AND RIVETING

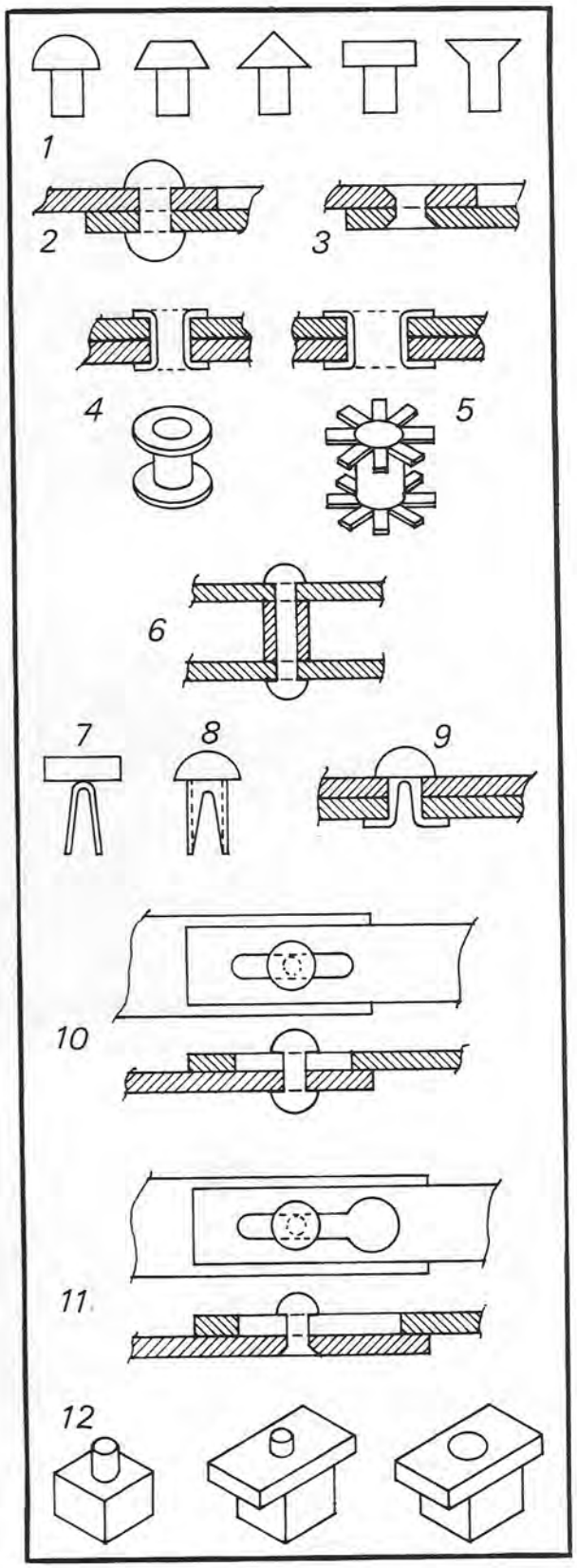
A cold percussion closed pressure joining system

Jewelry can be constructed by joining parts with rivets, joining devices that do not require heat, but are cold closed. The basic, conventional *rivet* is a malleable metal pin, usually cylindrical in shape, used to hold two or more metal parts together. A rivet consists of a *head* at one end, a *shank* which passes through the holes made in the parts being joined, and a *tail* or the end opposite the head, formed into a second head.

RIVET CONDITIONS USED IN JEWELRY

Rivets can be used in jewelry in different conditions. A *fixed rivet* is one that permanently immobilizes the parts joined by tight pressure exerted on the parts between the top and bottom heads. A *pivotal rivet* does not have a tight fit, but permits the movement of the enclosed parts with the rivet shank acting as a pivot that allows the parts to move in a fixed radius on the shank, the rivet acting as a spindle. This can be accomplished by inserting a thick piece of paper under the rivet heads, and when the riveting is completed, burning the paper away. A *sliding rivet,* also called an *almain rivet* which originated in use with armor, is one whose shank moves or slides within a groove. It is used when sliding movement is required. Although it slides, its installation can be permanent, or it can be removable along with an attached part, as when it is used as a fastening device for necklaces and bracelets. A *fixed almain rivet* can have a round or square shank whose diameter must equal that of the slot, the head diameter being larger than the slot so it does not pass through. By sliding up and back, the attached parts can move a total distance equal to the slot length, thus providing flexibility. *Removable almain rivets* require the presence at the slot end of a shape in the slot equal to that of the rivet head, allowing the rivet to be removed since the head passes through the opening.

The *brad* or *integral rivet* takes its name from the headless nail called a *brad.* This term was adopted in forging to indicate a rivet type made by shaping the end of a



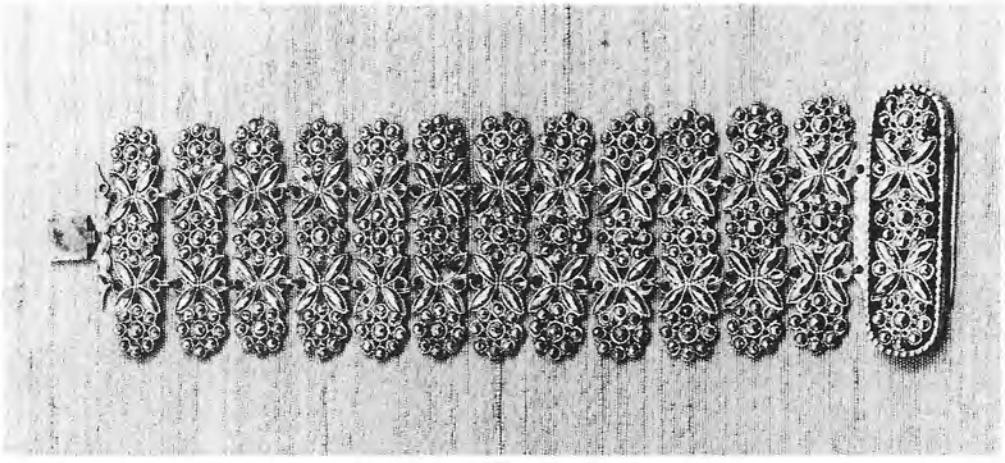
10–44 *RIVET TYPES*

1. *Rivet head shapes,* left to right: Buttonhead or snap; flathead or pan; steeple or conical; square; countersunk or flush.
2. *Buttonhead rivet* with both ends set down holding two sheets of metal.
3. *Countersunk* or *flush rivet* set down holding two sheets of metal.
4. *Tube rivet* with flanged top and bottom, set down holding two sheets of metal.
5. *Tube rivet* with saw-divided flanges.
6. *Rivet* used with *tube sleeve spacer* to hold apart the two units joined and allow flexibility.
7. *Split rivet* with square head and bent wire shank.
8. *Split rivet* with buttonhead and tapered, solid, split shank.
9. *Buttonhead split rivet* set down with legs spread.
10. *Permanent, fixed sliding* or *almain rivet,* the slot smaller than the rivet head; plan and elevation view.
11. *Removable sliding* or *almain rivet,* with slot that develops an opening equal to the head shape so it can pass through; plan and elevation view.
12. *Brad, tenon,* or *integral rivet, left:* the brad formed on the stock; *center:* the brad entered in a hole in the second part; *right:* the brad rivet head set down flush.

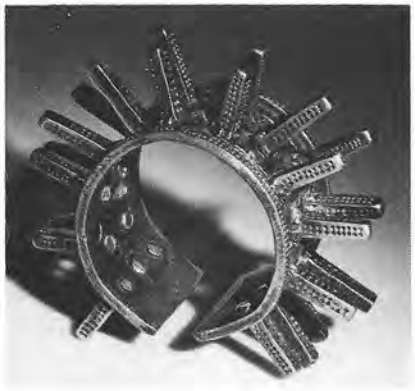
10–45 EMMY VAN LEERSUM, Netherlands. Bracelet in aluminum, bent and riveted. *Photo: Courtesy Museum Bellerive, Zürich*

10–46 BÖRJE RAJALIN, Finland, designer; manufacturer Kalevala Koru, Helsinki. Silver bracelet made without soldering. The two front balls are screwed together, and the almain sliding rivet closing locks because of the spring hardness of the bands. *Photo: Otso Pietinen, courtesy Kalevala Koru*

10–47 RUTH S. ROACH, U.S.A. "Weeds." Sterling silver bracelet with 14K gold shot soldered to 16 gauge B.&S. wires joined to the front, spring-hardened frame unit. The mirror-finished, plain inner band reflects the image of the weed units, creating a sense of depth. Four almain or sliding rivets at the back (seen in the rear view) fit the keyhole slots of the textured and oxidized front frame unit, allowing removal of the inner band for polishing. *Photo: Bob Carvill*

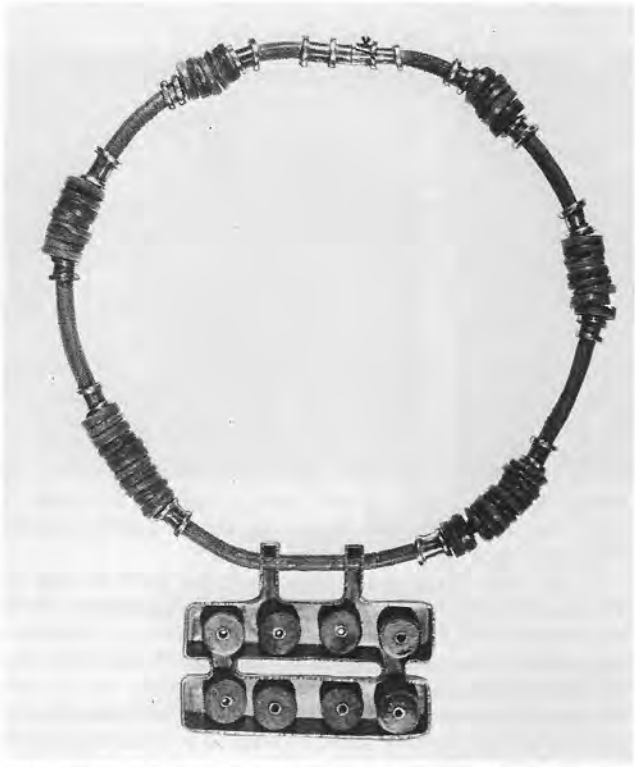


10–48 WOODSTOCK, ENGLAND, late 18th or early 19th century. One of a pair of bracelets, surface ornamented with densely placed steel rivet studs each with an integral rivet that passes through a solid or pierced work baseplate and is riveted at the back. The visible heads are rose cut and highly polished. Here the baseplates are linked together, but complex structures of several interlocking baseplates joined at the back by riveted crossing bars were also made. This cottage industry was centered mainly at Woodstock, north of Oxford. Similar work was done in France and at Tula near Moscow. *Photo: Victoria and Albert Museum, London, Crown Copyright*

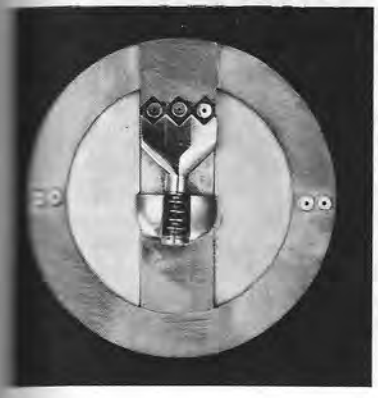


10–49 *Left:* BERBER, SOUTH MOROCCO. Silver bracelet with each upstanding square-shanked, pattern-stamped unit, equivalent to an extended and ornamented rivet head, joined to the band as a brad or integral rivet, its shank passing through to the inside of the cylindrical bracelet surface, and the tail hammer spread. Ø 11.7 cm. *Photo: Linden Museum, Stuttgart*

10–50 *Right:* DAVID LAPLANTZ, U.S.A. Pin fabricated of mild steel, copper, and brass, using headed rivets and tube rivets for function and decoration. Length 2½ in. *Photo: David LaPlantz*



10–51 RAMONA SOLBERG, U.S.A. Necklace with fabricated silver pendant to which disc-shaped Tibetan rosary beads made of human skull bones (*thod-'phreng*) are held by flanged tube rivets. The neckpiece uses the same beads in groups spaced by silver tube beads and sections of round leather thong. *Photo: University of Washington, Audio-Visual Production Services*



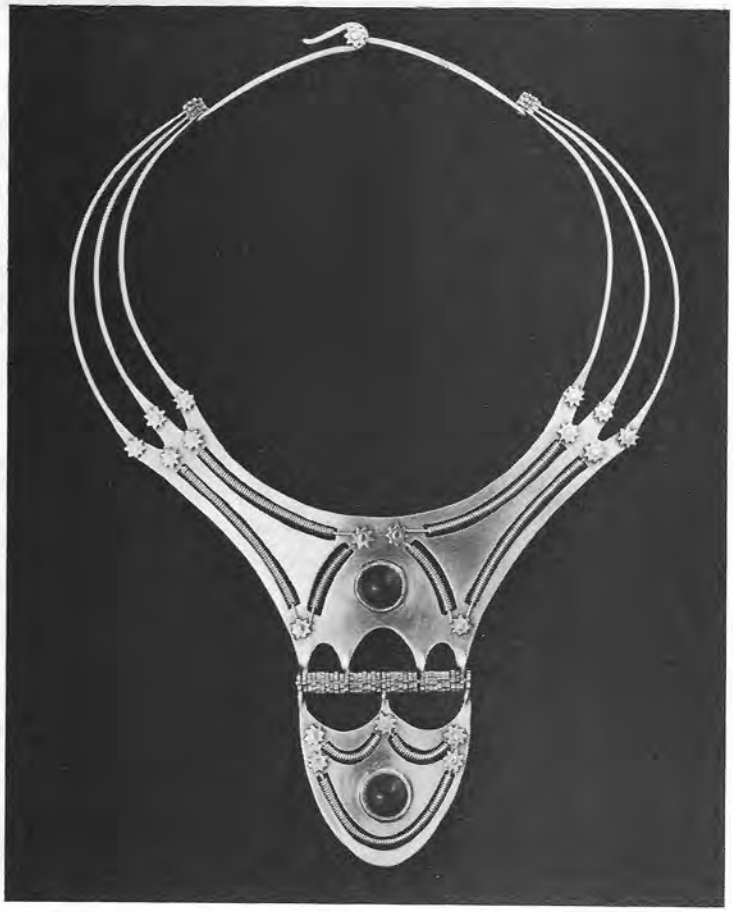
10–52 REINHOLD REILING, West Germany. Yellow and white gold brooch ornamented with rivets with centrally drilled holes. *Photo: Günter Meyer, courtesy Schmuckmuseum, Pforzheim*

square or round stock bar to the form of a headless rivet, joined structurally to the part from which it projects. The projecting rivet, which is an integral part of the main body, is passed through a hole in the next part and a rivet head is formed at its only end to hold them together; this process is called *bradding*. There are many situations in jewelry construction in which this system or a variant of it could be used.

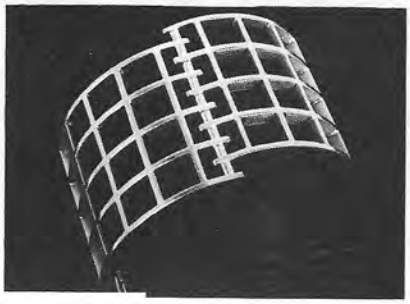
Split rivets have a conventional head, but their shank is bifurcated or longitudinally divided into two (or more) parts that might better be called legs. The legs can be made from a rod sawed just short of dividing it in two, or a metal strip or wire bent to a U shape, then soldered to a head. When such rivets are used, the head is often a decorative one, possible because this rivet is not subjected to hammering. The legs pass through the holes in the metal sheets, and the parts that protrude beyond them are bent backward, like a paper clip, to fix the head in place. The head can be kept from turning by making the legs from square or flat wire and making a square hole to match. This type of rivet is widely used in Tibetan jewelry and metalwork. Split rivets with decorated heads can also be used as *studs* in materials other than metal, such as wood, plastic, tortoiseshell, leather, or cloth.

RIVET HEAD SHAPES

There are several different types of preformed rivet heads, each named according to its shape. The more common ones are: *buttonhead* or *snap* which is half-round; *flathead* or *pan* which tapers upward away from the shaft



10–53 EMILY BOLSTER SOHIER, U.S.A. Sterling silver necklace, mainly rivet constructed. The star shapes sawed from sheet are decorative rivet washers used to form a seat for the rivet heads, and were drilled and countersunk before sawing. After assembly, including the looped wire ends of the wrapped wire units, both rivet ends were hammered to form a raised head at the front that fills the countersunk area. The free-floating crystal spheres are set in a sawed-out, domed disc soldered at the back. The ball was placed from the back and the straight bezel closed over it, just as for any cabochon stone. Length 8½ in; width 6¼ in. *Photo: Sohier and Olaf Skoogfors*



10–54 ANNI and BENT KNUDSEN, Denmark. Silver bracelet in two rigid units made of square wire, held together by a rivet hinge joint, the parts between square wires sleeved by nine tube sections that allow the relative movement of the inner rivet shaft. *Photo: Knudsen*

and has a flat top; *steeple* or *conical* which tapers to a point; *square* whose sides are straight and top flat; and *countersunk* or *flush* which is tapered toward the shank to fit a similar taper made in the metal with a rotating bur, and has a flat top. Except for the countersunk rivet, the heads of all these project above the metal surface.

It may not be possible to purchase ready-made rivets in desired sizes in the precious metals, but they can easily be made from round wire. Entire pieces of jewelry can be assembled with rivets alone; the rivet heads can be visible, or rivets can be used in unobtrusive ways to hold parts together.

RIVET SETTING

DEMONSTRATION 17

NILDA C. FERNANDEZ GETTY utilizes rivets on a pendant

Photos: Les F. Brown

SETTING OR COLD CLOSING A FIXED, FLUSH-HEADED RIVET

1 Measure the diameter of the wire used for the rivet shaft with *calipers* or *micrometer*. Select a *twist drill* of exactly the same size, and mount it in a drill or in the chuck of a flexible shaft.

2 Place the point of a *center punch* or, used here, an *automatic center punch* over the marked exact center of the hole. An ordinary center punch is then hammered, but this automatic type is pushed down on the body to release the striking mechanism, which is adjustable for light or heavy strokes.

3 Place the work on a wooden surface and drill the hole simultaneously through *both sheets* being riveted. Hold them tightly together, or tape them together with *masking tape* so they do not move and the hole stays properly aligned. A *high-speed drill* is used here. The resulting hole size should allow the rivet shaft to enter in a tight push-in fit.

4 The simplest rivet is made from a straight length of wire, here silver. It should be a little longer than the combined thickness of the two sheets to allow the formation of the heads from the surplus. This head will be flush and the rivet is a fixed rivet so the parts are permanently held together without movement. The rivet head formed must have a wider diameter than the hole so it does not slip out. Before forming the head, file the end of the shank wire flat and perpendicular to the shank so that when it is hammered to form the head, the same amount of metal is available to spread in all directions.

5 To set down a flush rivet, place the work on a *flat surface block*. Be sure the rivet shank end lies flat on its surface and is perpendicular to it.

(If you are using a rivet with one preformed head, such as a common buttonhead, place the shank in the holes and force the rivet down until its shoulder rests flat, squarely against the metal. Then place the head into a *rivet block* or *dapping block* depression that matches the rivet head size.)

To head the rivet, first use the cross peen of a lightweight *riveting hammer*. While the work contacts the block, strike light blows on the edge of the shank, and turn the work with the left hand until a full circle has been made. Reverse the rivet and work and repeat this from the other side of the rivet. Continue to upset the rivet end until the rivet holds the sheets tightly together. Then hammer the rivet head to spread it.

If the rivet shank is too long, or if the head on one side has been favored more than the other in the setting down, the shank may bend. Straightening it is very difficult or impossible. Remove the rivet by sawing off one head; then extract it and make a new rivet.

If construction indicates that the rivet pin may become twisted in use, or will allow unwanted movement, provide against this eventuality by using a square-shanked rivet and a matching square hole.

6 To hammer the head flush with the rest of the metal, flatten it with blows from the round planishing face of the rivet hammer, which will spread and level the head.

INVISIBLE, COUNTERSUNK RIVETS

A *countersunk bur* could also be used first to form a tapering depression in the metal before the rivet head is set down. In this case, the flush rivet can be almost invisible if it is of the same metal as the metal being joined.

SETTING DOWN A HEADED RIVET

Headed rivets can be set down with a *rivet set* (also called a *riser*) and a *rivet snap*. The set is a punch with a depression at its end that matches the rivet shank. The snap is another punch that at its end has a cup-shaped depression used to form the second rivet head (assuming the rivet already has one head), or for shaping both heads. A *combination rivet set and snap* tool exists, housed in an oval-shaped punch that has both depressions at the same end.

Assuming a rivet with one existing head, the total length of the rivet shank should be 1½ times the thickness of the sheets being joined, the extra allowance used for forming the second head. Proper shaft length is important to avoid

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shank bending. Also avoid a hole that is too large or the shank will not be supported vertically and will bend under head forming. Place the rivet snap upright in a bench vise and set the existing rivet head in its depression with the shank pointing upward. Place the rivet set over the shank end and hammer it until the metal touches the rivet shoulder. Remove the set and hammer the shank end with a *cross peen hammer,* first hitting it squarely on end, then slowly placing the blows in rotation around the shank edge to make it form a roughly rounded head. When movement of the sheets held between the heads ceases, remove the snap from the vise and place the original head in the depression of a *dapping block* that fits it. Place the snap over the newly formed head and hammer it sharply two or three times which should be sufficient to form a well-rounded head.

If a *series of rivets* are made in the same piece of metal, the distance from center to center of each rivet position is termed the pitch. In this case, drill the positions for all the holes through the *top sheet,* and only *one* of the holes through both sheets. Set the first rivet in this hole to hold the sheets together, then drill the holes in the second sheet through the hole in the upper sheet at each pitch location. The reason for this procedure is that it is very difficult to accurately drill several holes in two sheets of metal and be sure there was no movement between them. The remaining rivets are then set down.

HOLLOW TUBE RIVETS

7 A hollow tube rivet is an annealed section of open-ended tubing placed through a hole drilled in metal sheets equal in diameter to the outer tube diameter. Its length must be at least twice the total thickness of the sheets being joined. To make the upper and lower ends flange outward and so hold the sheets together as a rivet, place a *round-ended punch* of a size larger than the inner tube diameter upright in a vise. Place the lower end of the tube rivet over the punch end, and, at the same time, place a similar punch over the top end. An assistant holds the work while this is done. Hammer the top punch, which will cause both ends to deform in an outward-curving flange.

8 Repeat this on both sides of the tube with a broader, round-ended punch to spread the flange. Once the metal between is held firmly, place the tube rivet end on a flat surface block, put the same punch on top of the opening, and hammer the flange flat. Do the same from the other side.

In a variation, a tube rivet can be prepared by first cutting across the tube walls with a jeweler's saw blade so that it is divided into sections that can be easily bent back to form petallike parts following the same procedure.

USING A RIVET SLEEVE AS A SPACER

9 In this case, a rivet is being headed to hold two parts together, but between them, the rivet wire has been covered with a *length of tubing* or a *sleeve,* which by definition is any tubular part meant to fit over another part. Besides working to keep the two sheets a set distance apart, the sleeve can act as a hollow axle or quill to allow relative movement for the rivet shaft inside.

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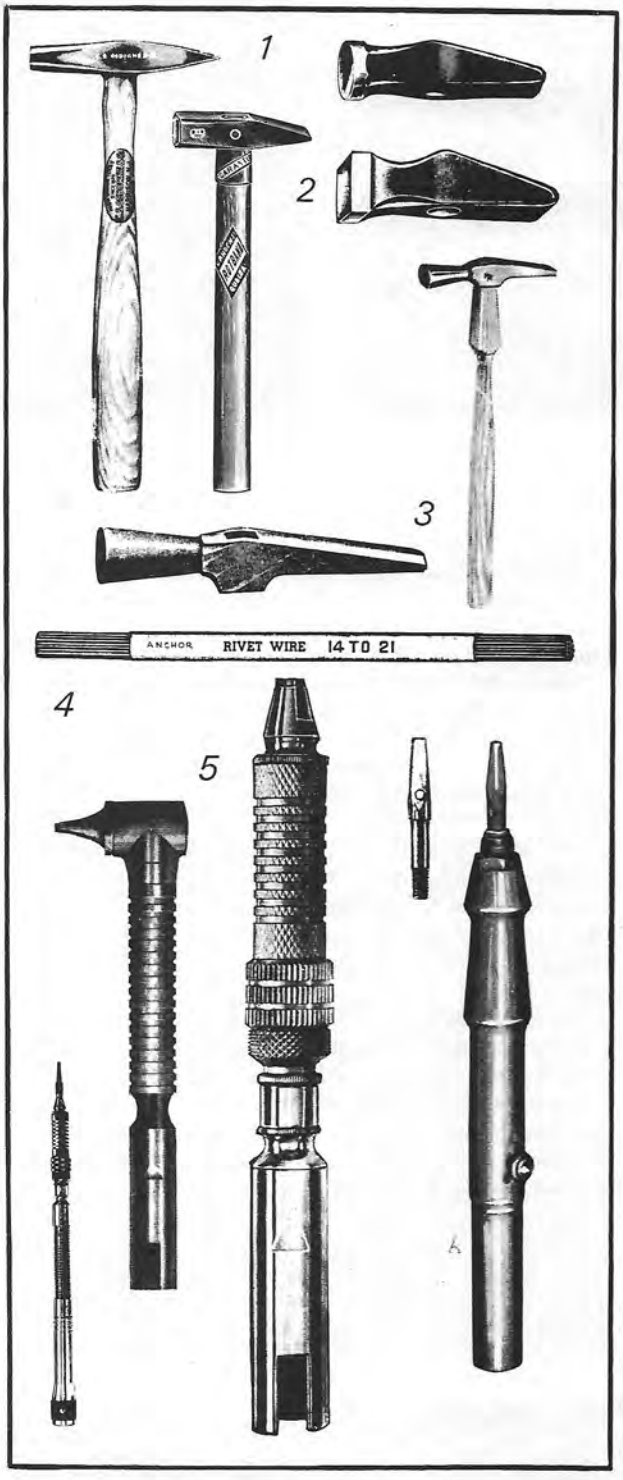

10–55 *RIVETING TOOLS AND MATERIALS*

1. *Round-faced riveting hammer* of drop-forged steel, available in light (2 oz), medium (4 oz), heavy (6 oz), and extra heavy (8 oz) sizes.
2. *Square-faced riveting hammer,* available in six sizes, head length 3–4½ in, face Ø ⅜–⅝ in; weight 2½–9 oz. The cross peen is used to upset form the rivet head, and the flat face to planish or flatten the head.
3. *Small, Swiss-style watchmaker's hammer,* available in head lengths from 2–3 in; can be used in setting down small rivet heads.
4. *Nickel silver and brass rivet wire* sold in assorted gauge sizes in 1 oz bundles. For use in riveting pinstems to joint findings, and cuff link findings.
5. *Automatic reciprocal cam-action handpiece hammers* for use attached to a flexible shaft and quickly detachable. A typical model operates with a 3/32 in stroke at speeds up to 5000 rpm. The strength of the stroke power impact is adjustable by turning a knurled wheel, and some models are available with an extra heavy spring for heavier work. Used with a flat anvil for setting down rivets, and for setting bezels and stone prongs in stone setting. Equipped with a carbide-tipped pointed stylus it can be used for marking, texturing, scribing, and engraving. *Left to right:* handpiece with flexible duplex spring; rigid handpiece with hammer head collet mounted at a right angle to the shaft; separate anvil hammer head, detachable and available in several sizes and weights; rigid handpiece with attached anvil hammer head.

10 The work is reversed and the rivet head is smoothed on the other side. A hinge with rivet has also been used in this design. (See Glossary: Jewelry Findings for the method of making a hinge pin.)

11 Front and back view of the finished brooch entitled "In Faith . . . Deceived, I," from a series called Proud American Medals. The brooch employs sterling silver, enameled fine silver, 14K gold, and copper, with moonstone, corals, golden sapphire, and an insert of an old photograph. Parts are joined by the use of flush-headed fixed rivets, and articulated parts by hinges containing riveted permanent hinge pins made of rivet wire, as seen in the back view. Size 10 in × 4 in × 3¾ in. (25.4 cm × 10.2 cm × 9.5 cm)

Photos: Claire Braude

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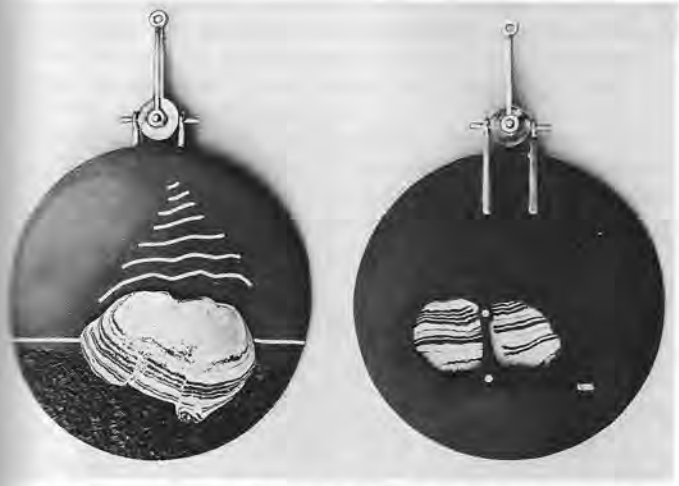


10–56 GENE PIJANOWSKI, U.S.A. Shakudo pendant inlaid with silver wire. A separate, central mokumé overlay form is held to the disc by two rivets, as seen in the reverse side photo. The lower textured portion is chip carved in facets. *Photo: Gene Pijanowski*

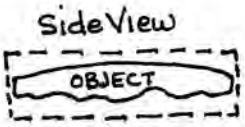
MOUNTING AN OVERLAY BY SOLDERED RIVET PIN SHANKS

A metal overlay can be rivet mounted on a sheet metal backing by soldering lengths of round wire perpendicularly to its back to act as rivet shanks. Their length should be sufficient to project through the back and allow a head to be formed. To mark the exact position where they must pass through the ground metal, first cover the area with a thin layer of wax. Place the overlay in position and press the pin ends into the wax. Drill a hole at each marked position with a diameter matching the rivet shank wire. Remove the wax and clean the piece. Place the pins over the holes, and press them through. With *nippers* cut off any surplus rivet shank at the back, but allow enough to remain for forming the rivet head. File the end of each pin flat. Place the work, pin ends up, on a rigid surface, or, if the front surface must be protected, on a piece of wet leather. Gently hammer the rivet pin ends to form a head, using a lightweight *riveting hammer*.

The same procedure can be used to mount a metal overlay on nonmetallic materials, or in reverse, to mount nonmetallic materials on a metal ground.

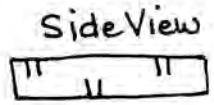
FRAMES

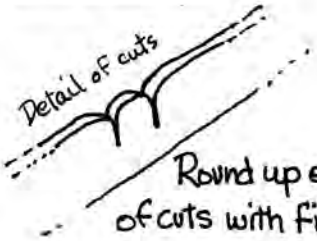
Fabricated Rim - good fit around object



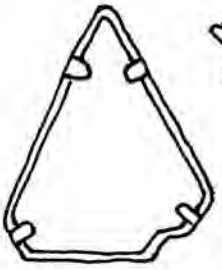
Rim MUST be taller than object

Determine prong location
Saw almost ½ way top and bottom

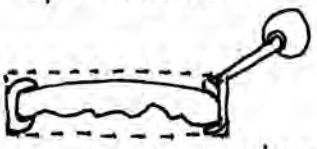




Round up edges of cuts with file

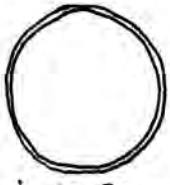


Push over EITHER Top or bottom prongs

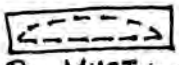


Drop in object - adjust height by raising - lowering bent prongs push over remaining prongs

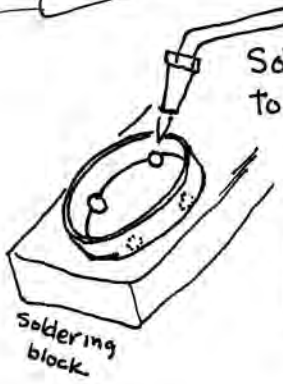
BALL FRAME



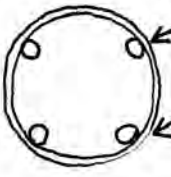
Fabricate frame good fit to object



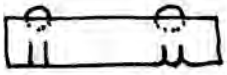
Rim MUST be taller than object



Solder in 4 identical balls to top inner edge of frame

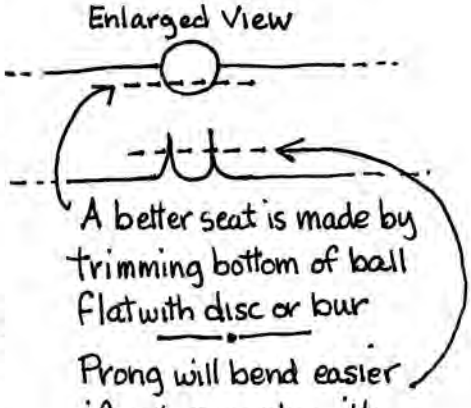


Same size, evenly spaced balls



Make prong cuts under beads, trim cuts with file

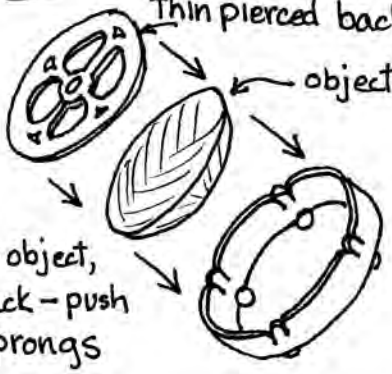
Drop in object push over prongs



A better seat is made by trimming bottom of ball flat with disc or bur

Prong will bend easier if cut on inside with bur or disc

Pierced Back Option

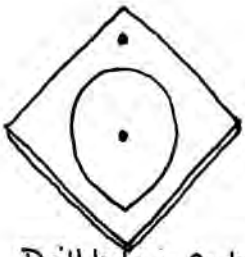


Drop in object, then back - push over prongs

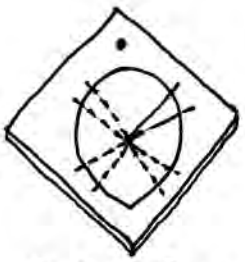
POP-UP PRONGS

FLAT-BACKED OBJECT

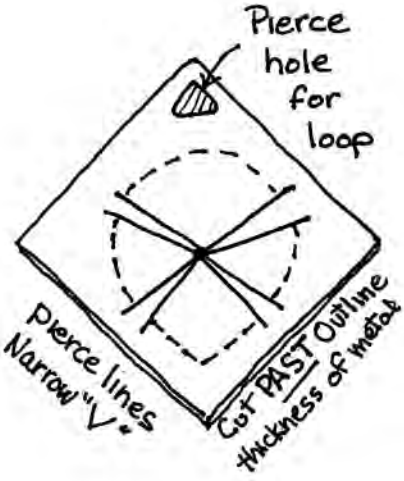
Draw outline of object

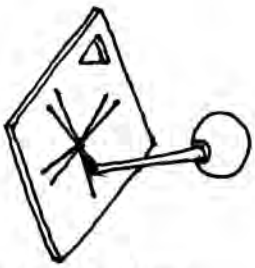


Drill hole in Center of outline, and at Top for loop



Scribe 4 Prongs





From back, push up prongs

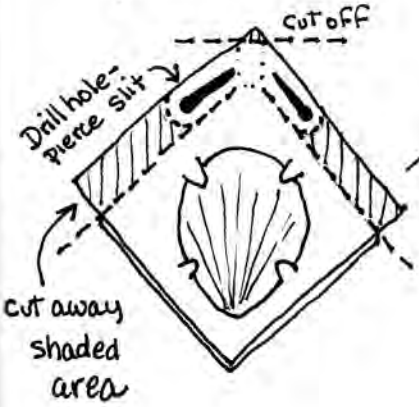
From front, pull up prongs with pliers

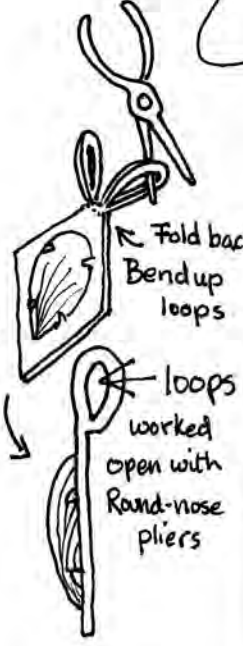
Drop object into seat push over prongs

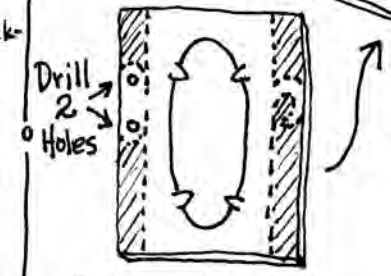
Snip and File excess prong

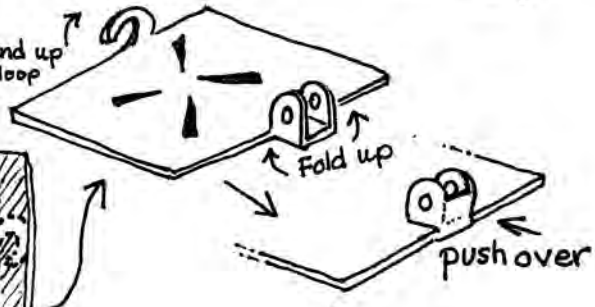
pierced-in pin attachment

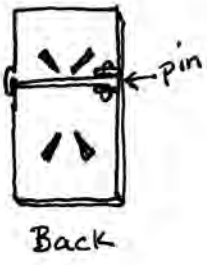
Pierced-in Bail









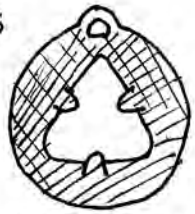


POP-UP PRONGS

Some Options

Open back up after piercing prongs for nice look

Pierced

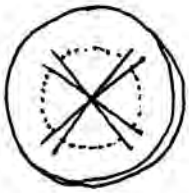


Use Roller-printed, textured, hammered etched, patina Metal

Vary prong designs and format

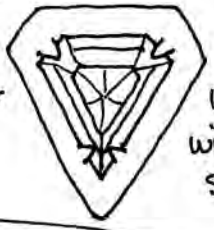
Faceted Stones and Non-Flat objects

Outline Stone and scribe prongs



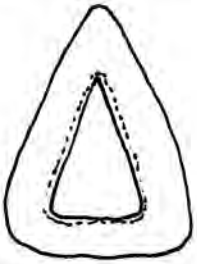
Pierce prongs past outline then cut away area SMALLER than stone to create seat

Push prongs over and finish

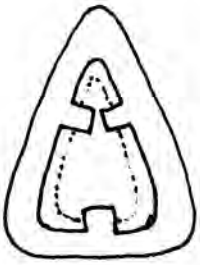


Will work with any shape

Suspended Object

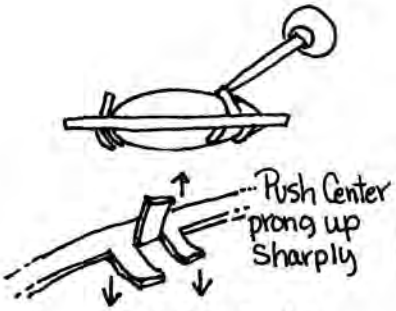


Scribe Outline of object



Scribe OUTSIDE outline, leaving wide prong tabs

Pierce out center Make 2 cuts in prong tabs



Push 2 outside tabs down slightly

Adjust prongs to center up and tighten object

HANDOUTS FROM THE 20TH CENTURY

(AND BEYOND)

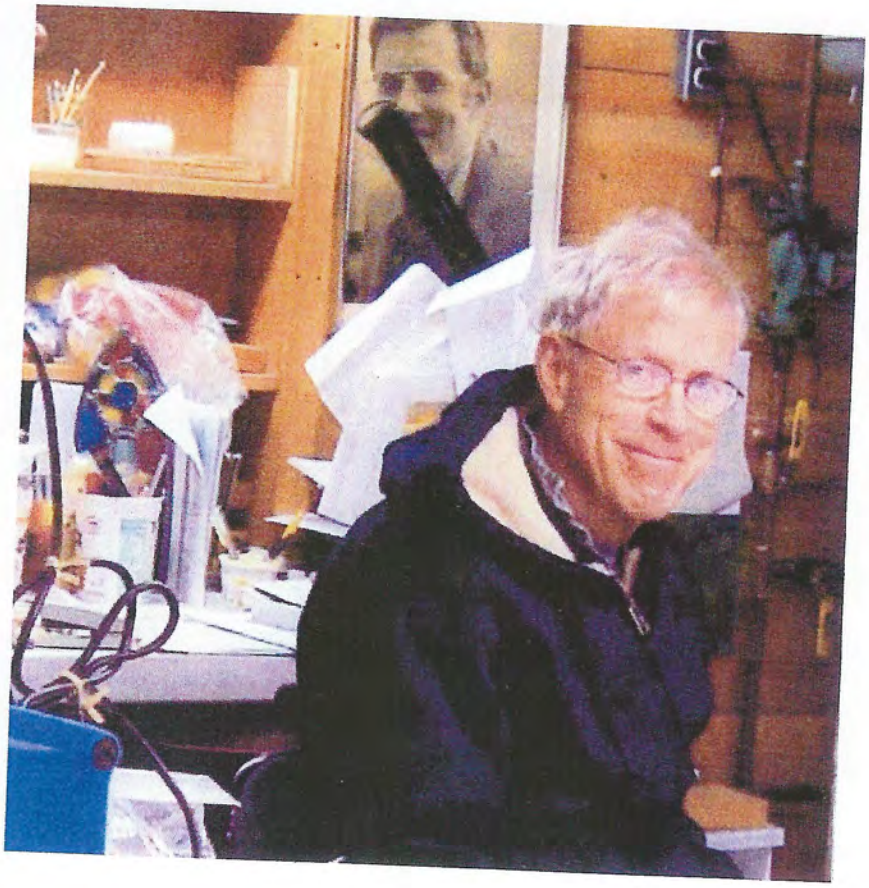
A COLLECTION

OF TEACHING AIDS

GATHERED AND/OR CREATED BY

J. FRED WOELL

(OVER A PERIOD OF 30 YEARS)



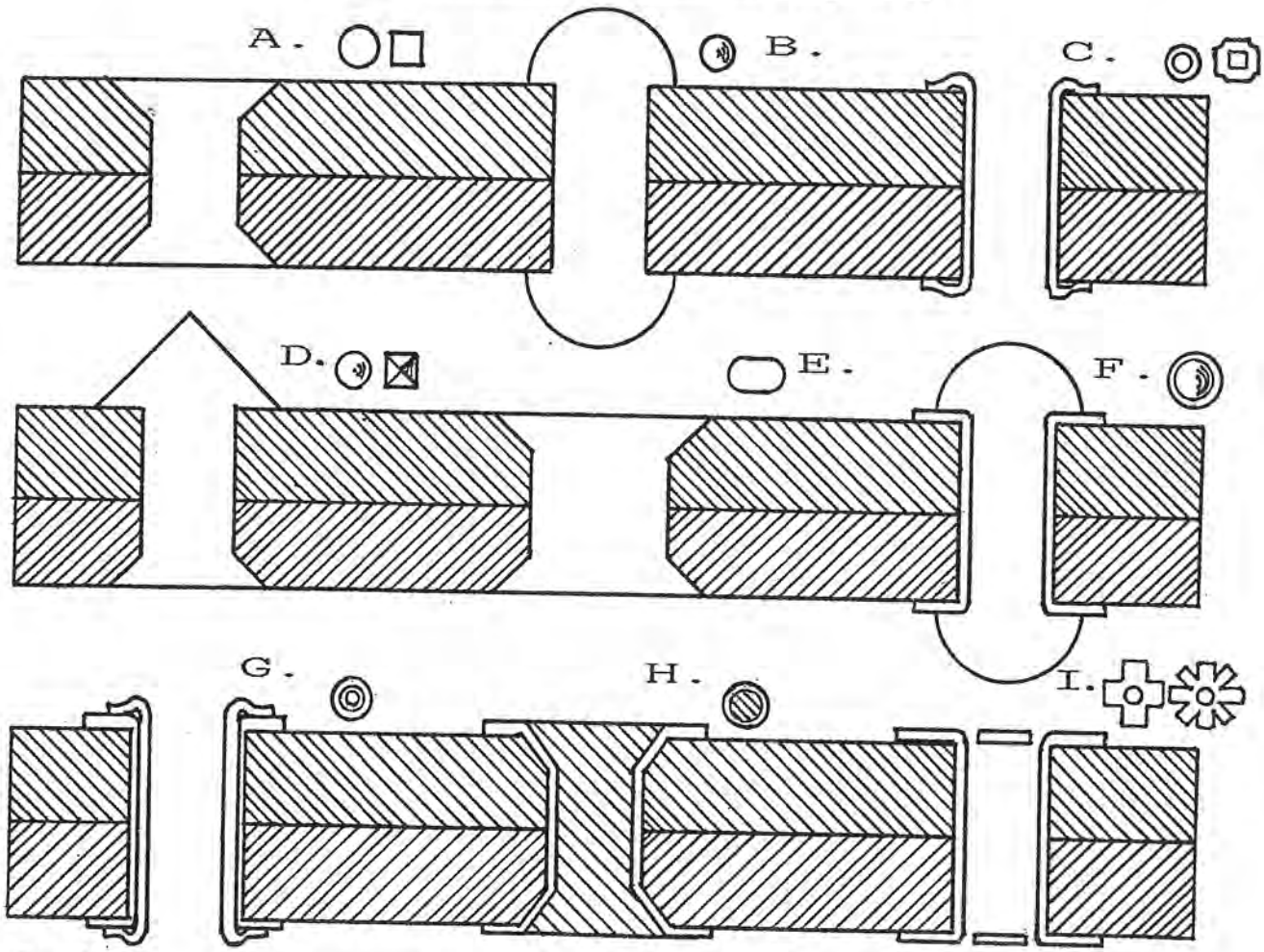
RIVETING

FORMULAS FOR RIVETING:

A. STRUCTURAL RIVETS: Minimum diameter of rivet, equal to or greater than the thickness of the heavier of the two metals being joined.
B. FLUSH RIVETS: A length equal to 3/4 of the rivet diameter should project beyond the surface of the metal.
C. ROUND HEAD RIVETS: Rivet should project a length equal to its diameter beyond the surface of the metal.
D. TUBE RIVETS: Length of rivet above surface of metal depends on diameter of rivet and the amount of the rivet you want to show on the surface of metal.
NOTE: Too much length may cause tube rivet to split or collapse. Always anneal tube rivet before upsetting it!

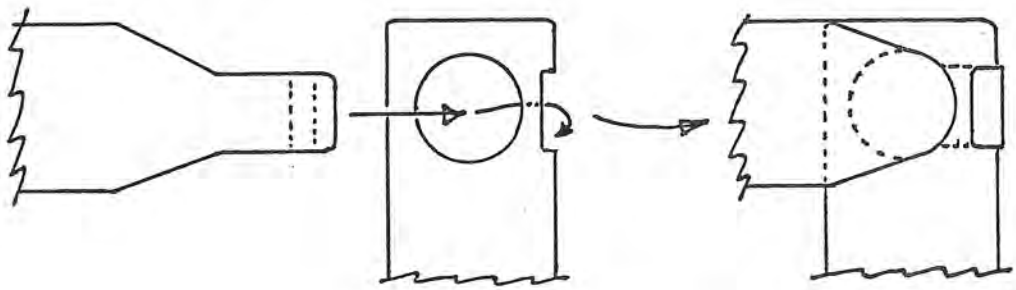
DRILLING:
A. The diameter of the hole should coincide with the diameter of the rivet. The rivet should pass through the hole easily but at the same time be tight.
B. The hole should be drilled rather than be punched.
C. Remove any burrs which might have occurred from drilling.
D. If several rivets are required, drill and rivet one at a time so that the holes line up correctly.

SOME EXAMPLES OF TYPES OF RIVETS:

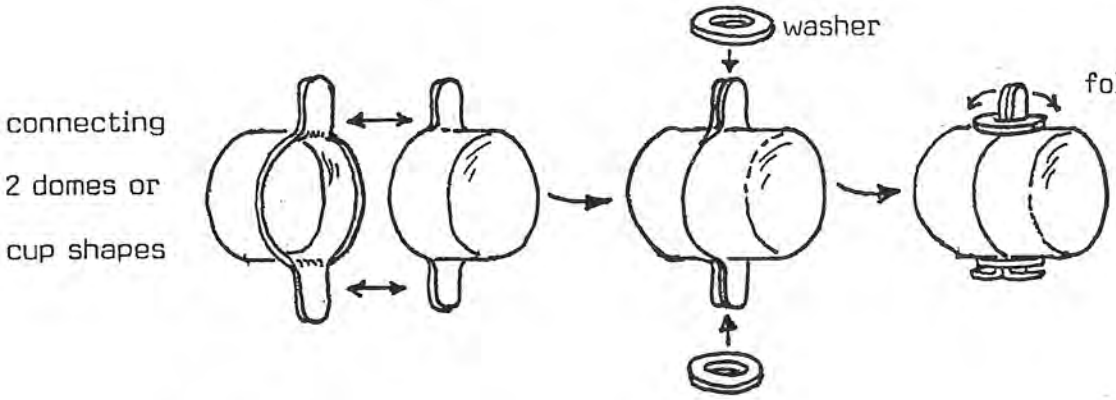


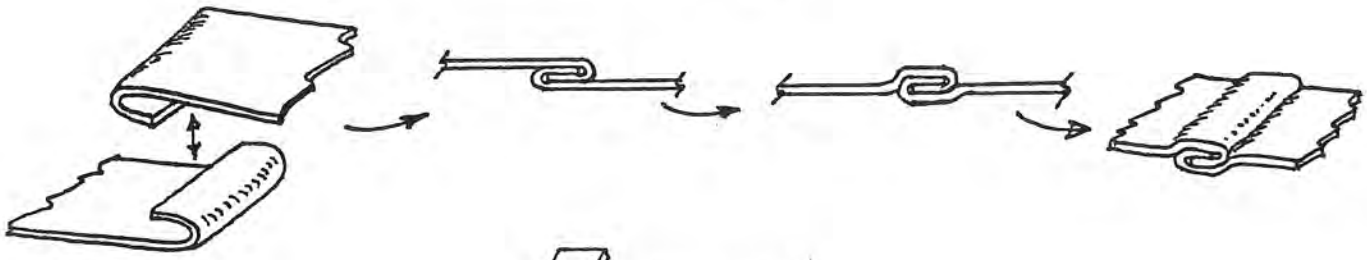
A. Flush
B. Round Head
C. Tube
D. Steeple Head
E. Oblong
F. Round head, Tube (combination)
G. Double Tube
H. Flush, Tube (combination)
I. Bifurcated Tube

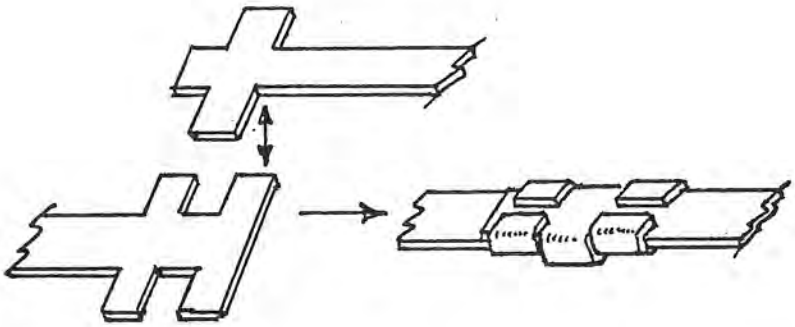
COLD CONNECTIONS:

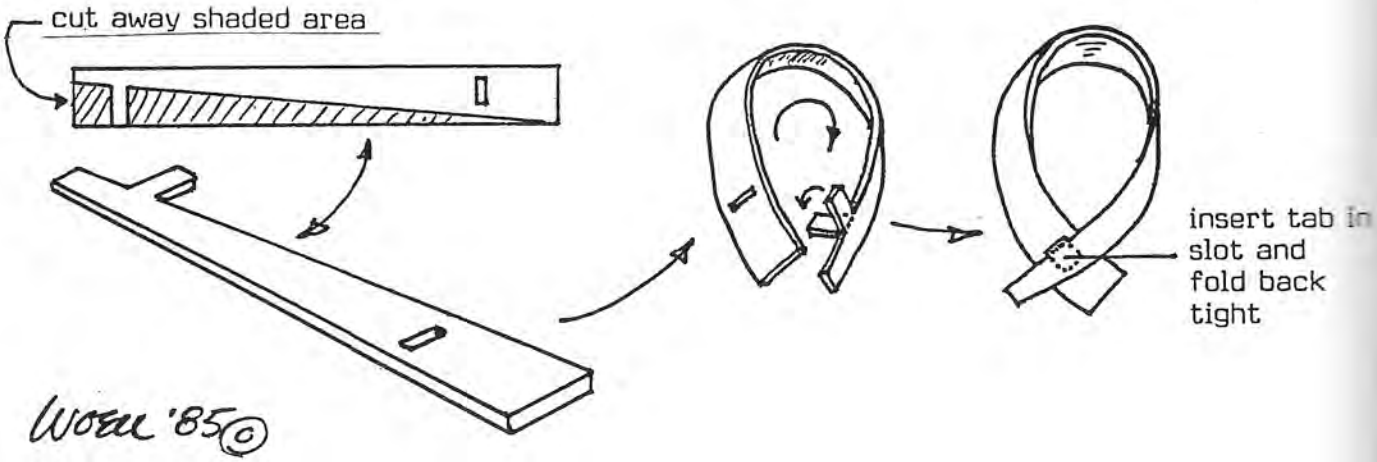


90° connection
two straps of
metal

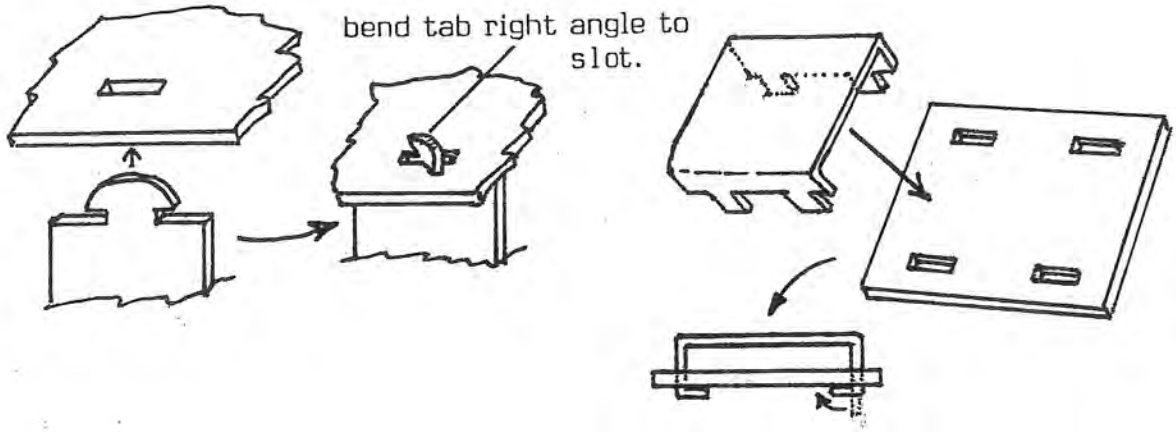




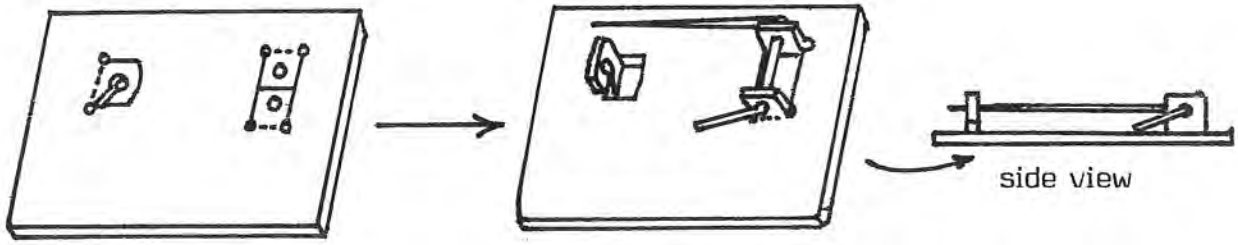


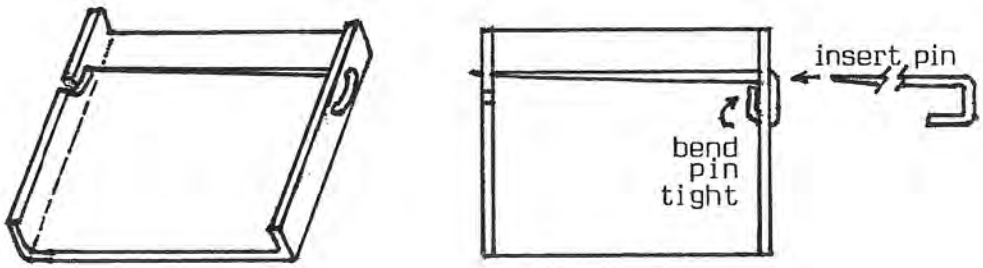


COLD CONNECTIONS

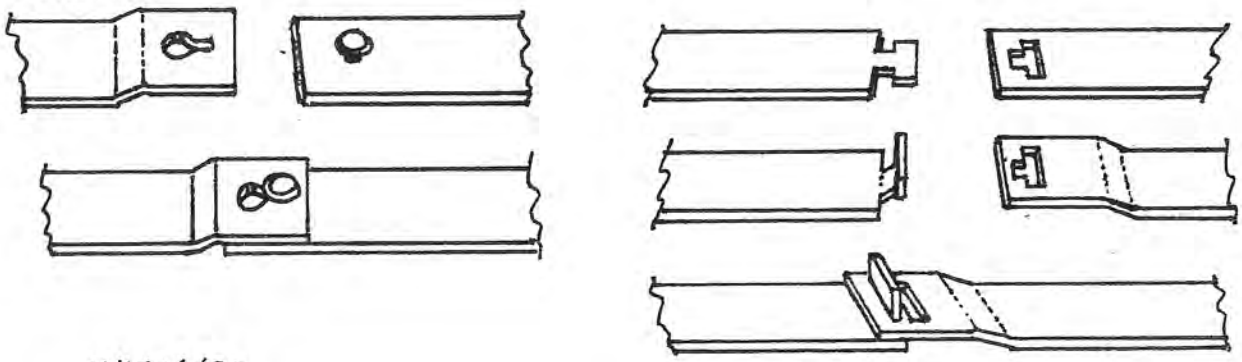


PIN BACKS:





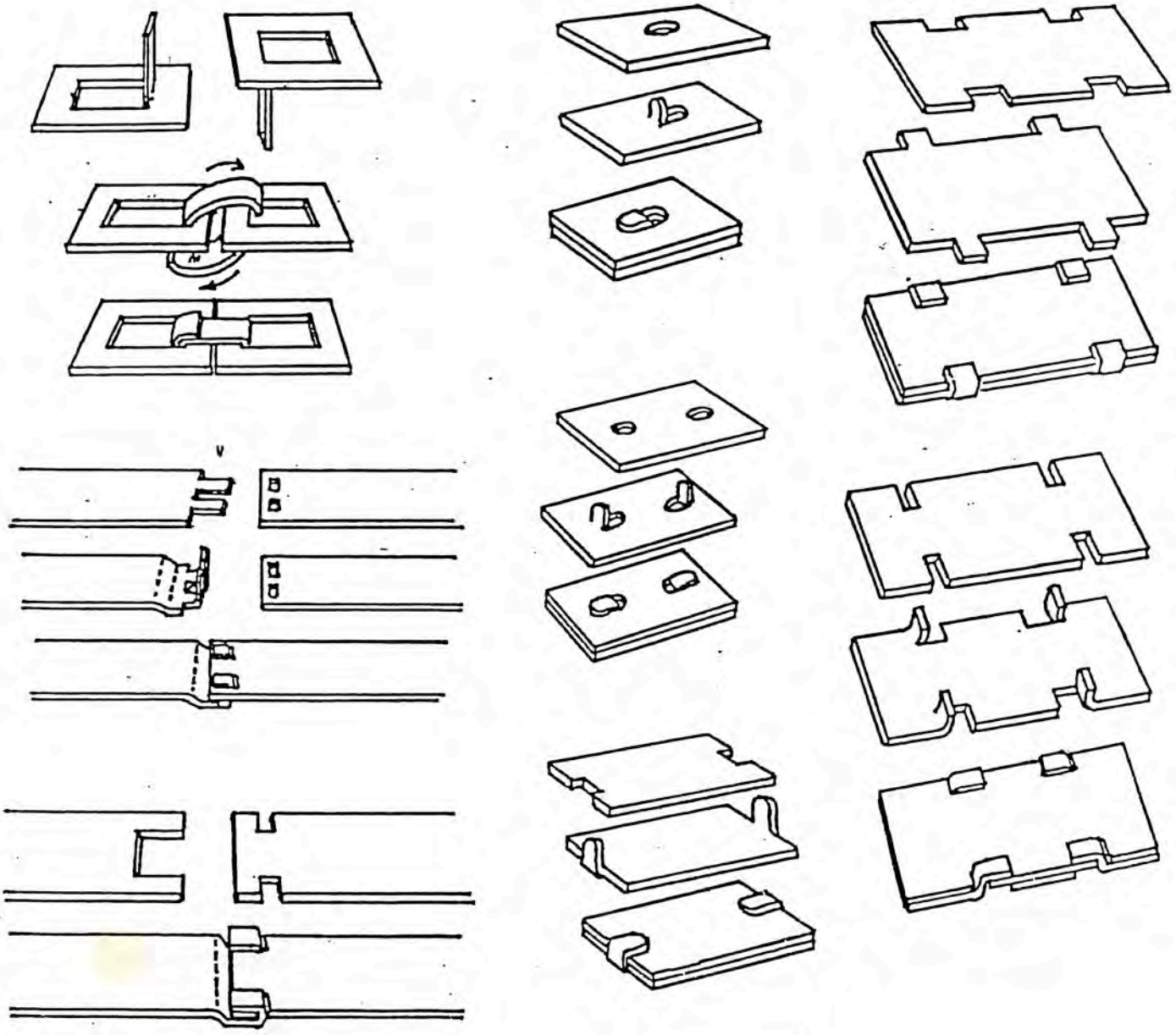
CATCHES:



WOELL '85

metals II - casting, cold connections + prongs, bezels, rivetings + mold making

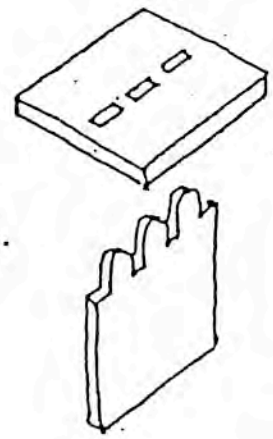
COLD CONNECTIONS:



Wren '85

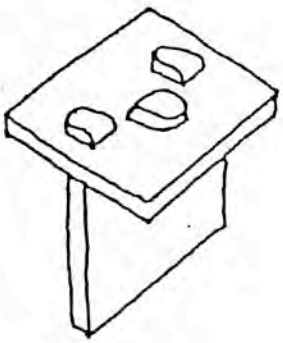
SLOTS + TABS = TYPICAL CONNECTIONS

E



(1)

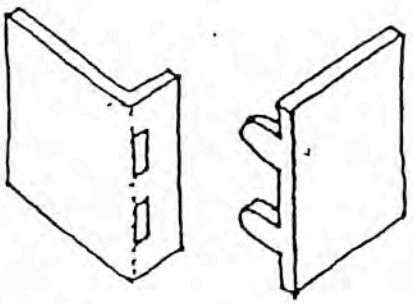
(2)



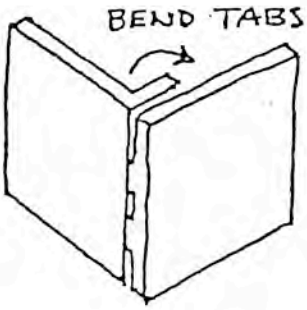
TABS BEND IN OPPOSITE DIRECTIONS

RNER

(1)

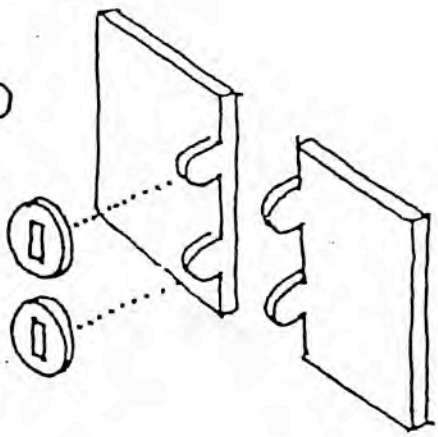


(2)

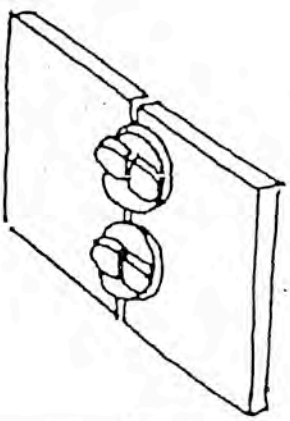


DGE-TO-EDGE

(1)



(2)



WORKS BEST ON SHAPED EDGES

BOLTS, SCREWS, AND NUTS

HEX

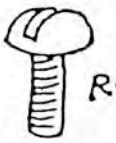
MACHINE SCREW

PAN HEAD

SET SCREW

WING NUT

FILLISTER



ROUND

CAP HEAD OR

HEX NUT