CBA Vista Forge
Level II Project Instruction Book

INDEX

*Source abbreviations: TBC= "The Blacksmith's Craft" (CoSIRA); WIW= "Wrought Iron Work" (CoSIRA); CB= "California Blacksmith" (C.B.A.); CBA= course-specific materials from CBA Education Committee; BH= Beth Holmberg; ABANA=ABANA downloads; iF=iForge

CBA Vista Forge
Level II Project Instruction Book

i. Introduction and Comments

This electronic collection of learning resources is designed to support the in-person teaching by CBA instructors in the Level II classes. It was developed for the California Blacksmith Association (CBA) teaching forge at the Antique Gas and Steam Engine Museum in Vista, California. The original collection was put together by Steve Maranhao in 2004 when he started teaching the class—it was known as "The Book", and consisted of 2nd to 3rd generation photocopies. Everyone joining the class was given a copy of that master. Some of the images suffered a little…

This version is a compilation of materials from various publicly available electronic sources, stuff produced by the California Blacksmith Association (either published in their 'California Blacksmith' magazine, or produced by the Education Committee), and some stuff I put together. The sources for each project is indicated on the Index page. Specifics for those sources are at the end of this section. If you use any part of this, please keep the original source information intact, and give proper credit as due.

The projects are each included as a separate Word file, with the project number at the front of the filename. The project files start with a few details or thoughts from me about the information that follows (or doesn't follow…). You might want to print out the whole thing and put it in a binder to bring to each class session (with little tabs marking the first page of each project...). At the least, do print and bring the information for the project being taught in that class. We don't usually do any other handouts at class, and the instructor will assume you have the right materials with you (and is likely to refer to them). We try to keep a list of upcoming projects on our forge website: www.cbavista.com. Note that, for the near future at least, the project numbers here and the 'tab #' on the website are **not** the same! Use the project names instead. We'll try to get them in synch sometime.

I hope you find this collection helpful in your learning. As an intermediate blacksmithing student, you may also find it useful to get a few blacksmithing books as supplementary learning sources. Books that are most useful for this course include:

A Blacksmith's Craft: The Legacy of Francis Whitaker, George F. Dixon, Blue Moon Press, Huntingdon, PA, 2004.

The Skills of a Blacksmith, Vol. 1: Mastering the Fundamentals of Blacksmithing, Mark Aspery, www.markaspery.net, 2006.

Hit it Hot!
Beth Holmberg
San Diego, CA July 2010

Our Sources:

ABANA= Materials published with open access on-line by the Artist Blacksmith Association of North America (www.abana.org). The California Blacksmith Association is a member organization of ABANA.

BH= Beth Holmberg. These parts, along with this introduction and the comments on the front of each project, are copyright Beth Holmberg, 2010. Use only with proper attribution. I can be reached at blacksmithbeth@gmail.com.

CB= "California Blacksmith", the publication of the California Blacksmith Association. Information available at www.calsmith.org. Members can access back issues at this site.

CBA= materials produced at various times by various members of the California Blacksmith Association Education Committee, and distributed to support blacksmithing instruction at CBA workshop forges.

iF= iForge, a set of archived (formerly) interactive project workshops published by www.anvilfire.com. Assume copywrite is held by the individual author listed on the project.

TBC= "The Blacksmith's Craft," produced by in 1952 by the U.K. Rural Development Commission (which became part of the Council for Small Industries in Rural Areas (CoSIRA), then absorbed into the Coutryside Agency). No authors are attributed. It's available free on the web. A good source is through the Herefordshire College of Technology at www.hct.ac.uk/Downloads/cp_blacksmith.html.

WIW= "Wrought Iron Work" was a second book in a series of three produced by CoSIRA. Again, no authors attributed. It can also be found free on the web, but not as easily as "The Blacksmith's Craft."

ii. CBA Level II
Project Record

#	Project	Date Completed
1	Turned and Welded Bolt Eye	
2	Welded Bolt Head (hexagonal)	
3	Forged (Upset) Square Corner Bend	
4	Scarf Weld (or drop-tongs weld)	
5	Scarf Corner Weld	
6	Turned Hinge	
7	Welded Hinge	
8	Ribbon Scroll	
9	Fishtail Scroll	
10	Solid Snub-End Scroll	
11	Fishtail Snub-End Scroll	
12	Ha'penny Scroll	
13	Bolt-End Scroll (welded)	
14	Blown-Over Leaf Scroll	
15	Beveled Scroll	
16	Williamsburg Bending Wrench	
17	Scroll Jig (golden ratio spiral)	
18	C and S Scrolls to measure	
19	Collars	
19a	Brian Brazeal Trivet (combines 16 - 19)	
20	Welded Basket Twist	
21	Leaf Hammer (and tooling)	
22	Water Leaves (and bottom tools)	
23	Forged Round->Square Blocking	
24	Copper Repousse (and tooling)	
25	Dan's Letter Opener	
26	San Luis Obispo Rake (combines 3, 4, and 20)	
27	Mortise and Tenon Joint (and tooling)	

iii. Recipes and Tooling Notes

This tome does *not* include instruction in heat treating tool steels. For a number of the projects, you'll need to make and appropriately heat treat, tools. Use what you've got for steel, and learn the right quench and temper for what you're doing! For most top tools (punches, slotters, etc), one option is to forge the tool in mild steel, then quenching it at critical temperature in Super Quench. The resultant tool will be in the Rockwell 50s hardness range, but be tough enough to strike with a hammer!

Super Quench was developed by Robb Gunter when he worked at Sandia National Laboratories. He came up with it as a less toxic alternative to Mr. Bessemer's mild steel hardener: lye! It costs about $12 to buy the ingredients at the grocery store, last I checked. It works by quenching so fast that the iron crystal end up off-square by 2°, producing tension and hardness. It's great for small beefy tools (punches), but not for things with thin edges (slitters, knives), which it will warp. Never use it on metal with more than 40 points of carbon- it may shatter! To use it, give it a good stir first (it tends to separate), heat the metal to critical temperature, and quench it fast, with vigorous agitating. If it screams or sings, it worked. Test the results with a file. Be sure to rinse the super quench off well- the salt will make your tool rust in moments!

Super Quench:
5 gal. water
5 lbs. salt (iodized or not...)
1 28 oz. bottle Dawn dishwashing liquid, blue only
1 8 oz. bottle JetDry or equivalent (in a color that won't obscure the color of the Dawn)

Mix together in a container you can seal between uses. Stir just before use. When the color becomes more green than blue, it is wearing out and needs to be replaced. One batch does a whole lot of hardening...

While we're on recipes, Dave Vogel (long time instructor of Level I at the Vista Forge) shares this one for making a good indoor finish for ironwork.

Museum Wax:
1 cup boiled linseed oil (any hardware store)
1 cup turpentine (any hardware store)
4 oz. beeswax (try the furniture refinishing area at Ace, or a sewing shop or apiary)
1 tsp. or so Japan Dryer (Home Depot or any art supply store)

Put the ingredients in a big old tin can, and set it in a pot of hot water. Stir with a stick until the beeswax melts. Pour into a sealable metal container (like a clean paint can from the hardware store). To use it, heat up the metal to a medium black heat, swab the wax on, then wipe off the excess with a rag. Good in indoor use, but it breaks down with UV exposure outside. Do *not* use for cooking tools- Japan Dryer is toxic (heavy metals...).

Project 1: Welded Bolt Eye

Material: 8-12” of ½" or 5/8" round H.R.

Generally:

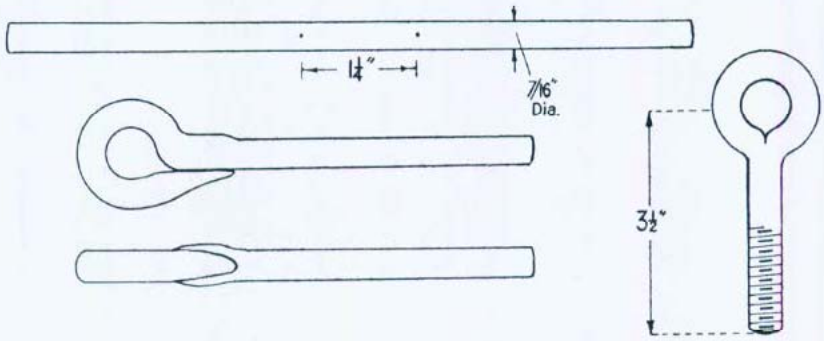
Figuring out the material length need for the eye and the weld is a key first step- it will vary with the material thickness!

A good upset in the area of the weld under the eye is the other big key- better to have it too long, and forge it down later, than have thin spots near the eye from scale-wasting.

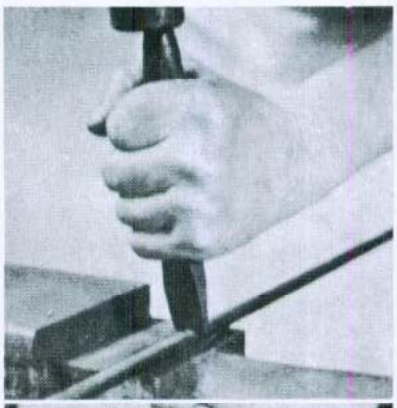
For details on weld scarfs, see Project 4: Scarf Weld.

Your weld should be well blended at the tip and sides, and go right up to the V at the base of the eye. The eye should be quite round (not cat's eye) in shape.

Lesson 15 TURNED AND WELDED EYE-BOLT



Cut off a piece of $\frac{7}{16}$" bar $6\frac{1}{2}$" long by nicking both sides with a cold chisel to give an even-sided end. A sheared cut is always one-sided, producing an uneven end which would cause the bar to skew and bend when being struck on the top for upsetting. See illustration D on the opposite page.



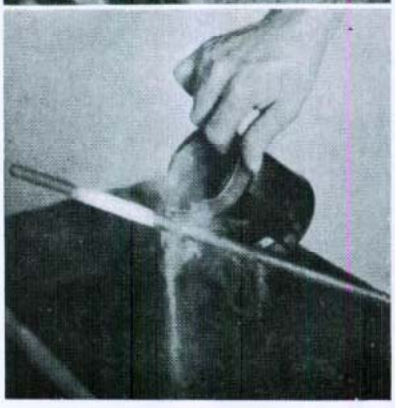
Make the first mark on the bar 3" from one end, and the second mark $1\frac{1}{4}$" from the first.

Take a NEAR WELDING heat between the punch marks.

To restrict the heat between the two marks, cool out from the end to the first mark by dipping in water, like this—

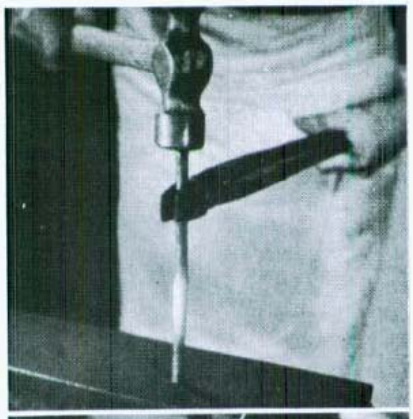
Cool beyond the second mark by pouring water from a tin as shown—

Both cooling operations must be done quickly to keep the maximum heat between the marks.



To upset the hot portion, hold the bar vertically on anvil and strike the top like this—

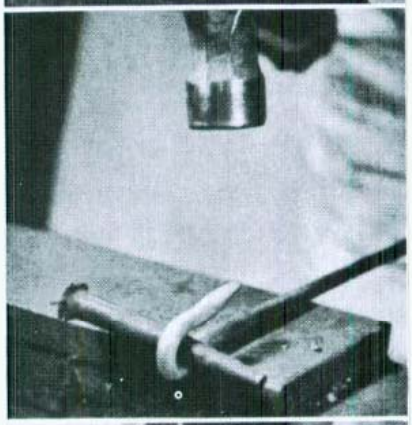
After every two or three blows straighten the resultant buckling on the anvil face and then continue upsetting until the diameter is increased to $\frac{9}{16}$".



D

Take a NEAR WELDING heat on the short end and draw to a blunt point to form a scarf.

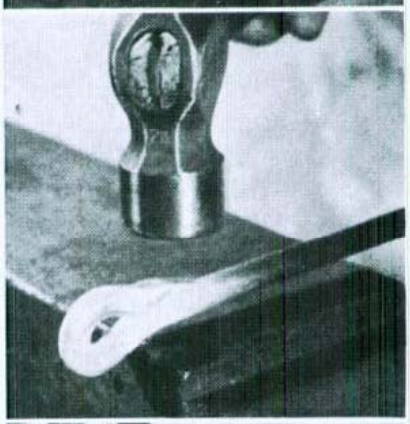
Bend this end from the upset portion over a $\frac{3}{4}$" diameter drift like this—



E

Take a FULL WELDING heat and weld the scarf into the shank with the bend of the eye over the rounded edge of the anvil like this—

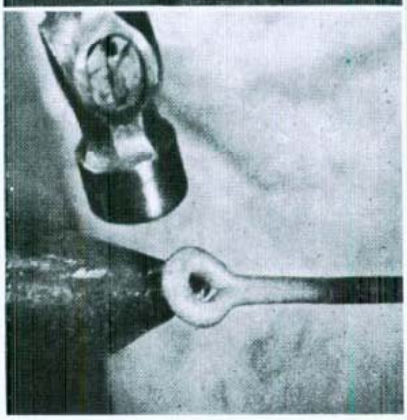
Round up the weld with light hammer blows, leaving a radius where the eye joins the shank.



F

Work up the eye on the bick, leaving a slight V in the junction of the weld, like this—

Don't use a swage to round up the weld as this may weaken the eye by cutting into the radius where the ring joins the shank.



G

Project 2: Welded Bolt Head

Material: 6-12" 5/8" round H.R.
12"+ 3/8" square H.R.

Generally:

Get a nice, beefy upset on the end. The ¾" diameter needs to be 3/8" long. Avoid puckers on the top or a sharp transition from the upset.

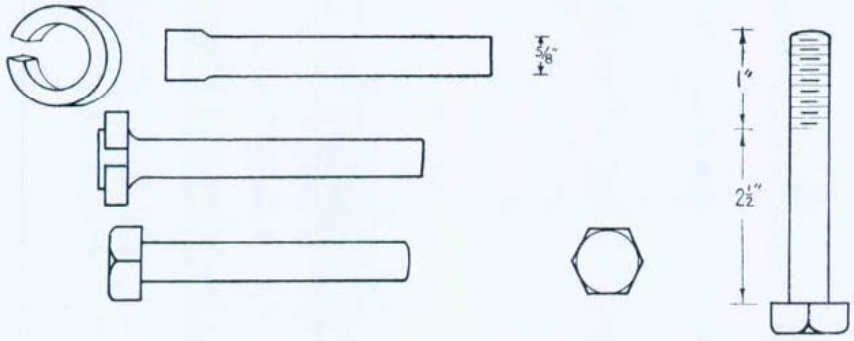
Before you cut the end of the collar material (3/8" sq.) to a 45° angle, scroll it at least 180° (otherwise it gets badly deformed in scrolling).

If you make your two chisel cuts to the collar material from opposite sides, you'll get a natural scarf between the two, vertically.

The collar must be a little too small, or it will weld to itself, but not to the bolt shaft!

The hex head can be worked up free-hand (it's not that hard!) or on a swage.

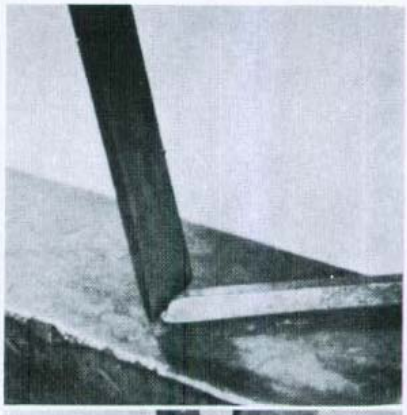
Lesson 20 **HEXAGON-HEADED BOLT**



First upset one end of the $\frac{5}{8}$" round bar to a diameter of about $\frac{3}{4}$".

The head of the bolt is made by welding on a collar made from $\frac{3}{8}$" square. This is a tricky weld, so it is better to use wrought iron for the collar as this gets hot quicker than the bolt. (Wrought iron, remember, will stand a higher temperature than mild steel).

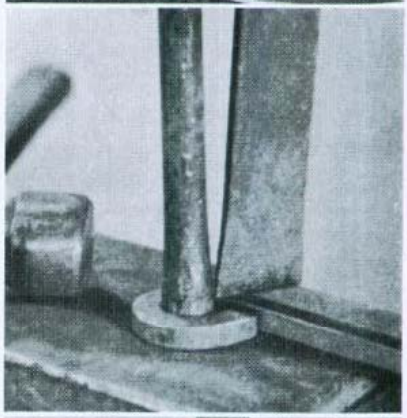
Next, cut the end of the $\frac{3}{8}$" square to an angle of 45° so—



A

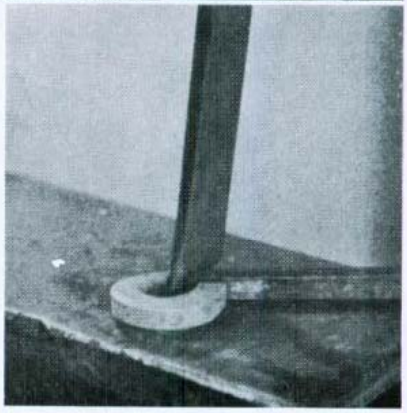
Hold the square bar over the tip of the bick with the point upwards and bend it into a tight circle. The metal will stretch while this is being done bringing the oblique end about square with the side of the bar.

Fit the collar over the upset end of the round bar and after allowing for a gap equal to the width of square metal, make a chisel mark like this—



B

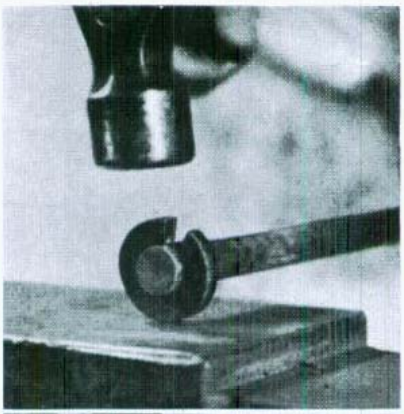
Take a BRIGHT RED heat, cut off the bar at the chisel mark and fit the collar over the upset end of the $\frac{5}{8}$" bar.



C

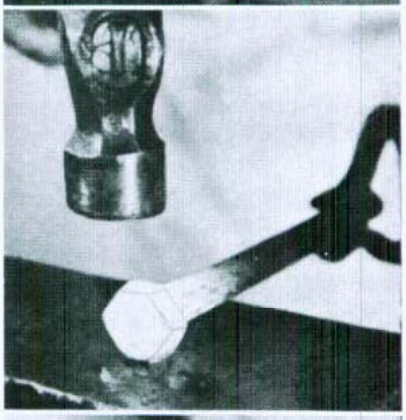
Close the collar tightly around the bar and return to the fire.

Take a FULL WELDING heat very slowly so that the heat penetrates to the centre of the bar without burning the collar.



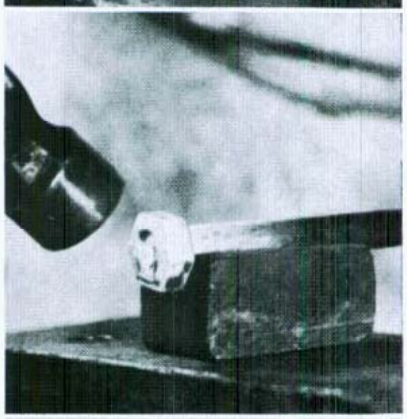
D

The ends of the collar must join at one corner of the hexagon. To close the ends and at the same time form the hexagon, *the order of the first three blows is most important*. Strike the first blow a little back from one end of the collar. This will partly close the gap. Before each of the next two blows, give the bar one-sixth of a turn. This will close the gap and the hexagon will form automatically between the hammer and the anvil. To complete the welding take a further heat. All subsequent blows must be delivered on the flats of the hexagon.



E

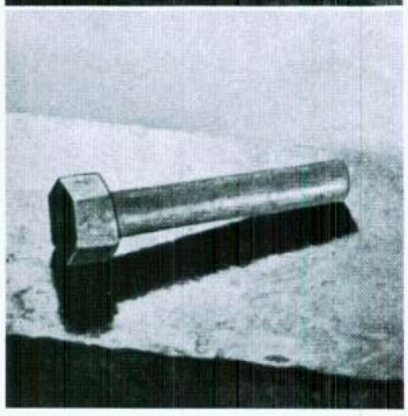
Before cleaning up the body of the bolt, true up the hexagon on the anvil face. Then lay the shank in the swage, and true up the diameter. Keep the head central and at right angles to the shank.



F

On all bolts the thickness of the collar should be half the diameter of the bolt or a little more according to the sizes of metal available.

In each case, the gap left is equal to the width of the square metal used for the collar.



G

Project 3: Forged Square Corner Bend

Material: 1-2' of 1/2:" square H.R.

You can use one long piece, and put a bend at each end for proctice, or do matching bends in two foot-long pieces, then add scrolled ends and screw holes to make a set of shelf brackets!

Generally:

Here are a couple of different approaches to the upset square corner—read both and try one. One has the upset before the bend, the other is upset in making the bend.

Upsetting before bending is a useful trick for sharp corners that *aren't* 90° (for making triangles, hexagons, octogons, etc).

A few goals to aim for: figure out (by measuring before and after) how much metal a corner uses up; actually have a square (90°) corner; no cracks on the inside corner; nice radius on the inside corner.

Be sure to put the punch mark on the location of the bend before you start, and keep it centered there as you work.

Keep the angle larger than 90° while you work- if it gets tighter, even for a moment, you *will* get a crack on the inside.

Pay careful attention to the orientation of the metal vs. your hammering arm- get it right, and the upset will build like magic; get it wrong, and you'll be working long and hard...

PART IV

The lessons which follow are on more advanced forging and welding, calling for a higher degree of skill. By applying the techniques he has already learned, the knowledge gained by experience and by using common sense the student should have no difficulty in following the exercises.

BENDS TO DIMENSIONS

In making bends to measurements, allowance has to be made for the amount of metal used in actually forming the bend. The allowance will vary with the type of bend and with the individual smith; no hard and fast rule can be laid down. Experience will show what allowance to make, but the figures given below are a good guide for a start.

(a) Radius Bends

Radius bends should have the *inside* radius equal to the thickness of the metal. No preliminary upsetting is required.

To make the U-shaped piece from $1\frac{1}{4}'' \times \frac{1}{2}''$ shown in Lesson 26, subtract once the thickness of the metal for each bend from 3″ which is the outside measurement over the bends. The marks will therefore be 2″ apart.

If the two dots are kept in the middle of each bend and the correct radii maintained, the dots will finish up in line with the inside surfaces and the given measurement will be correct.

The same allowances are made for the Z bend in 1″ round, also shown in Lesson 26, and again, if the correct inside radii are maintained the dots will finish up in line with the inside edge of each leg.

(b) Plain Square Corner Bends

Plain square corner bends have the inside corner forged square and the outside corner left rounded, and no *preliminary* upsetting is required. With light section, square and flat metal the corner can be strengthened by upsetting the material as the bend is made. The inner and outer corners must be forged simultaneously; if the inner one is squared first, it will be galled in forming the outer one.

To make the Z-shaped piece in $\frac{1}{2}''$ square shown in Lesson 28, *subtract* from the outside measurement half the thickness of the metal for each bend. If the dots are kept on the diagonal line joining the inner and outer corners of each bend, the finished measurement will be correct.

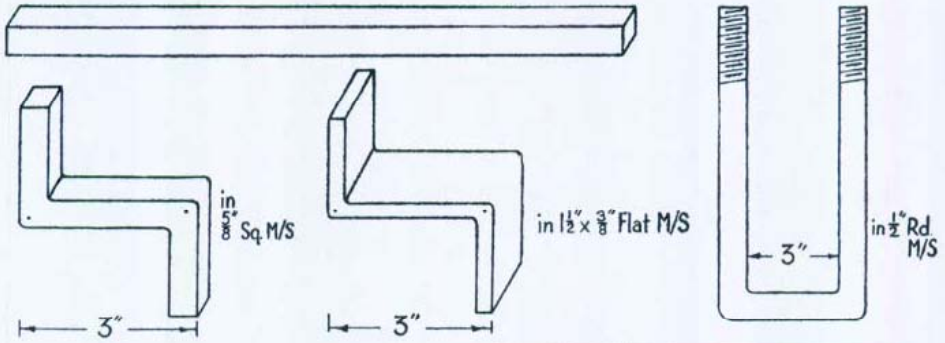
Although the shape is different, the same allowances are made for bending both the shaft staple in Lesson 27 and the **U**-bolt in Lesson 28. Again, the dots should be kept on the diagonal line through the corners of each bend.

(c) Forged Square Corner Bends

Forged square corner bends are upset before bending starts. The extra metal is then worked into the bend to form a corner square on the outside and with a radius on the inside.

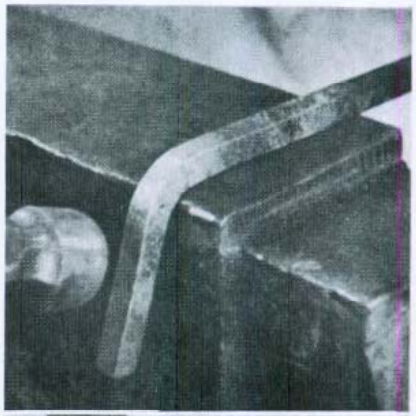
To make the **Z**-shaped piece in Lesson 29 (which has a square corner on the outside and the radius on the inside of each bend) it is first necessary to upset the metal to $1\frac{1}{2}$ times its thickness where each bend will be formed. To the outside measurement, add a quarter of the thickness of the material and mark the bar. Next, upset the bar evenly around the mark using $1\frac{1}{2}$ times the thickness of the material for each upset. The overall length of the bar will now be reduced by three times its thickness. The marks will be $1\frac{1}{4}$ times the thickness of the bar closer together than the outside measurement of the finished bend. If the marks are now kept on a diagonal line through the corner, the outside measurement will again be correct.

PLAIN SQUARE CORNER BENDS



To make the **Z** or cranked bends, mark the $\frac{5}{8}''$ square and $1\frac{1}{2}'' \times \frac{3}{8}''$ flat as described on page 78, paragraph (*b*) allowing half the thickness of the metal for each bend.

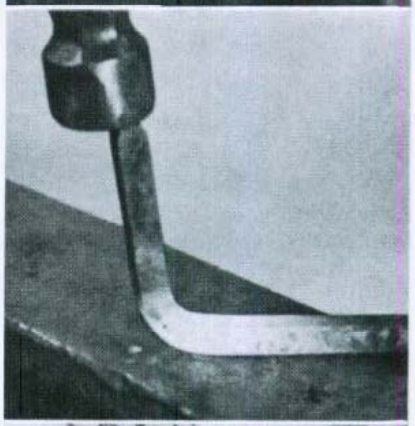
At a NEAR WELDING heat bend the bar over the rounded edge of anvil with the mark on the side of the bar beyond the edge of the anvil, as shown here—



A

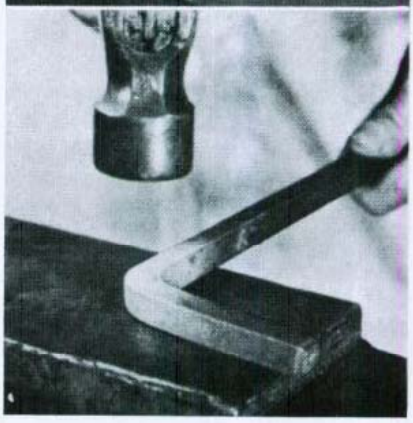
Take another heat, cool out the end and square the corner by laying the long part of the bar on the anvil face and striking the short end, so—

This will upset the metal slightly and produce a sharp bend with the punch mark exactly in the middle of the side of the thickened corner.



B

Keep the metal from thickening by flattening the swelling on the side of the corner as you go.

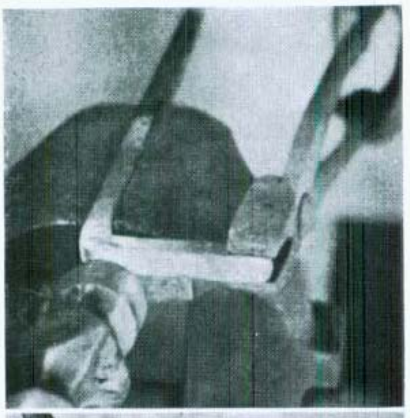


C

Finish off by gripping in the vice with the inside corner about $\frac{3}{16}''$ from the vice jaws and finally square the bend by hammering like this—

Do not drive the inside corner hard against the jaws or the sharp edge will cut it.

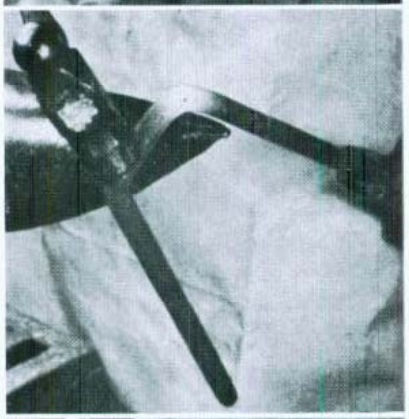
Make the other bend in the same way.



D

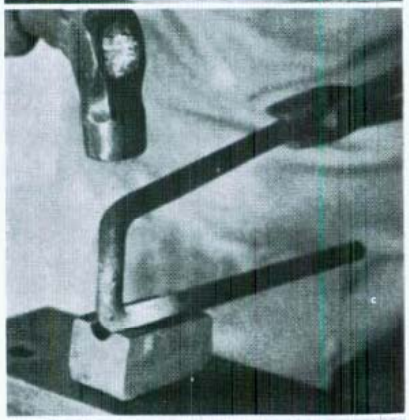
To make the U-bolt, mark off the $\frac{1}{2}''$ round, using the same allowances.

Take a NEAR WELDING heat where the bar will be bent, quench to about $\frac{3}{4}''$ on either side of the punch mark and bend with a full radius over the anvil bick.



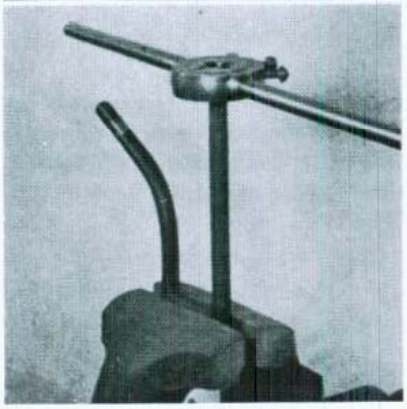
E

Lay it in a bottom swage and work up the corner like this—



F

In order to screw the ends, bend one side as shown to allow the die-stock to rotate.



G

The Upset Square Corner Bend

by Mark Aspery, Springville, California

A square corner bend is often used as a decorative element to embellish scroll work and frames. There are more than a couple of ways to make a square corner bend. The following method is taught at my school for a first square corner.

The example below uses 8" of ½" square bar.

I like to use a pre-determined length of bar so that it can be measured again to see what happened to the stock after the corner is made.

Center punch the middle of the bar and heat about an inch or more either side of the mark.

Clamp the bar in the vise with at least ½" between the side of the vise and the center mark.

The vises at the school have the edges rounded.

Position a dog wrench on the other side of the mark and an equal distance away from the mark as the vise *(Figure 1)*.

Bend the bar away from you. The direction is important and will be mentioned later. Also, do not bend to 90° yet. Bending to 90° will cause cracking in the inside of the corner later during the upsetting process.

Figures 2 and 3 show the bend and the angle.

Grasp the free end of the bar with a pair of tongs and reach for a light hammer. A light hammer is used for light rapid blows.

Certainly the process can be done with a heavy hammer, but the upset will be further into the bar than just the corner, something that you would have to rectify later.

Start to straighten the curve of the bar on one side of the center-punch mark *(Figure 4)*.

Do not let the centerline of your hammer migrate to the corner; in fact, keep it above the inside edge of the other leg of the bar.

Because of the natural arc of your hammer, material is pulled into the corner area. If you had bent the bar towards you initially, the arc of your hammer would pull the material away from the corner.

Notice that the corner is not held tight up against vise as this could cause galling of the material.

Take another heat and clamp the other end in the vise to work on the second side.

Unfortunately, you cannot see the center-punch mark, as it is on the underside of the bar. However, you do have the flat side that you just forged as a guide *(Figure 5)*.

At this stage you should see a thickening of the stock at the corner. Go to the anvil and flatten the excess stock as shown in *Figure 6*.

Return to the vise and continue to work up the corner as before, until the corner is sharp.

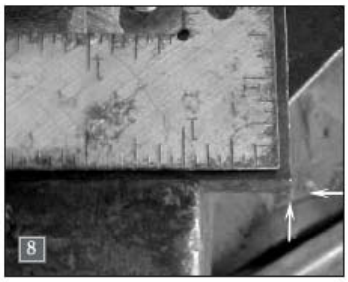
Only when the corner is nearly finished do you allow the corner to come to a right angle *(Figures 7 and 8)*.

The inside of the corner should be free from cracking *(Figure 9)*.♣


5


6


7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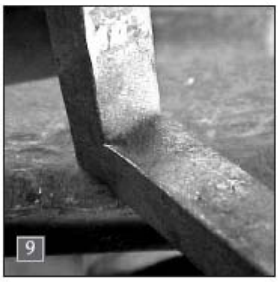

9

Project 4: Scarf Weld

Material: Whatever- square or thick (1/4") flat is nice for learning. Or do this as part of the SLO Rake (Project 26).

Generally:

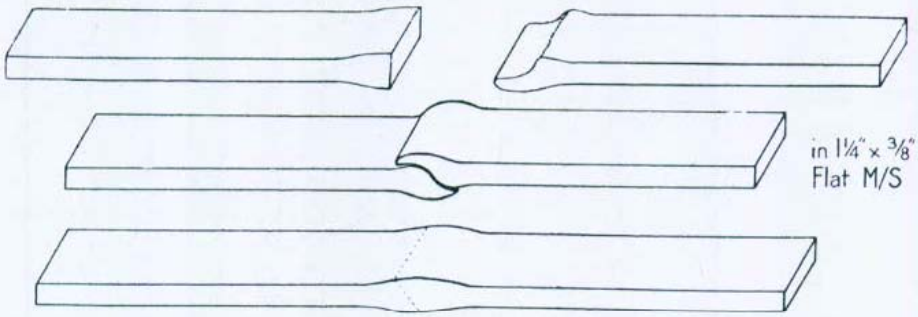
Read Mark Aspery's theory of scarfs before you start.

Be sure to have plenty of mass in the overlap- watch for scale-wasting next to the weld.

Do your first one with a friend swinging the hammer on the initial weld- practice cold with the friend first.

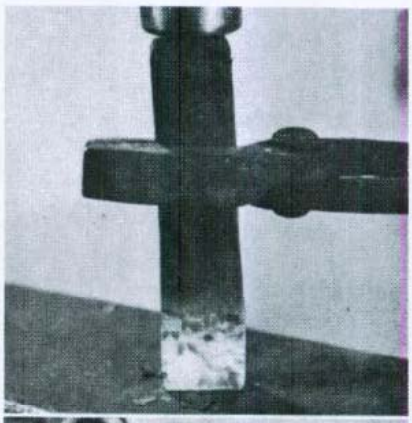
To do a drop-tong weld, the scarf on the far side of the anvil faces up, and on the near side it faces down (holding the other piece in place while you grab the hammer to weld). Get your right and left hand sorted out so your hammer hand is the one dropping the tongs. Practice cold 20 times before you try it hot...

Lesson 30 STRAIGHT SCARF WELD



Before starting these welding lessons, study carefully the description of fire welding in Chapter 4, page 21.

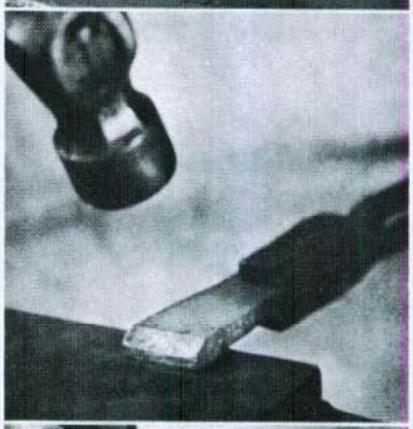
Take a NEAR WELDING heat on each bar in turn and upset the ends which are to be welded to ½" thick, but keep the width the same.



A

Before starting a large scarf, the upset end of the bar should be forged to a short bevel, leaving the edge about $\frac{3}{16}$" thick like this—

The hammer blows should be delivered at an angle of 45°.



B

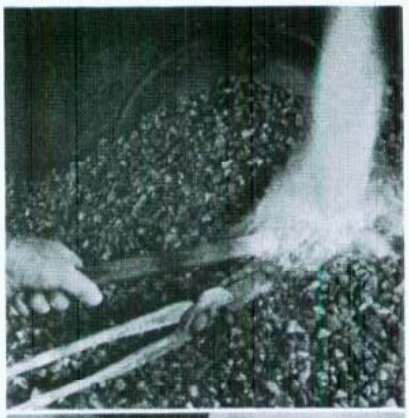
Next, with the bevelled edge downwards over the rounded edge of the anvil, forge the scarf as shown here—

C

Lesson 30—*cont.*

Before starting to weld, remove any clinker from the fire which must be clean with a good heart.

Lay both pieces side by side in the fire with the scarf lips on top. To ensure they are both heating equally, jockey them about and, as they approach welding heat, draw each in turn to the edge of the fire to judge the heat. If sand is being used as a flux now is the time to sprinkle a little on each piece.



D

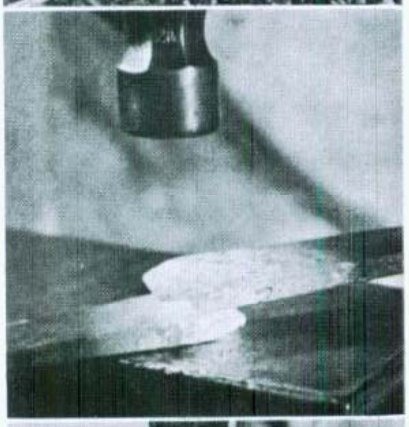
Now work quickly—take both pieces from the fire together, tap them over the edge of the anvil to knock off the dirt, and lay them on the anvil with the scarfs matching and the middles in contact.

The order of the first three blows is important:

First on the centre of the top scarf so that any dirt is driven out towards the ends.

Second on the thick part of the top scarf so that it welds to the thin end of the under scarf which is being chilled by the anvil face.

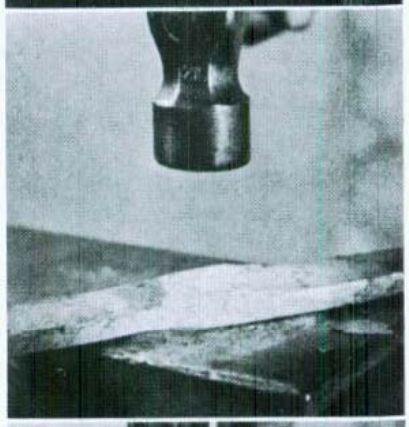
Third on the thin end of the top scarf before this cools.



E

If another heat is necessary to complete the weld, take it now.

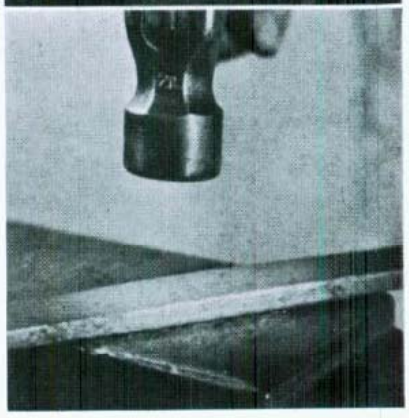
Continue welding by turning the piece to and fro, hammering both sides alternately. Take care not to reduce the section below the size of the original bar.



F

The completed weld should be like this, with no reduction of section and with the corners very slightly chamfered.

The finish of the weld should be smooth, as a rough edge or a hammer mark may cause a fracture to start.

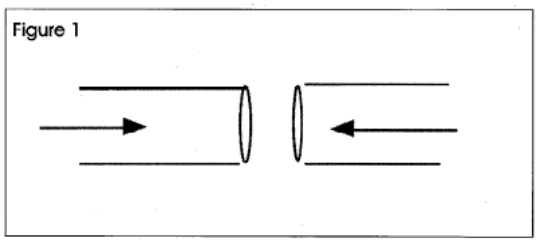


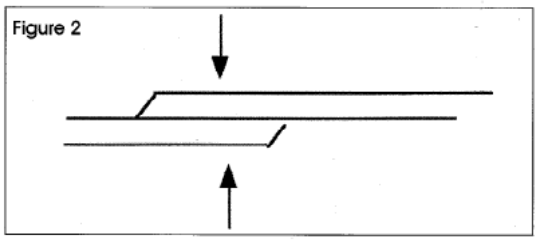
G

Lap Weld Scarf

story & photos by Mark Aspery, Springville, California

There are many different types of scarfs for this weld. Some are regional (German, UK or USA), others favor a fuel source (coal, coke or propane) and still more are but personal preferences.





Rationale: If I were to take two bars *(as in Figures 1 and 2)* and try to weld them, I would expect the hammer blow to come from the direction of the arrows. Looking at that, it would seem that the faces of the welding surfaces are for the most part perpendicular to the force of the blow. This consideration should be acted upon when we make our scarf. The surfaces in a scarf that are not 90° to the force of the hammer have a tendency to shear past one another and not start to weld until they start to approach 90° to the blow.

Here are the steps *(see corresponding photos on following page)* involved in a scarf that is used in a coke forge, without flux. It will work with any fuel and with flux. One of its advantages is the mass at the scarf end.

Step 1: Whenever we raise a high heat on a piece of steel, an oxidization occurs that we see as slag. The area of the weld usually has enough mass to it because of the overlapping pieces. However the areas right behind the weld are also subject to a lot of heat and will suffer from wastage just from the heating process. To protect it we upset the area as shown. It also allows for some thinning due to errant hammer blows as we close the scarf.

Step 2: Now bring two of the sides back to the size of the parent stock. The photo shows a flattening of the upset. It will move metal to the other two sides and allow the weld to be taken without unduly thinning the result.

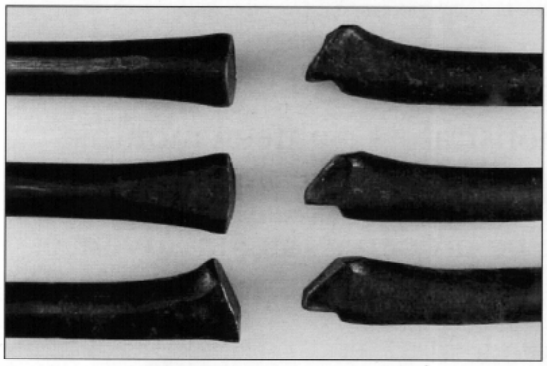
Step 3: By pulling back one side, it is easier to form the scarf with less of a tendency to form *fish lips*.

Step 4: The step in the scarf is left small. It is sufficient to index the two pieces when we are welding them on the anvil. These upright surfaces of the step will not start to weld until they are almost horizontal.

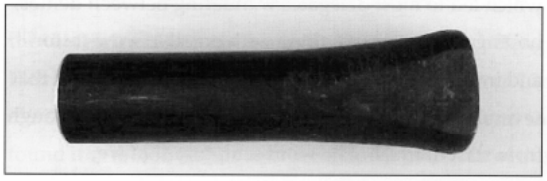
Step 5: The toe of the scarf is refined so that it is smaller than the bar to which it will be welded. That will allow for it to spread during the welding process and not exceed the thickness of the bar to which it is welded. When this allowance is not made, closing the scarf can be problematic.

The toe of the scarf shown has been left thick *(see Step 6)*. For general forge welding, it is about ⅛". It does have a slight slope and will blend in nicely. Its primary function is to afford sufficient mass to resist burning as we take the high heat without flux. It also serves as a mass to carry heat as we move from forge to anvil. It works equally well with flux.

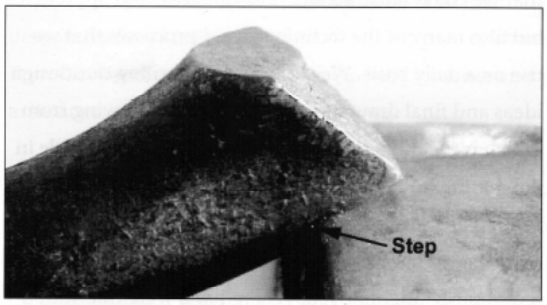
Step 6: The surfaces of the scarf are relatively short. Long scarfs do not necessarily provide a stronger weld, in fact they can make a weld suspect.



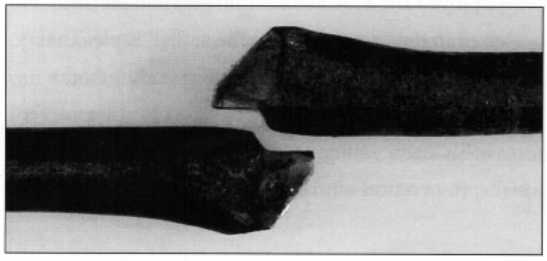
Steps in forming the scarf for forging.



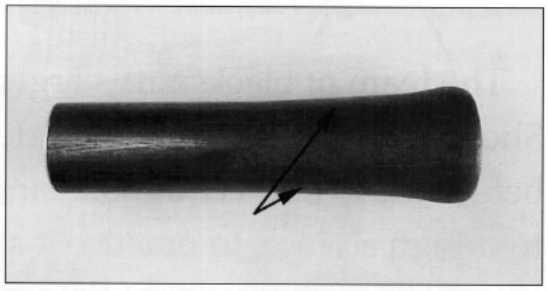
2. Bring two sides back to size of parent stock.



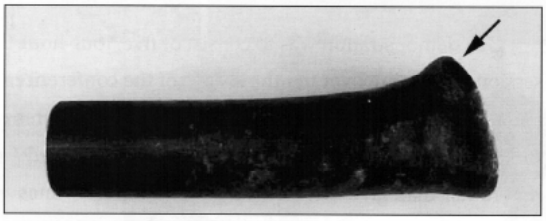
4. Using a half-faced blow on the near side, forge a small step.



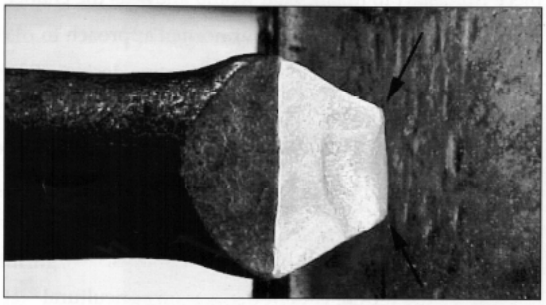
6. Scarfs should align in match pairs.♣



1. Upset the end. The area behind the scarf suffers from wastage while taking the welding heat, so it is important to have the upset this far back.



3. Pull back one of the remaining sides.



5. Refine the end so that it is smaller than the bar to which you will weld.

Project 5: Scarf Corner Weld

Material: 2 pieces about 12" long of ¼" x 1" H.R.

You can use other sizes- this is good for learning. Too thin is hard to upset and weld.

Generally:

Do the straight scarf corner weld first- it's lots more forgiving than the diagonal one.

Be sure to get good upsets in the area where the edge of the weld will be- avoid having wasting next to the weld.

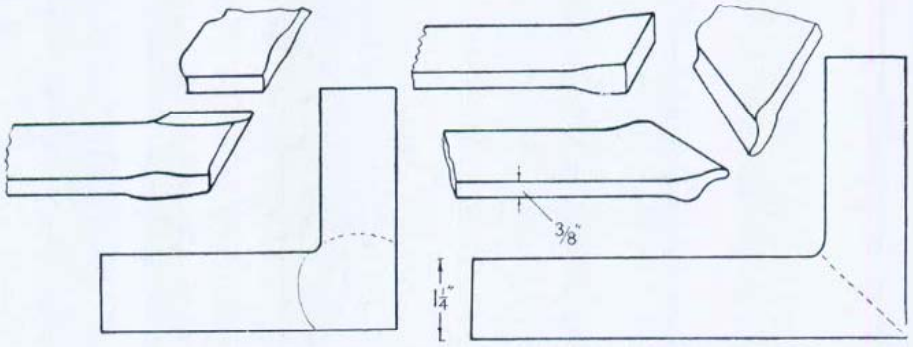
Both scarfs should be *identical*, not R and L handed!

Practice positioning the two pieces for welding with them cold. Get it all worked out before you heat anything!

Anytime you weld two pieces together, it's important to have them both at the same temperature when they come together.

To make a nice corner, forge out the weld thickness (producing a nice radius on the inside corner), then use a chisel to *cut* off the excess material on the outside of the corner- clean up with a rasp and hammer.

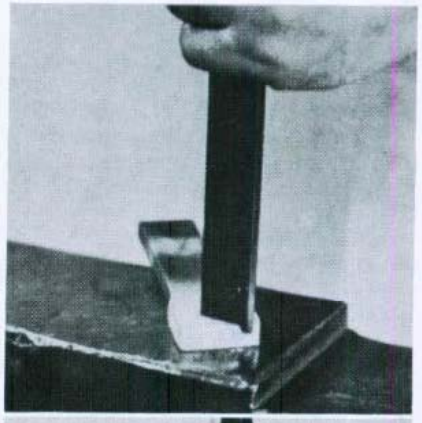
Lesson 36 DIAGONAL and STRAIGHT SCARF CORNER WELDS



Diagonal Scarf Weld

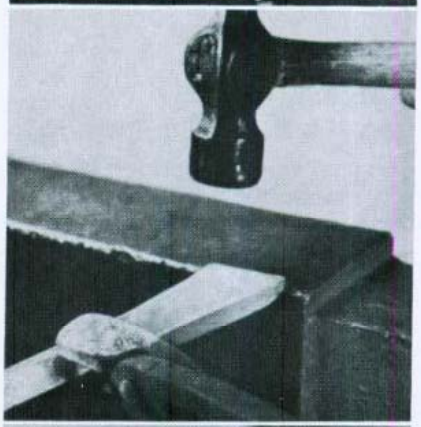
The quickest way to weld a square corner is to use diagonal scarfs, but the resulting joint is not so strong as the straight scarf method.

Take a NEAR WELDING heat on each piece in turn and after upsetting the ends cut them off at an angle of 45°, leaving a blunt corner, like this—



A

Take another heat and, using the rounded edge of the anvil, forge a scarf on the same side of each piece, so that they pair up when laid on top of each other at a right angle with the scarfs matching as shown in the next illustration.

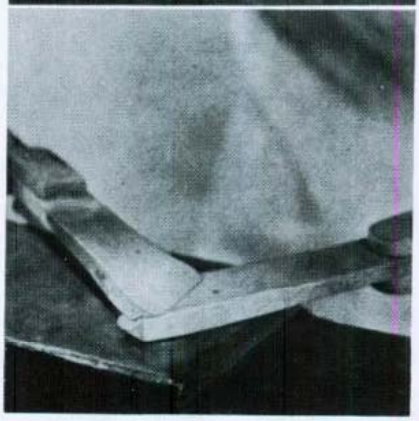


B

Take a FULL WELDING heat on both pieces together and lay them on the anvil as shown.

Strike the first blow on the thick part of the top scarf so that it welds to the thin part of the under scarf which is being chilled by the anvil face.

Finish off with a minimum of blows so as not to reduce the thickness, because a diagonal scarf has no surplus metal in the finished weld.



C

Straight Scarf Weld

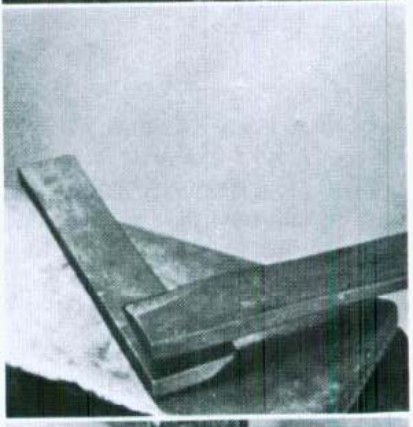
A straight scarf corner weld has greater strength than a diagonal scarf weld, but it takes longer to prepare and make.

Take a NEAR WELDING heat on each piece in turn and upset, first quenching the tip so that the swelling starts about $\frac{3}{4}$" from the end.

After upsetting take another heat and form a scarf on the edge of one side of the bar from the end to the middle of the upset.

D

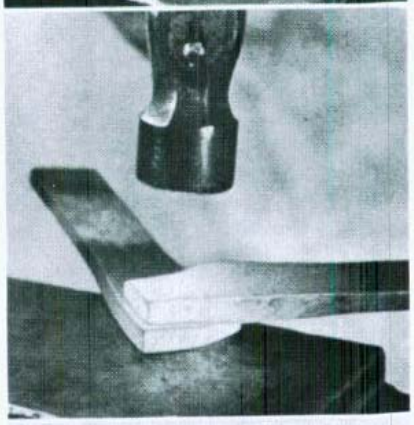
Each bar is scarfed on the same side so that when one piece is turned over and laid under the other at right angles as shown here, the side scarf on each piece must be in contact with the upset part of the other piece.



E

Take a FULL WELDING heat and deliver the first blow on the thick part of the top piece to weld the thin under scarf before it is chilled by the anvil face. Continue hammering across the thin part of the top scarf making sure that the inside corner is welded at this heat.

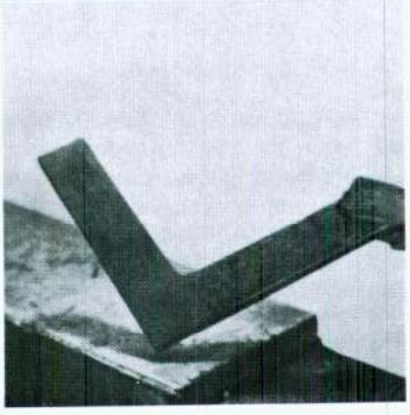
Take another FULL WELDING heat and finish by hammering from the inside to the outside of the corner.



F

There is no need to forge in the superfluous metal, so trim it off with a hot chisel; ample has been allowed for the strength of the joint.

The finished welds should look like this with no reduction in section, and a small radius on the inside corner.



G

Project 6: Turned Hinge

Sorry- I failed to find any publicly available sources for hinge eyes! See Dave Vogel's butterfly hinge instructions on www.cbavista.com for some basics.

I like doing blanket chest hinges, such as those seen in Don Plummer's "Colonial Wrought Iron: the Sorber Collection," and other sources. These involve punching a slot to produce a pintle, then accurately scrolling a tongue through this slot.

Key aspects to turned hinges are getting a short scarf on the right (back) side of the tongue, and scrolling a neat, round eye from the very tip back.

Project 7: Welded Hinge

I couldn't find a public source for welded hinge eyes. Most good smithing books will cover this skill. Welded hinges are more durable than turned eyes, because the eye can't open with use and abuse.

A key aspect is forging a sharp upset corner to bring the eye material to the front before scrolling it around back in an eye. This makes the eye weld clean and tight, and makes a nice eye. Be sure to make and use a drift the size of your pintle to get a nice round, tight eye.

Try welding the pintle directly into one of your eyes- it only needs to stay put (not a perfect 360° tight weld).

A great material for simple welded hinges is horseshoes cut in half- they weld easily and look cool.

Project 8: Ribbon Scroll

Material: 15" of ¼" x ½" or ¼" x ¾" H.R.

You can use other sizes- this is good for learning.

Generally:

Forging the end isn't too hard. Preform the end by reducing it's width before you start forging the taper (and stop tapering anytime the width is back to the same as the original bar).

Make sure your final end no wider than the original bar!

For All Hand-Formed Scrolls:

Scrolling is an excellent way to develop both fine hammer control and your eye. Take your time and learn to do it well!

The scrolls you learn in class (with the exception of the C and S scroll) should all be formed by hand and hammer- no jig, no bending forks. The point in doing this is not torture, but pushing yourself to get that great eye-hammer connection that leads to better ironwork! Do use forks and pliers to undo scrolls, if you need to. Having learned to scroll well by hand, you'll be able to whip off gorgeous scrolls for your personal projects with a fork and wrench.

Always make sure your scroll end is well-formed before you begin scrolling.

A good looking scroll will generally have the radius of the bend increase continuously, and at the same rate. This usually means that the distance between the metal in each turn is always greater as the scroll winds out. When in doubt, draw a golden ratio spiral on a sheet of metal, and work to match it. (Google it or look it up in a pre-algebra book.)

Start scrolling over the anvil edge with the very tip of the scroll- a flat tip in the middle of the scroll is an embarrasment to a real blacksmith.

Keep *looking* at your scroll from the side as you develop it- know what you want it to look like, and hit it only where you need to in order to achieve that. Do not blindly hammer away to just roll the metal up! Never hit a flat spot; always hit a tight kink.

Watch your heat- the scroll will always tighten more at the hottest spot, no matter where you hit it! Only change the bend where it's actually hot...

A good looking scroll usually means the metal goes through between ¾ and 1 ½ turns. Less then that isn't much; more usually starts looking weirdly overdone (look at nice iron work and see how much fits in this range...).

Lesson 1 **RIBBON-END SCROLL**

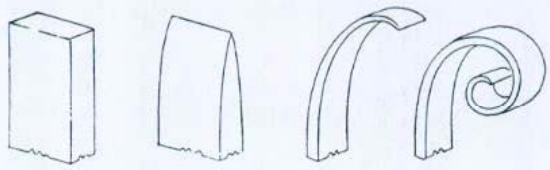
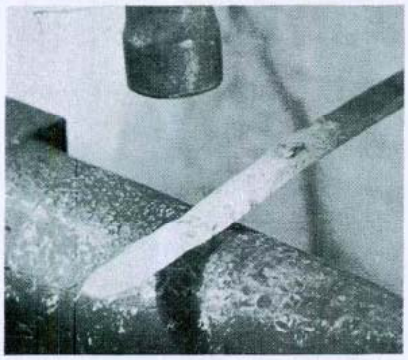


Fig. 16

A

The ribbon end is drawn down in two stages.

First, on the face of the anvil, reduce the width of the bar. Do not allow the thickness to increase, but do not reduce it either.



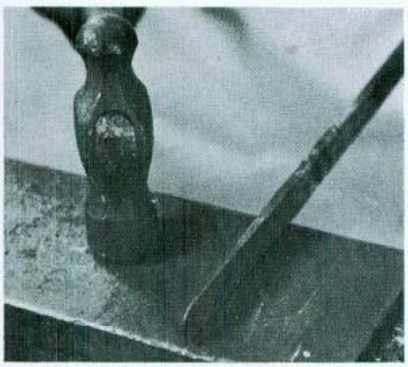
B

Next, move on to the bick, turn the metal on to the flat and draw the taper down.

The reduced width now spreads to the original size or a little over.

C

With the bar on edge, round up the tip neatly.

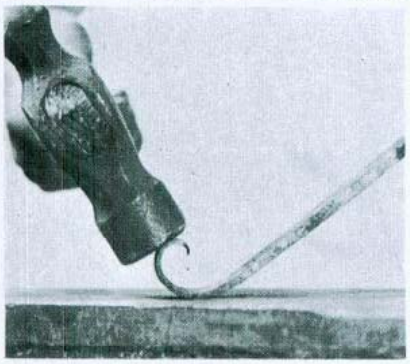


D

Level up on the edge to the width of the parent metal. If the first stage was well judged, little will have to be done now.

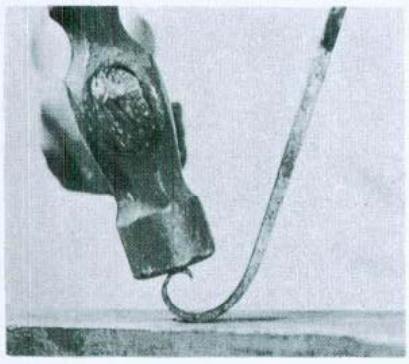
E

Roll the tip of the scroll over the edge of the anvil. Start at the extreme end and take care not to chop the metal against the corner of the anvil.



F

Now continue to roll up the scroll, at a RED heat, on the anvil face. As the scroll is formed, both the bar and the direction in which the blows are struck should steadily approach the vertical.

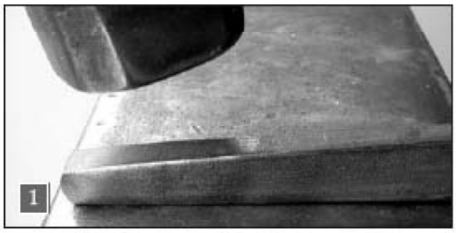


G

You will probably have to repeat these movements two or three times.

The Ribbon Scroll

by Mark Aspery, Springville, California



This article covers the manufacture of traditional scrolls. As such, these scrolls are of a bygone age, and their use on ironwork today needs to be questioned. Some clients will request scrolls purely because they don't know that they can get anything different. The skills required to make these traditional scrolls are invaluable. If you can control a scroll as you make it, then you can control other more contemporary forms as well.

The ribbon scroll is nothing more than a chisel tip on the end of a bar. The stock used for this example is ¼" by ¾". If you were to just flatten the end into a taper, the end would be much wider than the bar. If you now tried to correct this excess of width, the end of the bar will take the path of least resistance and fold. To compensate for that, it is first necessary to take the weight out of the end before you spread the bar. In this way, there is not enough material in the end of the bar to spread much wider than the width of the parent stock and any corrections should be slight. First reduce the weight, and then flatten on the bick. Finally dress the taper on the face of the anvil first along the edge and then on the flat. Finish by forging the end into a half round *(Figures 1 through 6).*

A long taper into the end of the bar helps this scroll look delicate. After you have forged the taper, knock off the sharp corners so that the taper fits in with the parent bar-stock. The initial part of the scroll will be made on the offside edge of the anvil. With the extreme tip of the bar just over the edge of the anvil, roll the end over the edge. It is a bending maneuver, and you should not hear the sound of the anvil as you do this. If you hear the anvil, you may be chopping the bar into the corner of the anvil, creating unwanted divots *(Figure 7)*.

Slowly feed out more stock and continue to roll it over the edge. I say roll rather than bend as a bend to me means a kink in the line of a piece. If you can keep the tip of the scroll resting upon the side of the anvil you should be in good shape. Did you roll with the tip on the side of the anvil?

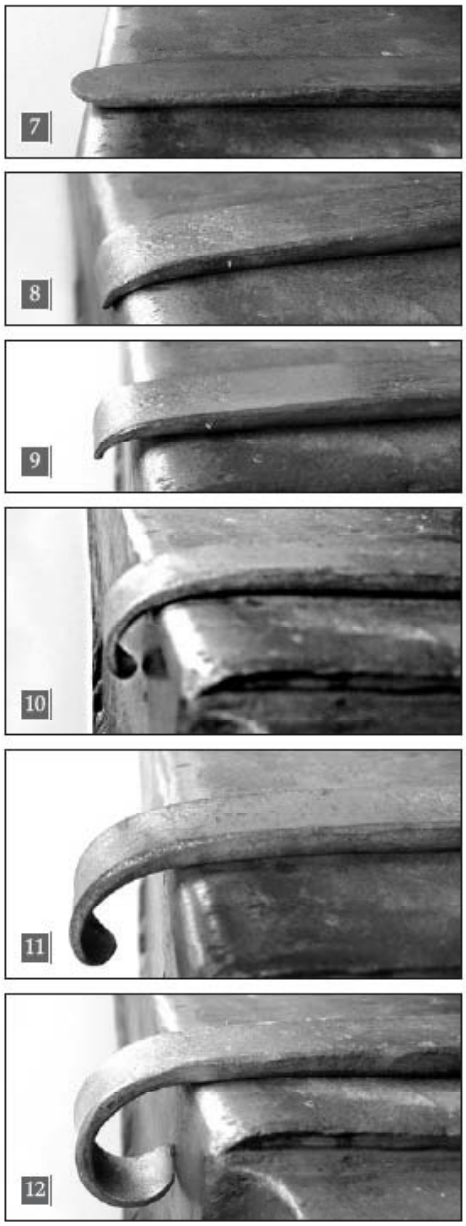
The scroll should form automatically (after a bit of practice). If you look at the physics of what is happening, then the actions may become a bit clearer *(Figures 8 through 12)*.

A taper to the end of the scroll means that any one place in the taper will be unique in size. It will be thicker than the bit just ahead of it and smaller than the bit just behind it. Knowing that, if you keep the force of the hammer blows at a constant, then the thin end will move a lot more than the thicker stock behind it. That forms a scroll.

It takes a bit more than that when the rubber meets the road and you go from theory to practice. If you have a flat spot on the end, you put too much stock out for your first blow or two. If you have kinks in the scroll behind the end, your feed was not smooth or you had an errant hammer blow.

Now you will have to adjust what you have just produced to get the best result that you can. The adage is: *Never hit the same place twice on a scroll and do not hold the scroll in the same place on the anvil for more that one hit.*

Move the scroll to the anvil face and start with the scroll and the hammer opposite each other horizontally. Start to tighten up



the end of your scroll. Bring both the hammer and the scroll into a vertical position, as shown by the next few photographs, as you refine the end of the scroll *(Figures 13 through 15)*.

I found that the best form of practice was to have a number of tapered ends ready to scroll and then do them one after the other. If a scroll starts to go *pear shaped*, fix it right away. If you wait until later to fix it, the correction will throw off the rest of the scroll. Try to identify what went wrong; I can hear your reply, "No kidding." What I mean is to stop after every few blows and look at the result. What did you do to get that result; what could you do to improve the result next time? After you are happy with a few of the ends, it is time to move on and continue the scroll.

Let's go back to physics. Take a small piece of bar and put it in between the jaws of your vise. As you tighten the vise, what will happen to the bar? It will bend. In fact it will make a nice curve until the jaws close too much and you get a kink in the bar. If you can relate the closing of the vise to a hammer-blow, a little power caused a curve and an excess of power caused a kink. That's information you can use to finish the scroll.

You have formed the scroll end, but you have a lot of material yet to go. Using the information we gleaned from the piece in the vise, let's divide the length of the scroll into smaller sections and squeeze these smaller sections between the jaws of a hypothetical vise. This hypothetical vise will be created with one jaw being the anvil face and the other jaw being your hand hammer.

First divide the remaining scroll into smaller sections. One at a time, isolate a section and then curve it; then isolate another section and curve that one until the scroll is complete. You will start with small sections and increase the size with each new section. The smaller sections have to receive more of a curve as they are near the center of the scroll. As you approach the outside of the scroll you can take the largest sections, as they


13


14


15


16


17


18

require the least amount of curve. You can choose to do this next move over the offside edge or over the bick. With your already formed scroll end pointing towards the floor, push about 3" out beyond the anvil and bend the bar *(Figures 16 and 17)*.

Looking at the result, you have a small section of almost straight bar between the already formed scroll end and the bend you just created. Now squeeze this section between the hammer and the anvil face. Starting with your hammer and the bar-stock opposing each other, gradually lift up the bar and change the direction of your hammer blow so that they both approach vertical on the anvil. Going back to the small bar in the vise, we found that too much force (which could also be a gentle force applied too many times) caused too great a bend. Too little force (or not enough blows) and the curve will be too slight.

Blend this new curve into your existing scroll end, and you are ready for the next section *(Figures 18 and 19)*. Do not make so much of an initial bend this time, and remember to increase the length of the section a fraction. Correct any problems before you move on to the next section *(Figures 20 through 22)*. Inertia can play a part in this procedure. If your entire scroll is hot and you start to form a new section, an existing section may be deformed due to inertia. If you see that happening, chill the existing scroll before you start the next section. ♣


19


20


21


22

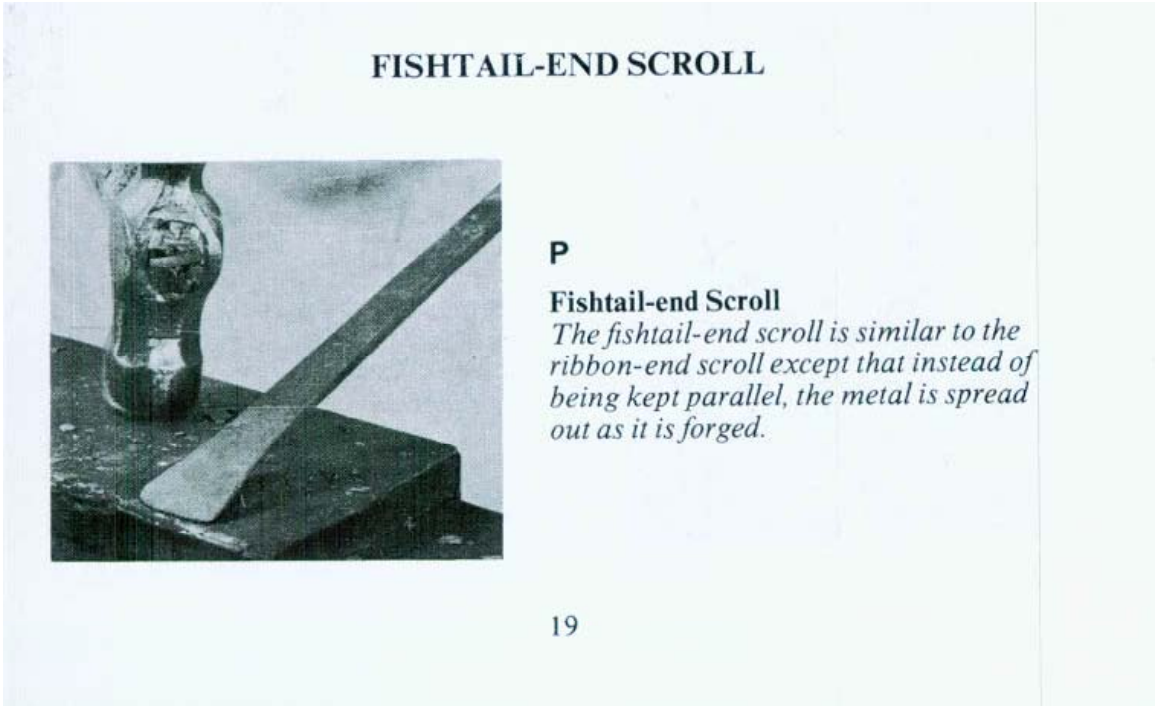
Project 9: Fishtail Scroll

Material: 15" of ¼" x 3/4" H.R.

You can use other sizes- this is good for learning. Too thin is hard to forge to a good fishtail.

Generally:
Not a lot to go on here, eh?
The best way to get a good fishtail is to start forging the taper with a cross-pein, hammering with the pein lined up with the axis of the metal.
Start in the middle of the bar, and work with overlapping blows out to one corner, then repeat from the center to the other corner. Overlapping blows are key to a nice fishtail shape. Keeping the pein in line with the axis, making parallel blows, produces a wide flare and keeps the end pretty square.
Finish the fishtail taper with the flat face of the hammer- it should even-up nicely. Make sure the end is pretty neatly square.

See Project 8 (ribbon scroll) for general scroll forging thoughts.



Project 10: Solid Snub-End Scroll

Material: 15" of ½" square H.R.

Generally:

You have two versions here- Mark Aspery's (the second) includes a nice set of photos of mistakes to avoid- look before you forge!

Because of the upset on the end, you can control the size of the snub-end a lot.

Be sure to bother with a decent taper behind the end- do it just after you seperate the mass, before squaring it up and rounding it.

If you want a nice, round snub, you need to get a nice, even square mass first. An uneven square makes an even circle impossible.

When you scroll it up, you are trying to get the negative space (the empty space between the metal) to have an 'eagle beak' shape coming off of the snub. This means getting a tight start to the scroll, but not going overboard and wrapping the taper around the snub!

See general scroll formation notes in Project 8: Ribbon Scroll.

Lesson 2 **SOLID SNUB-END SCROLL**

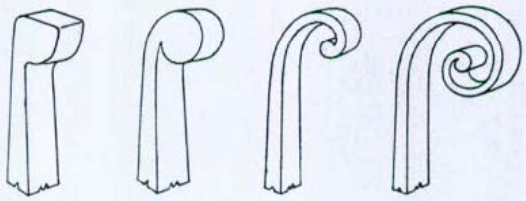
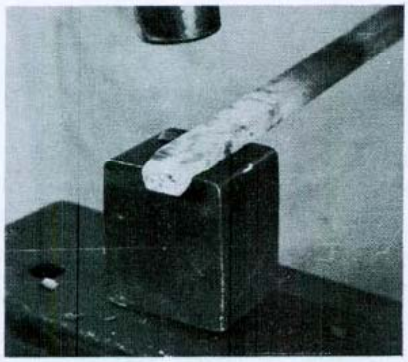


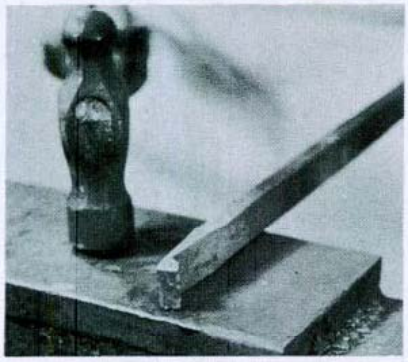
Fig. 17



A

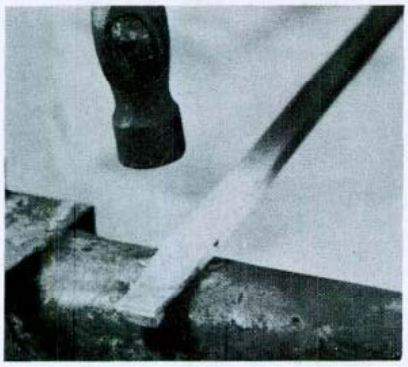
The snub-end is formed over the square edge at the far side of the anvil, or, if the anvil is worn, over a square-edged stake as shown here.

The amount of metal projecting over the edge should be equal to the thickness of the bar.



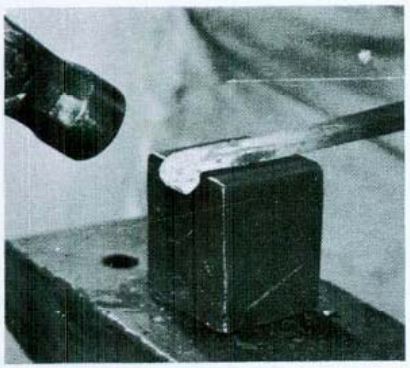
B

Forge in the swelling and level up on edge.



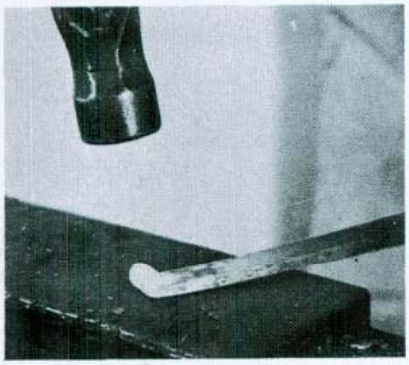
C

In order that a solid snub-end scroll shall look graceful, the metal should be forged to less than half its original thickness for a considerable way behind the snub, scarcely widening at all.



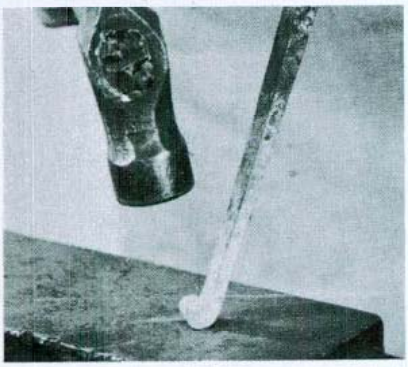
D

Forge in the outside corner of the snub over the anvil or stake edge.



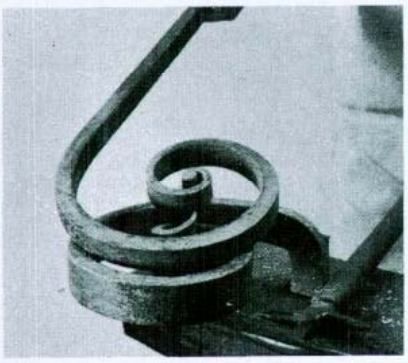
E

Turn the back of the piece on to the anvil face and forge in the remaining corner.



F

Dress up the snub, which should be perfectly round. It should join the taper with a flowing curve so that the scroll may bend gracefully from the snub.



G

When making any kind of snub-ended scroll on a scroll tool, it is vitally important to give the scroll a good start with hammer and pliers (as in Lessons 1 and 4).

The curve of the scroll must fit the scroll tool and grip it. On no account must the snub be allowed to do any of the holding or it will be distorted; this is very difficult to rectify.

Here is the finished scroll.

The Solid Snub-End Scroll

by the CBA Staff

Want to push around some steel? Making the square blob for the snub requires that you push/pull the steel with your hammer in any way that works. You'll enjoy the plasticity of the steel! Material may be square or rectangular. The size of the snub is determined by the material overhanging the anvil in the first step. The material shown was ½" square with a 1" overhang.

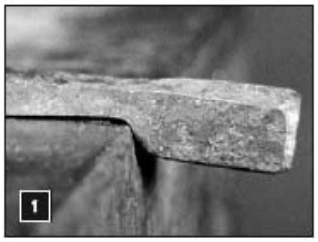
CoSIRA's *Wrought Ironwork* states, "The amount of material projecting over the edge should be equal to the thickness of the bar."

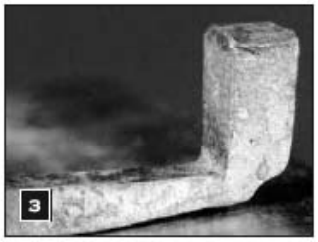
Step 1. With your predetermined overhang, hammer half over the anvil to start the scroll. Forge the spread back to the material width. The thin section should be about half to a third the bar thickness. **If thin section cools to a dark red, stop working.** A crack will develop and you will have to start over. See "Two Things to Avoid" on the next page.

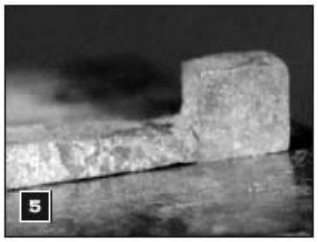
Step 2. Turn over the work and bend the snub down, but less than 90°.

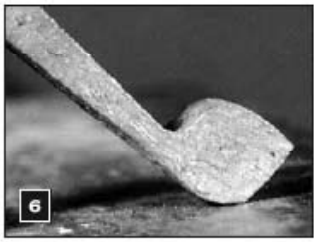
Steps 3 & 4. Turn the snub up and hammer down at more than 90° to start a square *(as viewed from the side).* (Feel the plasticity of the steel?)

Step 5. Hammer, wipe, do whatever you need to do to square the snub. **Check the square. Use a square. Measure the sides.** Getting it square makes it easier to round it later.





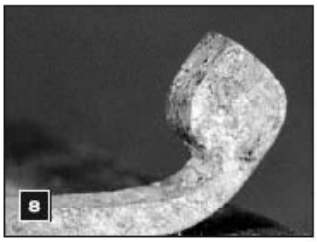




Steps 6 & 7. Forge in the two corners to get a leaf-like blob.

Steps 8 & 9. Turn the snub up a bit. Round the last corner. Start your scroll with your hammer as shown in the final result *(see first picture)*. Bring the snub around into a nice curve. Mark Aspery sees an American Eagle's beak as the scroll opens. *(Look at the negative space, not the steel.)*

If you are only making one or two scrolls you may want to finish the scroll with your hammer. For several scrolls you will certainly want to make a scroll iron. When using a scroll iron, CoSIRA states, "On no account must the snub be allowed to do any of the holding or it will be distorted; this is very difficult to rectify." ♠



Two things to avoid

Remember the thin metal next to the snub must be hot enough (red) so that it will not to crack while you are working. If it cracks, start over.

If you get carried away with the hammer on the last corner, the end of the eagle's beak will be gone. Start over.

Project 11: Fishtail Snub-End Scroll

Material: 15" of ¼" x ¾" H.R.

You can use other sizes- this is good for learning.

Generally:

See Project 9: Fishtail Scroll on how to make a good fishtail with your cross-pein. On this one, you want a *wide* tail, so consider starting by leaving a blob on the end, and tapering the material thickness behind, first (as per step A).

Make sure the end of the fishtail is straight across and is notched- these are key to rolling it up neat and tight without weird sausage bulges in the middle.

Spend time getting the start of the scroll as tight as you possibly can, but *don't* let the metal actually fold over- it has to roll to be round.

If you look at European grille work, you'll probably find that some folks used this rolled-up-taper method for non-fishtail snub-ends, too! What ever works for you...

Start the scroll carefully- you are going for the 'eagle beak' negative space, again.

For general scrolling thoughts, see Project 8: Ribbon Scroll.

Lesson 3 FISHTAIL SNUB-END SCROLL

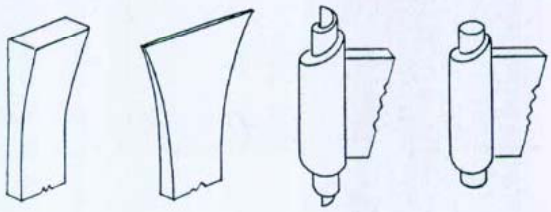
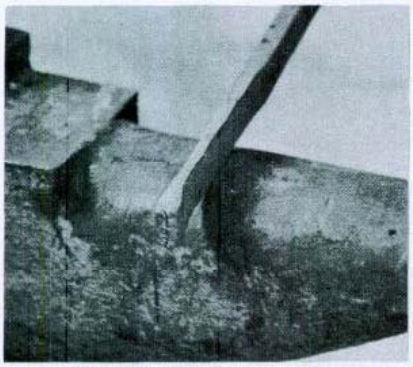


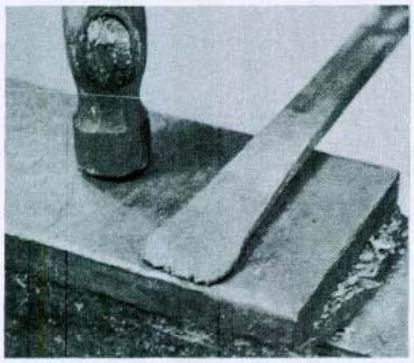
Fig. 18



A

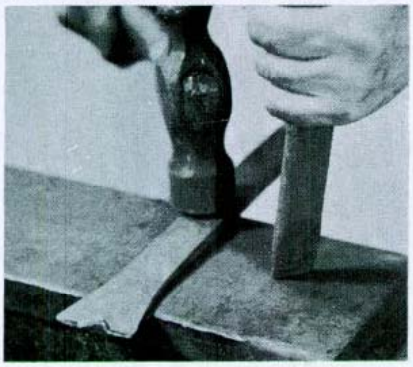
Reduce the metal on the bick of the anvil, leaving an untouched lump at the end and a long taper. It is shown here on edge, cold.

In the same heat, move it on to the anvil face, turn it on edge, and level it up.



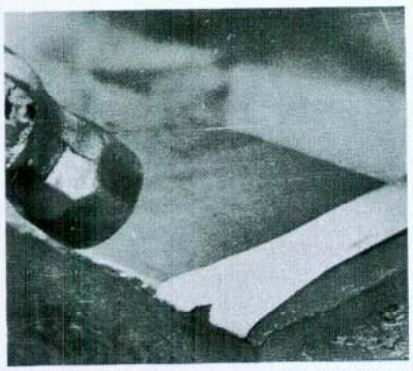
B

Take a WELDING heat on the end in case the metal has cracked, and forge the lump into a broad, short fishtail.



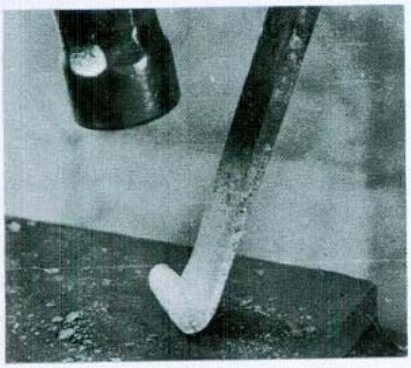
C

Notch the end as shown. This, by removing surplus metal from the centre, makes it easier to roll a tight snub, and prevents the middle of the snub from bulging when the end faces are burred.



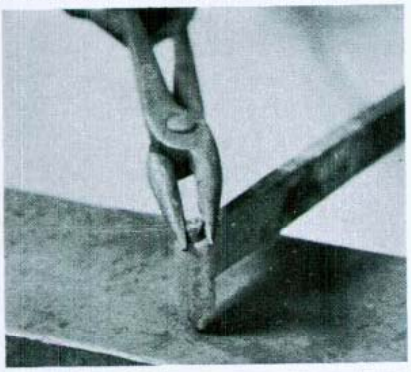
D

Starting at the extreme tip, begin to roll up the snub end.



E

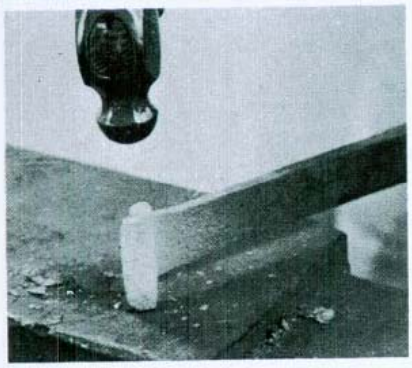
Tighten the roll in the same way as the solid snub was formed.



F

The projecting ends can be tightened up neatly with the round-nosed pliers.

A scroll is sometimes left in this form, and is called a Fishtail Knib. It is delicate in appearance but apt to catch on clothing, so it is more often finished in a Fishtail Snub as below.



G

Flatten the end faces, burring them carefully so that the ends of the roll appear solid. If one end flattens more readily under the hammer than the other, cool it a little with water.

Project 12: Ha'Penny Scroll

Material: 15" of ¼" x ½" or ¼" x ¾" H.R.

You can use other sizes- this is good for learning.

Generally:

That's "half penny" in American- it refers to the coin shape of the scroll end.

Do a solid snub-end scroll or two before doing this one. You can then apply the flip-and-upset technique from that to this one to make any size 'penny' you want!

Like the solid snub-end scroll, you need a nice even square shape on the end before you can make a nice circular disk.

Make sure you do a decent taper behind the coin mass, then adjust it to center the coin before you scroll it up. This taper, though, is only in width, not thickness (unlike most other scrolls).

The twist-trick here is a great one to apply in other places (between tong jaw and boss, for example). You can forge it out square again, or round the neck.

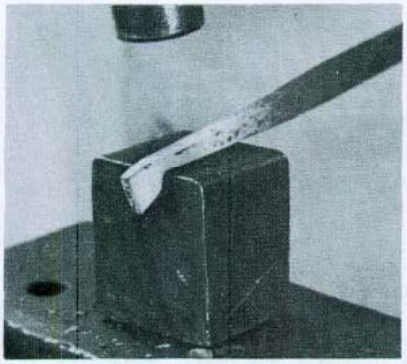
Start the scroll carefully- you are going for the 'eagle beak' negative space, again.

For general scrolling thoughts, see Project 8: Ribbon Scroll.

A great looking variation on this scroll is to do it in round stock, and round the taper all the way out to the coin finial.

Lesson 4 HALFPENNY SNUB-END SCROLL

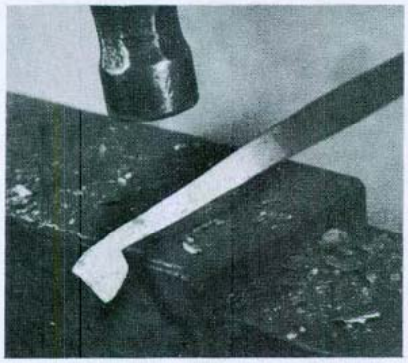
Fig. 19



A

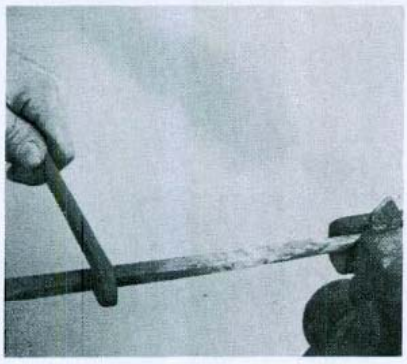
As in making a solid snub-end (see page 20), it may be wise to use a square-edged stake.

With the metal projecting as far over the edge of the anvil or stake as the bar is wide, forge an offset neck.



B

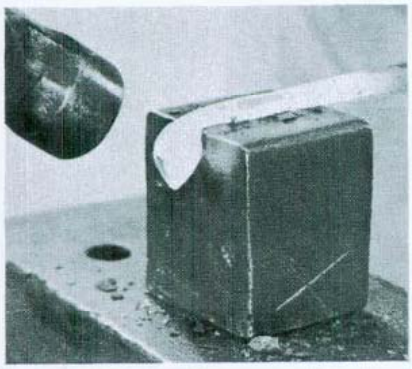
So far, the snub is being formed in the same plane as the bar, but in the finished scroll it must be at right angles to this. The snub will, therefore, need to be twisted through a right angle. Before making this twist, round up the neck, as the corners would show up the twist and it is more difficult to forge them in afterwards.



C

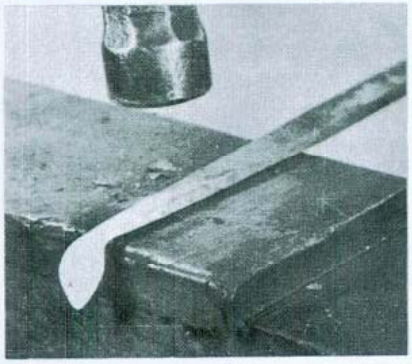
Take a BLOOD RED heat, and concentrate it on the rounded part, using water if necessary.

Now grip the snub in the vice and twist the bar at right angles using a suitable wrench or a pair of tongs.



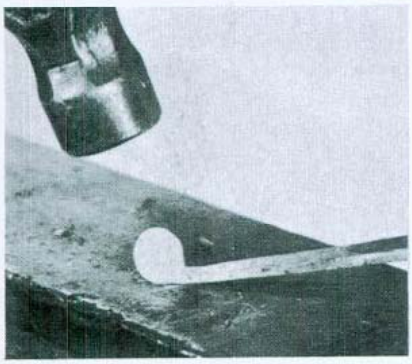
D

Take a heat on the snub and forge in the far corner.



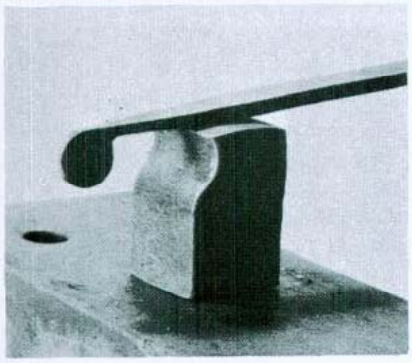
E

The neck which was rounded for twisting should now be squared up again. If this were left till later, the head would get in the way.



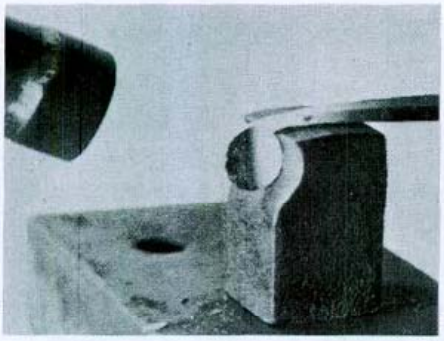
F

Turn the piece on its back and round up the snub on the anvil face.



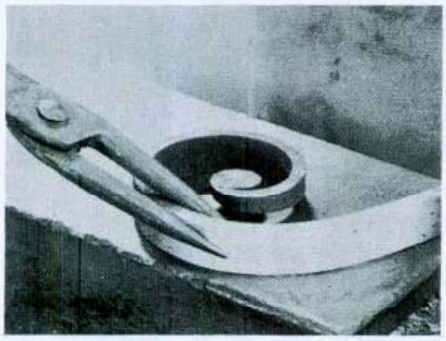
G

Here is the special tool (shown on page 10, Fig. 4) with the piece, showing the radius in the neck as forged so far.



H

To finish the snub and make it blend gracefully into the neck, take a near welding heat, cool the far edge quickly to avoid damaging it and get rid of the radius with light blows.



J

As the normal scroll tool cannot readily be adapted to these scrolls, it is usually easier to bend them with the round-nosed pliers.

If a large number is needed, a special scroll tool with an open centre should be made.

Project 13: Bolt-End Scroll

Material: 15" of ¼" x ¾" or ¼" x 1" H.R.
9-12" of 5/16" round H.R.

You can use other sizes- this is good for learning.

Generally:

Start with a well-forged fishtail (see Project 9: Fishtail Scroll), but with a slightly thicker end (to have enough metal mass for welding).

The bolt end is going to look best when it is a bit wider than the fishtail (think of a fiddlehead)- keep this in mind when deciding where to nick the round bar.

The hardest part of this scroll is getting the round bar centered on the end of the fishtail, then welded, all while staying at welding temperature in small stock! Tibor Laky invented the solution: after nicking the round bar, bend it (about an inch past the nick) to an accute angle, and then arc the rest of the bar just enough to bring the round stock 'handle' in line with the fishtailed bar. The effect is a tall, skinny number '7'. Lay this on the fishtail, with the future bolt-end in just the right place, then use tie wire to firmly lash the two pieces of metal together. Now you can heat them, flux them, and weld them all in the correct relative positions! Bonus: you can do the weld with the round stock down, keeping enough heat in the fishtail for the weld to actually take!

For a better result, finish the weld, and blend in the joint, on a half-round bottom swage.

Be sure to have the weld in the vice when you snap off the extra round stock!

Use the vise, as suggested in steps G and H, to start the scroll, and do start it with an almost complete wrap of the bolt bar.

Start the scroll carefully- you are going for the 'eagle beak' negative space, again.

Be sure to clean up the bolt ends (rasp, hammer) so they are nice and flat.

For general scrolling thoughts, see Project 8: Ribbon Scroll.

Lesson 5 **BOLT-END SCROLL**

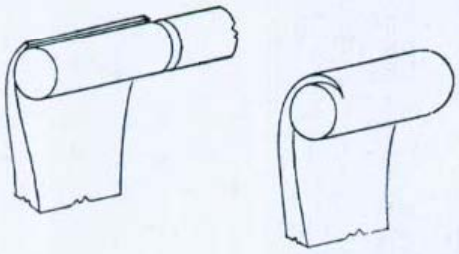
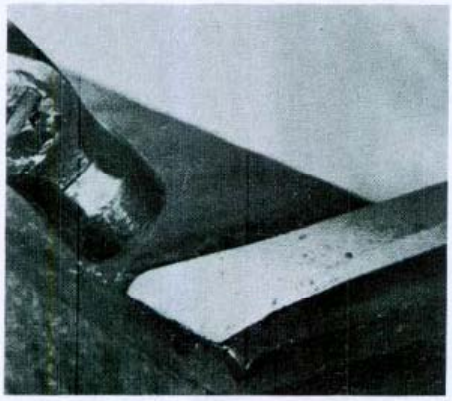
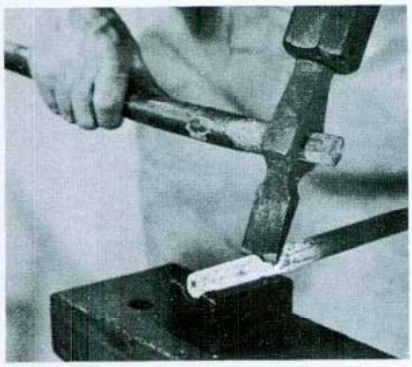


Fig. 20



A

Forge a fishtail, leaving the end not less than $\frac{1}{8}$-inch thick. If the bolt-end is to be wide in proportion to the bar, it will be necessary to upset the end to some extent first.

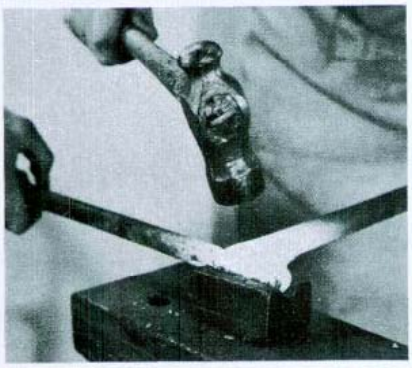


B

The bolt is made from a round bar, and should be at least ¼ in. longer than the width of the fishtail.

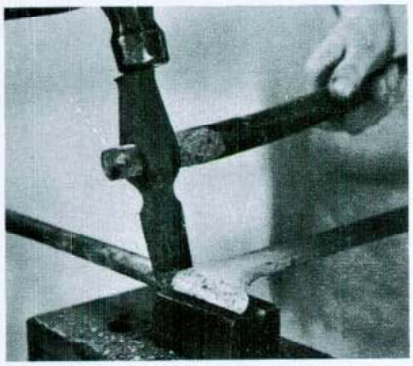
Make a notch all round the bar with a hot set, leaving just enough metal at the centre to support the bolt while it is being welded.

Hold the set to one side, as shown here, so as to leave a square end on the bolt.



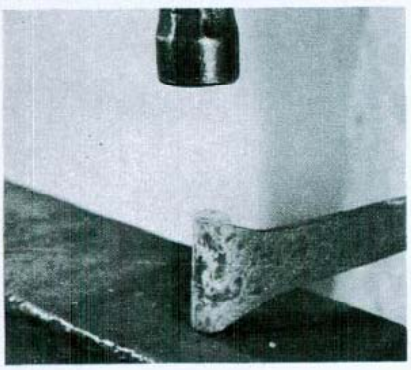
C

Help will be needed for this weld. Take a WELDING heat on both pieces. Have your mate take a wire brush in one hand and the round bar in the other.
He should lift the round bar from the fire and place it in a bottom swage, wire brushing it on the way.
Lift out the fishtail and present the end, bottom upwards, to your mate. He should give it one stroke with the wire brush.
Turn it over and immediately weld it to the bolt.



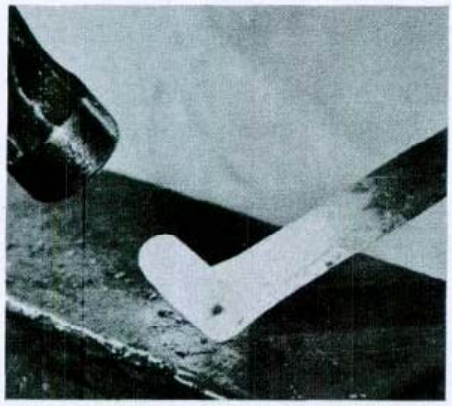
D

Hand your hammer to your mate and sever the bolt from the bar with a hot set.



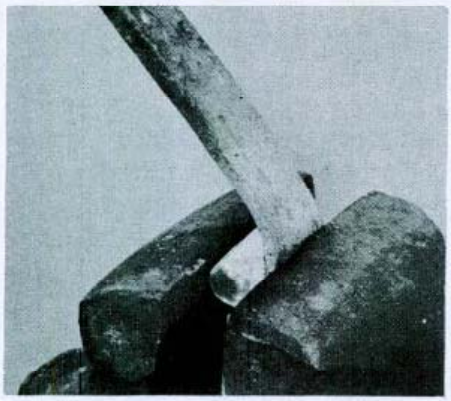
E

Square up the ends of the bolt.



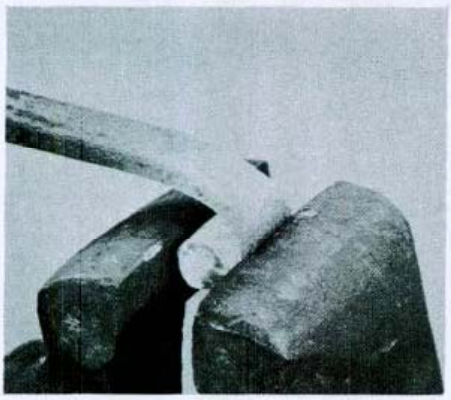
F

Very slowly, so as not to burn the thin fishtail, take a FULL WELDING heat and strengthen the weld, rolling the bolt up a little.



G

Grip the bolt in a vice and pull the bar over to begin the scroll.



H

Take a fresh grip and repeat the process until the bar almost encircles the bolt, then form the rest of the scroll with hammer, horns and wrench (see page 33 E).

Bolt-ended scrolls are not very common and are normally fairly sturdy, so scroll tools are seldom used for them.

Project 14: Blown-Over Leaf Scroll

Material: 15" of ¼" x ¾" H.R.

You can use other sizes- this is good for learning.

Generally:

This scroll and the beveled scroll both do the same general hocus-pocus: the scroll is made of flat stock bent 'the easy way', but the end of the scroll gently brings the material around to bend 'the hard way' on the inside. Done right, the effect is striking- narrow swirls fatten to elegant, bold ends.

You have two sources for each of these- CoSIRA and Mark Aspery. I think Aspery does a much better job of explaining how to get the scrolling to work right, without ugly kinks or corkscrews.

Be warned that there are lots of ways to screw up this scroll! First focus on making a nice leaf. Then take a break. Then focus on getting the scrolling to happen the right way, like its a separate project!

You may want to do several of these, and play with how much metal you use for the leaf.

Be sure to decide if the scroll is a righty or a lefty before you start to bevel the leaf!

When you start scrolling, consider using a mallet (wood, hide, bronze) instead of a hammer, to avoid flattening out the nice bevel line you just made. Yes, yes- of course you will *only* hammer the metal *over air*, so it shouldn't forge-out at all...but this provides a bit of leeway if you, um, miss.

To be successful with this scroll, be absolutely scrupulous about keeping the axis of the scroll at a 90° angle to the axis of the horn (see Aspery's illustrations)- if you are even a little off in either direction, your scroll will behave very badly, indeed! Every bad version of this scroll I've seen could be traced to this.

Aim for a scroll that turns about ¾ of a turn in total, to really get the feel for how this works and how to use this scroll end.

The leaf end on this scroll is also a nice alternative for forging key ring fobs- it has lots of life in it (and doesn't have chiseled veins).

For general scrolling thoughts, see Project 8: Ribbon Scroll.

Lesson 6 BLOW-OVER LEAF SCROLL

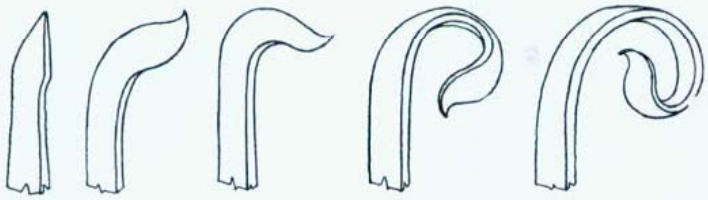
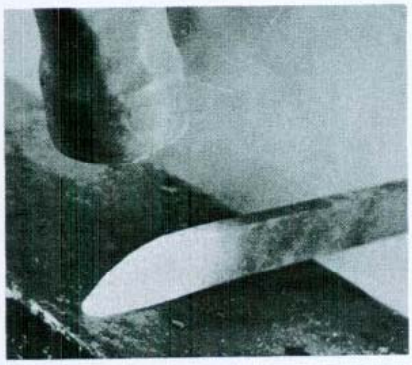
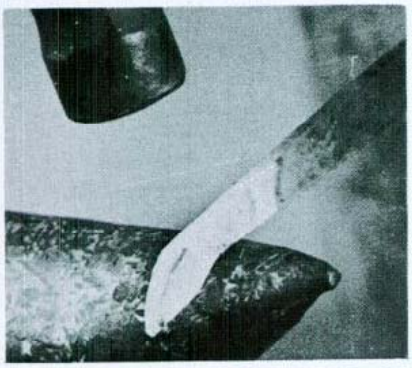


Fig. 21



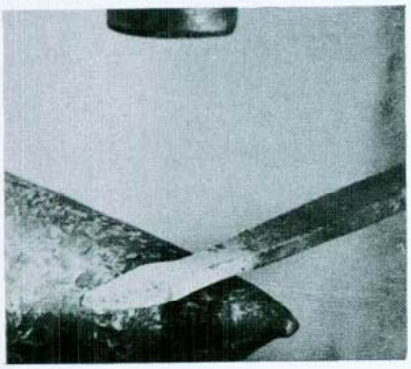
A

Forge the end of a bar to a radius. The curve should be no longer than shown here, otherwise the leaf-end will be too long.



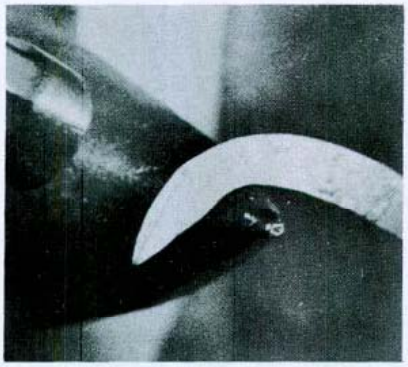
B

Neck over the bick, leaving the straight bottom edge of the end a little longer than the width of the bar.



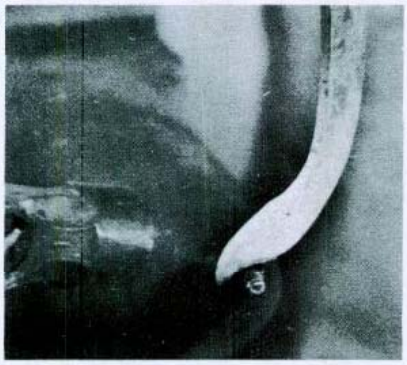
C

Thin the neck on the flat, to about two-thirds.



D

Bend the neck, on edge, over the bick.

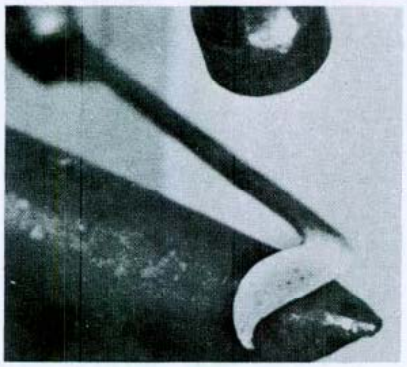


E

Cock the tip, still on edge, in the opposite direction to the main bend.

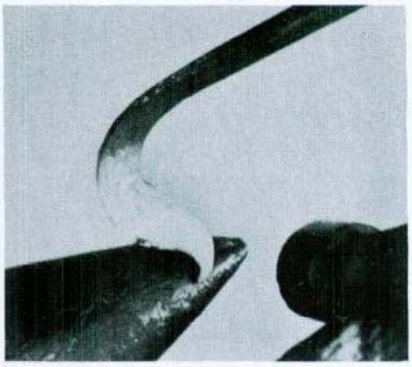
F

With ball-faced hammer, thin both edges, on one face, controlling the curve as you do so.



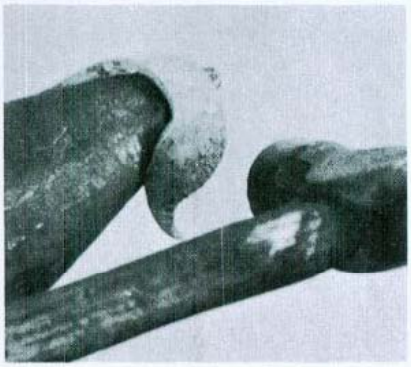
G

So far, the piece has been bent on the edge. Now, with the hammered face upwards, curve the leaf on the flat.



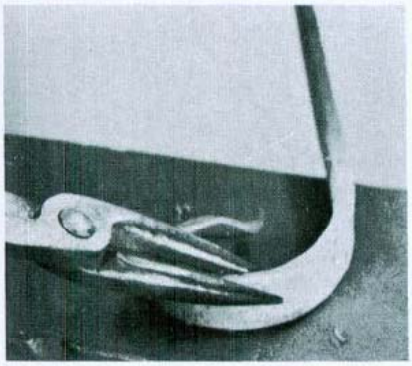
H

The tip has already been cocked in the opposite direction to the main curve on edge (E). Now cock it in the opposite direction to the curve you have just made.



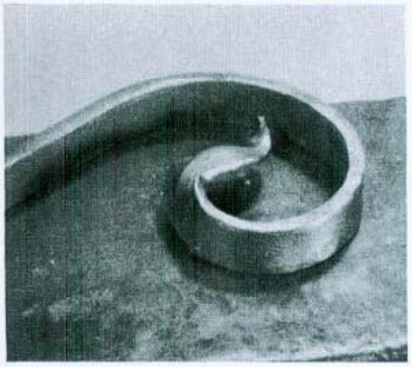
J

Increase the curl in the neck at the same time twisting the leaf partly into line with the bar. Avoid solid blows which would distort the shape.



K

Form and adjust the scroll with pliers.



L

The finished scroll. The leaf can be aligned a trifle if necessary, with light blows.

The Beveled Leaf Scroll

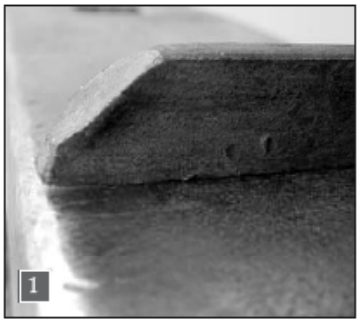
by Mark Aspery
Springville, California

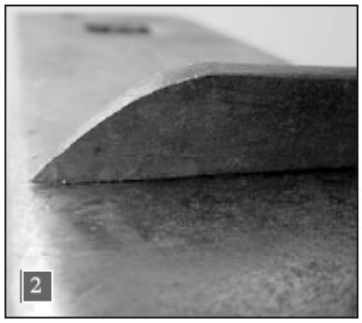
Note: This "C" Scroll has slightly longer leaves than the process described.

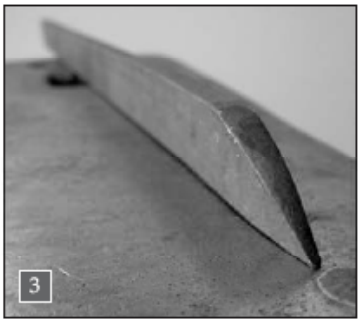
I find this scroll to be one of the most pleasing in the bunch. It does have a few steps to its manufacture, but the result is worth the effort.

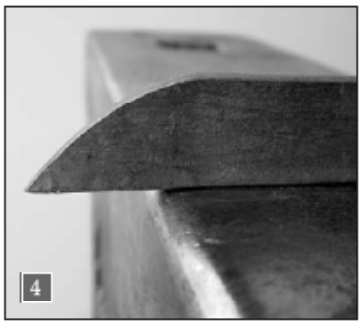
Forge a short point on the end of the bar. The taper will be flat on one side and curved on the other. I also thin the point down a little, as it adds to the effect. Try to keep the taper fairly short, not much longer than the width of the parent bar-stock *(See Figures 1 through 3).*

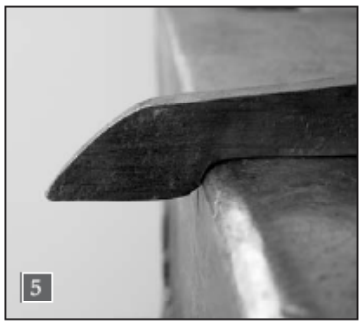
Next is to define the leaf by forging a set transition. Shown is a half-faced blow over the offside edge of the anvil, but it could equally be forged over the bick to produce a slower transition. The important thing to remember here is to keep the leaf short; perhaps the width of the bar stock. The leaf may look a little small after this move, but the leaf will, dare I say, "grow" during the beveling step *(See Figures 4 & 5).*











After defining the leaf, the bar needs to be bent through approximately 90°. Keep this bend short, within an inch to an inch and a half, just behind the leaf *(See Figures 6 & 7).*

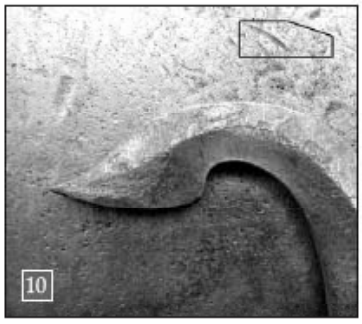
This type of scroll is one sided, and a decision must be made as to which way the scroll will turn. If you place the leaf on the anvil with the bend going to the left, you will forge a left-branching scroll and, of course, vice versa. The example shown is for a left-branching scroll *(See Figures 8 & 9).*

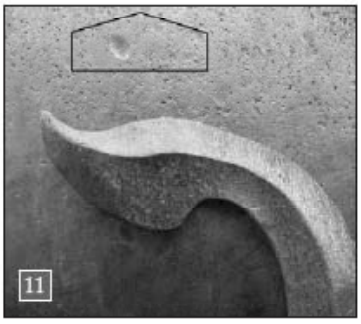
Decide on the direction of your scroll, and using a ball-faced hammer, chamfer the edges. Note that chamfering the outside edge will tighten the bend while chamfering the inside edge will open it. It would be nice if after chamfering, the bend were returned to its original position *(See Figures 10 & 11).*

And now to the scrolling part. In order to better understand how to scroll this type of scroll, get a piece of cardboard (a breakfast cereal box will do nicely) and draw the outline of your forged scroll on the cardboard. Cut the cardboard scroll out with scissors.

Holding the cardboard in one hand between the thumb and forefinger, start about halfway down the leaf and make a bend 90° to the centerline of the leaf. Feed out about ¼" and do the same thing. Continue that along the entire scroll. You should find that the leaf and the bend have made a slow 90° turn and are now resting in line with the rest of the scroll. That knowledge helps you when you go to the anvil. You could turn these scrolls off the side of the face of the anvil if you didn't need some clearance for the turning leaf. As such, we turn these scrolls on the end of the bick, as it allows us the clearance that we need for the turning leaf and scroll.

As you feed the leaf and scroll over the bick, make sure that you keep the centerline of the scroll 90° to the centerline of the bick. I like to use a small leather mallet

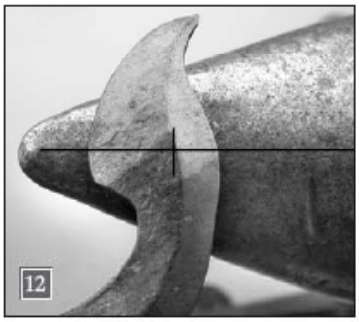




here in order to protect the line of the adjoining-bevels *(See Figures 12 through 16).*

Before you turn the complete scroll, stop and bend the tip of the leaf back in the other direction. That can sometimes cause a bit of frustration. Rest the leaf on the end of the bick, and make sure that you do not move the hand holding the scroll as you bend the leaf. Moving your hand now can cause the scroll to open rather than causing the tip of the leaf to bend. If you are having problems, consider quenching the bend of the scroll up to a quarter of the way up the leaf and then give it a go *(See Figures 17 & 18).*

Reheat the scroll and continue to bend. At some point you will want to continue scrolling with either a dog wrench and horns or with some scrolling tongs *(See Figures 19 & 20).* ♣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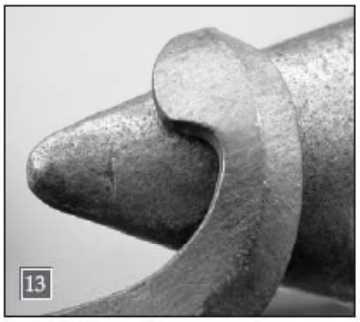
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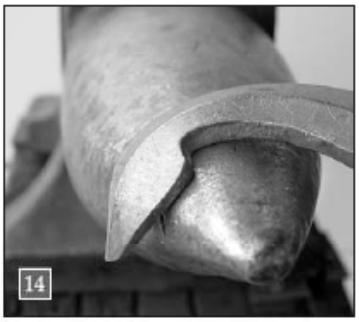
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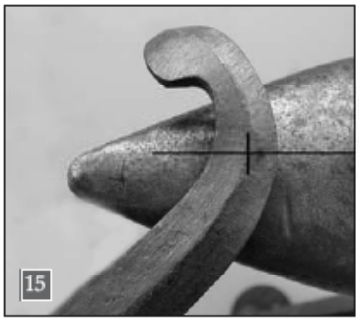
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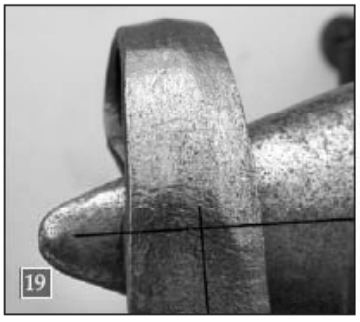

19


20

Project 15: Beveled Scroll

Material: 15" of ¼" x ¾" H.R.

You can use other sizes- this is good for learning.

Generally:

You have two sources for this- CoSIRA and Mark Aspery. I think Aspery does a much better job of explaining how to get the scrolling to work right, without ugly kinks or corkscrews.

I strongly recommend trying the exercise Aspery suggests at the end of his article- make a scroll in heavy paper, and use a series of tiny folds to see how the metal will bend through a 90° orientation change as the scroll grows. Better yet, cut out three scrolls- do one with the folds at perfect right angles to the scroll axis, then one with the folds angled a bit in each direction. You will quickly learn what happens if you don't scroll correctly!

Note that you need to decide if the scroll is a righty or a lefty before you start bevelling it.

When you start scrolling, consider using a mallet (wood, hide, bronze) instead of a hammer, to avoid flattening out the nice bevel line you just made. Yes, yes- of course you will *only* hammer the metal *over air*, so it shouldn't forge-out at all...but this provides a bit of leeway if you, um, miss.

To be successful with this scroll, be absolutely scrupulous about keeping the axis of the scroll at a 90° angle to the axis of the horn (see Aspery's illustrations)- if you are even a little off in either direction, your scroll will behave very badly, indeed! Every bad version of this scroll I've seen could be traced to this.

Be a bit careful with CoSIRA step K- I've found it better to lay the scroll face *down* on the anvil, and tap the upper edges gently to flatten the center a bit.

Your final scroll should have a particularly nice negative space (the spaces between the metal), with a nice snub-end shape at the center, and an ever-expanding wedge as it circles out.

The methods in this scroll can be used in lots of other ways- I like the idea of forging a rounded taper, offest to one side, as the start for any bend done 'the hard way' in flat stock. Watching the scroll tighten and loosen at you bevel the outside and inside is also extremely instructive, and a handy technique for solving a variety of problems.

For general scrolling thoughts, see Project 8: Ribbon Scroll.

Lesson 7 **BEVELLED SCROLL**

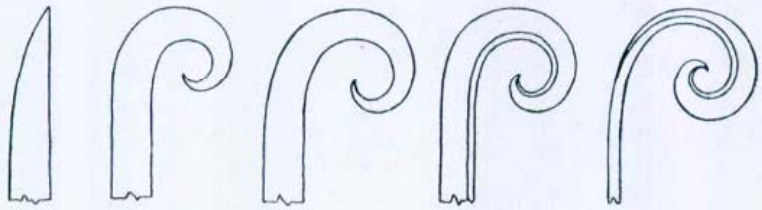
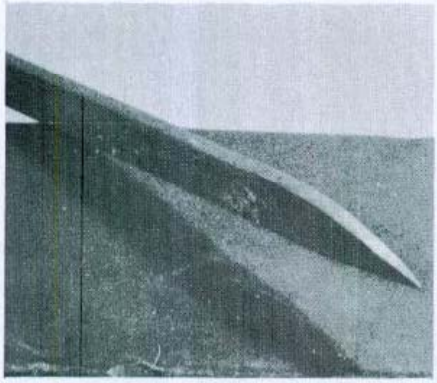
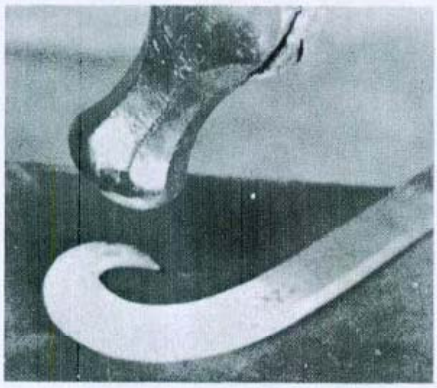


Fig. 22



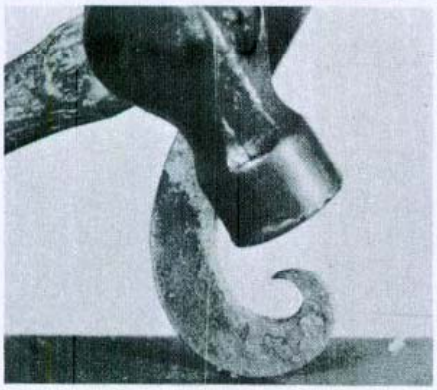
A

Draw the end of the bar with one edge curved, the other straight, and the extreme tip sharply pointed. Curl on bick.



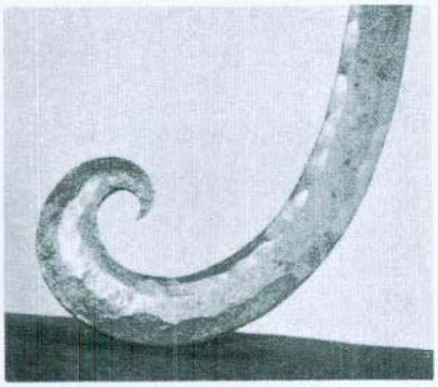
B

With ball-faced hammer, thin both edges on one face, controlling the curve as you do so.



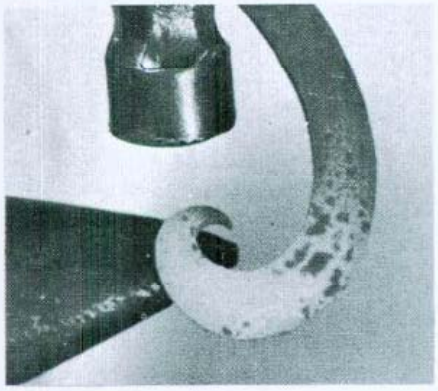
C

Tap the end of the scroll out of alignment and tuck in the end, neatly, on the anvil face.



D

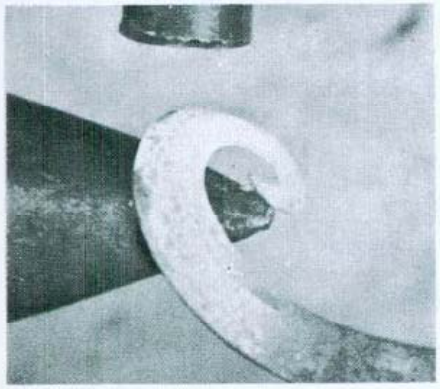
Here is the result so far, shown cold. Note the steady increase in radius from the tip.



E

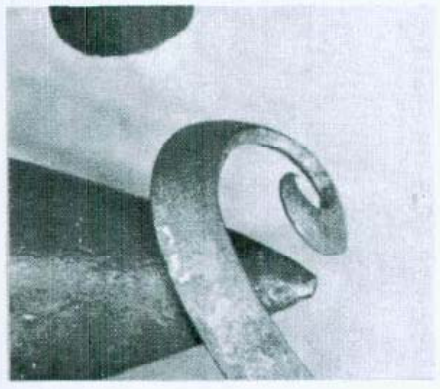
Place the inner edge of the tip on the point of the bick, the outer edge being kept a little off it.

Hammer the outer edge lightly down onto the bick, bending it only. Avoid solid blows which would distort the shape.



F

Continue in the same way round the scroll, re-heating as necessary.



G

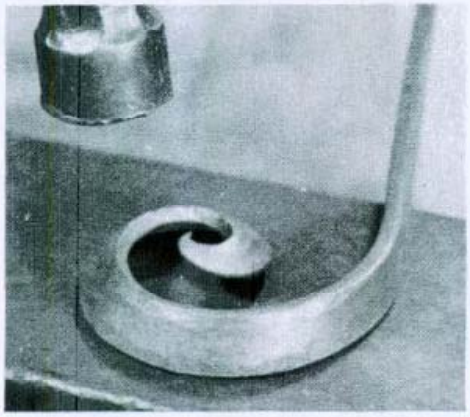
Here is the result, almost completed.

H

Complete the bending with horns and pliers.

J

By varying the position of the scroll and the pliers the scroll is not only bent but also twisted to maintain the balance between the bevel and the curve.



K

Finally the centre can be flattened a little if necessary.

The Beveled Scroll

by Mark Aspery, Springville, California

This scroll is the sister to the blown over beveled leaf scroll. The techniques are very similar.

To start, draw a slightly round taper of at least 2" on the end of the bar. Bring the end down to a sharp point, **Steps 1A through 1C.**

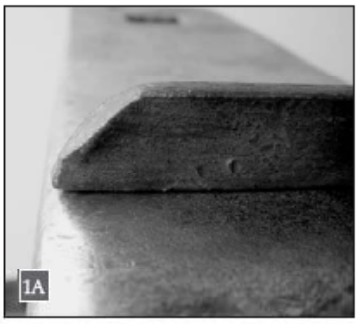
The next step will dictate the shape and size of the finished scroll. Turning the bar on edge, turn a scroll on the end of the bar. I like to start a bit back from the end.

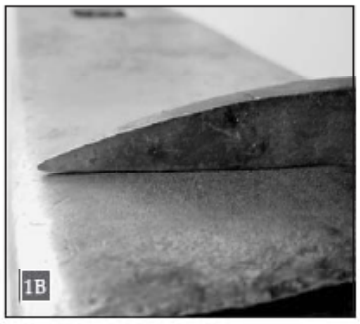
Bend as much as you can from the top and then place the bar underneath the bick and bend the majority of what is left. I like the scroll to make about one complete turn through 360º, **Steps 2A through 2C.** The result of working on the bick is shown in **Step 2D.**

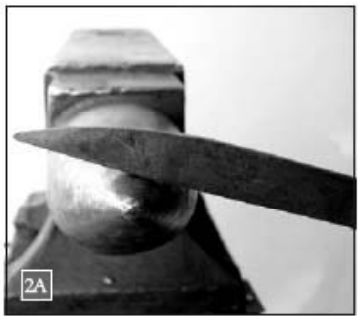
Getting to the very end of the scroll can be difficult. In order to get to the end, you will have to knock the end out of alignment. Take **Step 2E** and finish scrolling, using your hand hammer on the face of the anvil.

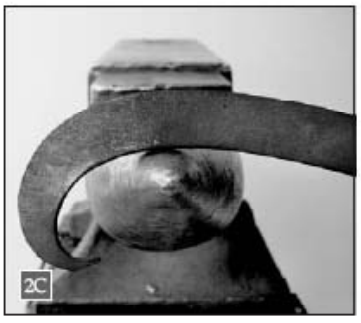
Once the scroll is formed, edgeways on the bar, decide whether this will be a left or right-handed scroll. This type of scroll has a front and a back, making it one-sided visually. When you lay it on the anvil face to be beveled, if the bar scrolls to the right, it will produce a right-facing scroll, and of course vice versa, **Step 2F.**

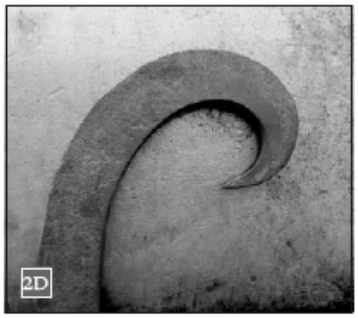
At this stage bevel the edges. The inside edge will receive most attention visually and so requires a little more effort than the outside edge.



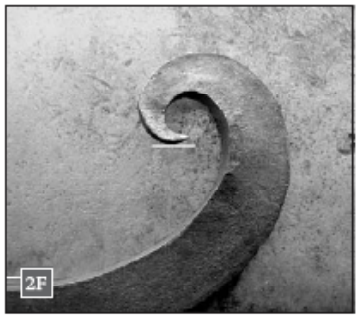







2D


2E


2F

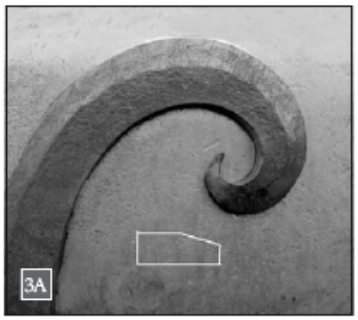
When you bevel the inside edge, the scroll will open; when you bevel the outside edge, it will close the scroll, making it tighter.

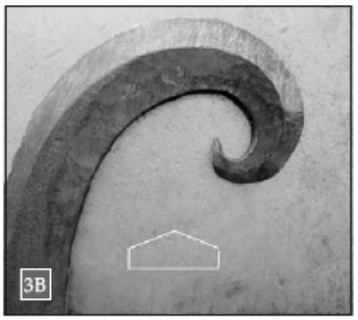
I like to have the chamfers meet in the middle of the bar for the first couple of inches, **Steps 3A and 3B.**

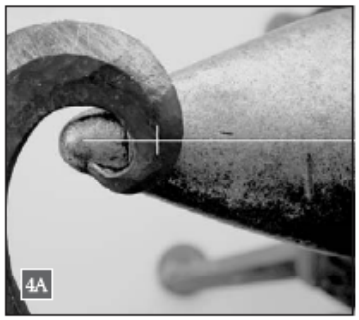
After the chamfers are complete, the scroll must now be turned 90° to the parent bar.

And now to the scrolling part: in order to better understand how to turn this type of scroll, get a piece of cardboard (a breakfast cereal box will do nicely) and draw the outline of your forged scroll on the cardboard. Cut out the cardboard scroll with scissors.

Holding the cardboard in one hand between the thumb and forefinger, start at the end and make a bend 90° to the centerline of the scroll. Feed about ¼" out and do the same thing. Continue along the entire scroll. You should find that the scroll end has made a slow 90° turn and is now resting in line with the rest of the scroll. That knowledge helps you when you go to the anvil. You could turn these scrolls off the side of the face of the anvil if you didn't need some clearance for the turning end. As such, we turn these scrolls on the end of the bick as it allows us the clearance that we need for turning the scroll, **Steps 4A through 4D.** ♣


3A


3B


4A


4B


4C


4D

Project 16: Williamsburg Bending Wrench and Forks

Material: 24" of ½" round or ½" square H.R. for the wrench
A few extra inches of 3/8" and ½" round H.R. for forks

Generally:

These are also called scrolling wrench and scrolling forks- either language works. They are great for forming controlled bends in hot metal, either alone (wrench or fork) or paired. They really shine when you need to *undo* a bad scroll or flawed bend! Another use for the wrench is to pull hot metal against a scrolling jig or other form, insuring an excellent fit. These last two are why you'll want them for making and using your scrolling jig...

For the wrench, square stock makes it easier to get a good, beefy weld in the handle- just remember to round the two ends, first!

Do make yourself several U-shaped scrolling forks in a couple of diameters of stock, and at a few different spacings. This will let you do bends of various arcs in different weight steels. You'll find plenty of other uses, too (like adjusting rat-tail scrolls or making the wrapped handle eye on Dave Vogel's steak turner design...).

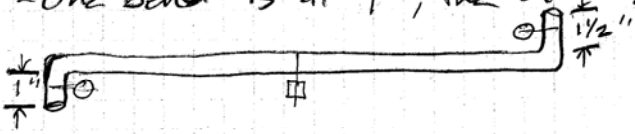
WILLIAMSBURG BENDING WRENCH

B. HOLMBERG, 2010
(after W. Parris)

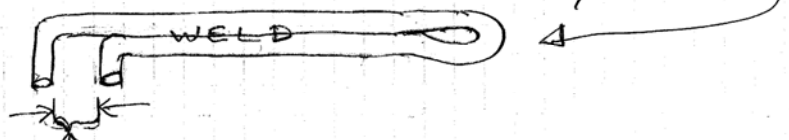
MATERIAL: 24" of ½" square H.R.
(or ½" round H.R.)

(1) IF working with square stock, make the cross-section ROUND at each end.
One end should be 1" long round, the other 1½" long.

(2) Sharply bend the ends 90°
- Bends go to OPPOSITE sides
- One bend is at 1", the other at 1½"

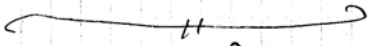


(3) Fold near the center, so that the 1½" end lays over the 1" end. Done right, these two fingers end up being the SAME LENGTH! You should have most of the handle as a tight 'sandwich', but can leave an eye at the end of the handle if you like.



This gap should be around 1"-1½".

(4) Weld shut the seam in the handle. Focus on an EXCELLENT weld right next to the fingers - if you don't, the wrench will open + bend in heavy use.



ALSO: Make yourself 2-4 banding forks to use in the vise. These are just a bit of 3/8" or ½" round formed in a "U" shape with nice parallel sides. Do various opening sizes for different bends.

BENDING FORK

Project 17: Scroll Jig (or Scroll Tool)

Material: 24" of 3/8" x ¾" or 3/8" x 1" H.R.
A stick of chalk in a light color
A regular pencil, maybe a little dull

Many folks are tempted to use thinner bar stock for their jigs. A good jig is a lot of work, but a good jig is also useful for many different projects. Thin stock makes it too easy to bend you jig out of shape in use, making it worthless. Use the 3/8" thick stuff, suffer through, make a good jig, then never make another one!

Generally:

You need to start with a really good, full-size drawing of the scroll you want. Do not do this scroll 'by eye'- it won't work. The best scroll for your first jig is a Golden Ratio spiral- you can find it shown and explained all over the internet, or in a pre-algebra text or Archimedes' writings... Since you'll probably be using this jig to make C- and S-scrolls for the Brian Brazeal trivet, the drawing labeled Project 19a: Brian Brazeal Trivet is a great one to use.

See the last couple pages of this project for a good method for transfering your drawing from paper to some slightly rusty steel. This allows you to lay the hot metal you are forming right on the pattern to check it. You will be doing this a lot...

When you forge the taper, make sure it's 4" or longer, or it'll be hard to do the inner part of the scroll jig. Do not make the end too thin, though! Keep it over 1/8".

The tricky part of a good scroll jig is that the *outside* surface of the jig needs to match the *inside* surface of the scrolls you want to form from it. The result is that the scroll jig is, frankly, kind of ugly to look at. Make sure you know what line you are following on your pattern before you start scrolling.

Make sure you get each half-turn of the scroll perfect *before* moving on to the next part. Trying to fix problems inside the jig is really hard, and every adjustment you make inside will affect (negatively) the shape of the rest of the jig. Keep looking for flat spots, kinks, wrong arcs, etc. and get rid of them immediately.

Use whatever you need to for forming a jig- hammers, scrolling forks and wrenches, tongs, etc. Try to avoid grinders...

One hard thing is keeping track of where you want to tighten or open the scroll- try rubbing the area of concern with chalk before you heat it to make a big visual target.

Another hard thing is quickly aligning the jig with the pattern to check it's shape. Try making chalk tick marks on the pattern (like markings on a clock, at, say, 6 and 9), and corresponding ones on the metal. Even just a couple of these makes it much easier to work!

Be patient- making a really accurate jig in sorta heavy stock is a lot of work. But it will pay off quickly when you start cranking out scrolls on it, so give yourself a break and expect a slow, brain-draining experience making the jig.

The end of the jig can be left straight to go in the vise, or folded cleverly to make a boss that fits in your hardy hole (make sure it's a good fit, though).

Lesson 8 MAKING A SCROLL TOOL

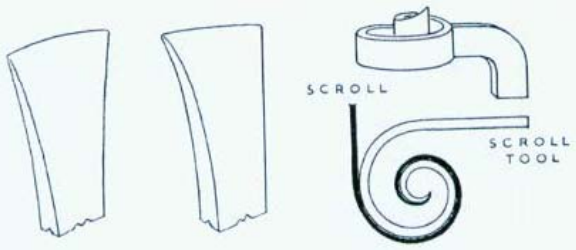
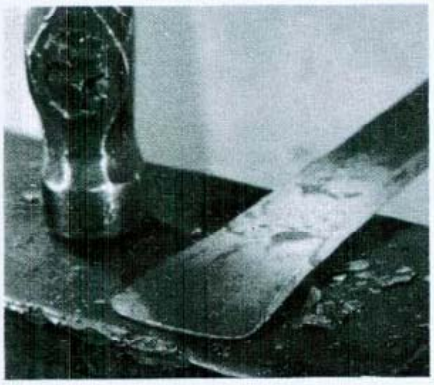


Fig. 23

It is not necessary to make a new scroll tool for every job. In any established shop there will be a number of scroll tools to hand which have been made or adapted to the job in hand. Sometimes the beginning of the scroll tool only is used, a chalk mark being made to show how far the scroll bar should be pulled round. New scroll tools, however, have to be made sooner or later.

It is easier to make a scroll tool direct from the drawing than it is to make one from a scroll. So if the job warrants a new scroll tool make it before you make the first scroll. Once you know how the scroll tool is used this is not difficult.

Simply make the outer edge of the scroll tool conform to the inner edge of the scroll on the drawing. The thickness of the scroll tool does not matter.



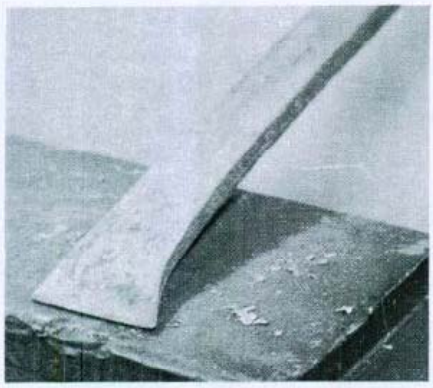
A

Take a bar somewhat heavier than the scroll to be made.

Forge a fishtail on the end.

B

Offset the fishtail by straightening one edge.



C

Cut off the end square with the straight edge.

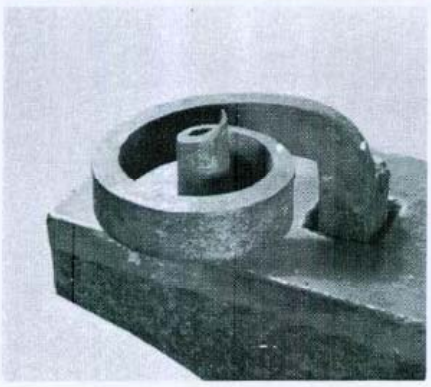
D

If you are right handed, begin rolling the scroll tool with the offset edge to the left, over the far edge of the anvil, or vice versa for a left-handed smith.

E

When you have made a good start with the hammer, continue with horns and wrench.

Pull with the wrench, rather than with the hand holding the bar, as the shape is more easily controlled by the wrench.



F

Finally bend the end of the scroll tool at right angles and wedge it into the swage hole of the anvil. The purpose of the off-set fishtail can be clearly seen; it makes the start of the scroll accessible.

The scroll tool can be held in the vice if it is more convenient.

To Transfer a Drawing on to a Metal Plate

Whenever metal has to be shaped hot to a drawing, the drawing must be transferred to an iron plate. A sheet of brown paper, chalked on one side is used like carbon paper to transfer the drawing on to the plate.

Fig. 12

A

First choose a piece of plate with a surface neither too new nor too rusty. Spread out the brown paper, and file a piece of natural or school chalk on to it with a bastard file.

Fig. 13

B

Rub the chalk in with your finger tips.

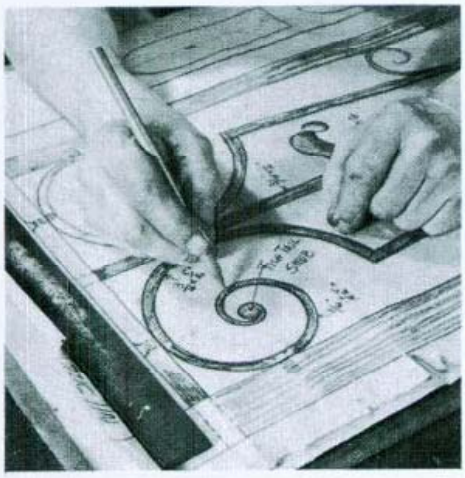


Fig. 14

C

Blow off the surplus chalk, turn the paper over, lay the drawing on top, and go over the lines with a pencil.

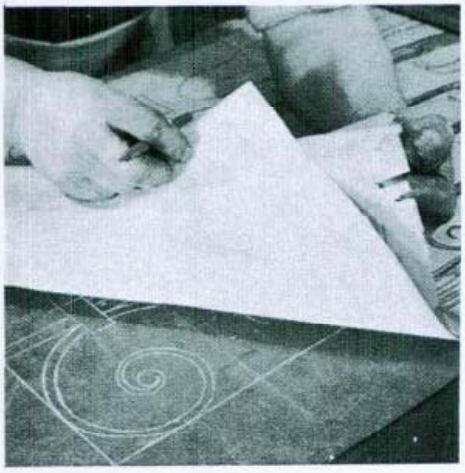


Fig. 15

D

This is the result. Strengthen any weak lines with engineers' chalk.

Project 18: C- and S- Scrolls to Measure

Material: 10'of ¼" x ½" H.R.
Paper and pencil
Pattern for scrolls, on steel (see Project 17)

This is the material length if you are making your scrolls for the Brian Brazeal Trivet (Project 19a). Its enough for the 3 scrolls you'll need, and the 10" (inside diameter) circle for a frame, and 18" or so for messing around with and working out your scroll sizes.

If you are just making practice pieces, you'll still need at least 5' of material, with some of it use for determining all your measurements.

Generally:

Note that the first pages show you how to use a jig, with the following pages covering the specifics of C- and S-scrolls.

You will need to record a bunch of measurements to do these scrolls right. Do not trust your memory! Don't start work without paper and pencil at hand.

To get an estimate of how much stock you'll need for a given scroll, lay the jig on your pattern, chalk-mark the jig at the size for ½ of the C- or S- scroll you'll make, then wrap a piece of soft solder or ball chain around the jig to that point, then measure the straightened length.

To make scrolls to measure, you first need to make the ends to measure. Use about 18" of spare stock (or more than enough for ½ of the largest scroll you'll make). Mark it somewhere in the middle with a center punch. Measure the distance from the end to the punch mark, and *write it down*. Now make a nice ribbon taper. Measure the length of the taper, and *write it down*. Measure the distance from the end to the punch mark, and *write it down*. This allows you to know how much the metal will grow in length every time you make a taper of the same size. Calculate this growth, and *write it down*.

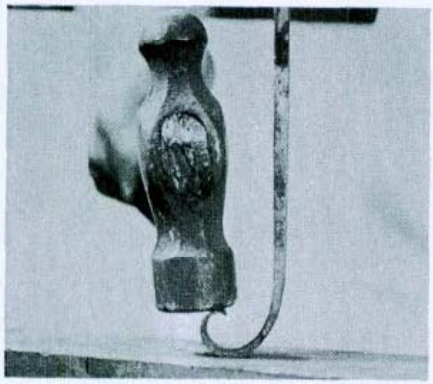
The first (innermost) ¾ turn of the scroll should be done by hand, and forged to fit on the scroll jig.

When using the jig, heat a length of metal, quench the scrolled end, place it on the jig, and gently pull the metal around the jig. Use a pair of scrolling tongs to hold the end in place when you start. Use a scrolling wrench and/or hammer as needed to shape the scroll to follow the jig. Do *not* try to bend the metal that isn't hot- all you'll do it cause the hot metal to pooch out away from the jig (which you'll now need to fix with a hammer). Instead, stop scrolling and heat up the next bit you want to bend.

Scroll the metal until it matches ½ of the C or S you are trying to make. Use chalk to mark the spot on your jig that you should scroll to. Mark the ½ spot on your scroll, too. Measure from this mark to the punch mark on your practice stock, and *write it down*. Use this and your previous measurements to determine how much metal is in the half-scroll you've formed. *Write this down*, then double it to fugure out how much metal a complete scroll this size will consume.

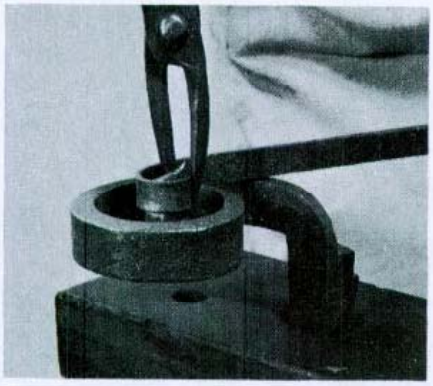
Now that you know how much metal you'll need, cut it, forge your tapers (to your recorded measurements!), and scroll the two ends- presto! Make sure you scroll the second end the right way for your C or S...

The length of C- and S-scrolls can be adjusted a bit to get a perfect fit in your frame. Heat up (evenly) the center of the scroll between the two ends, then lightly hammer (to shorten) or use tongs to pull (and lengthen) the scroll. Done carefully, it should still be graceful and symmetrical.



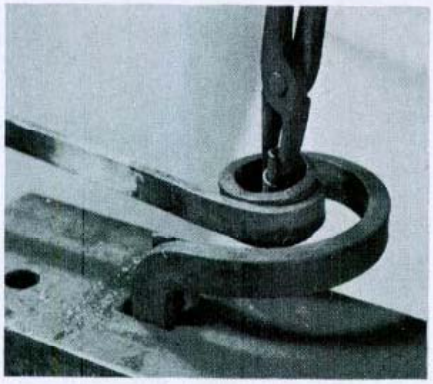
H

Scrolls can be completed by this means. But they are more often finished on a scroll tool as shown next.



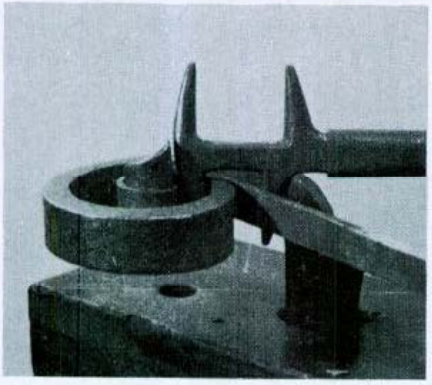
J

The making of a scroll tool is described on page 35. It is better to begin on one made by an experienced man and see how it works before making your own. Take a RED heat on the bar. Place the tip of the scroll which you have forged on the tip of the scroll tool. Hold them together with round-nosed pliers. Pull the end round far enough to ensure that the end of the scroll has firmly gripped the tool.



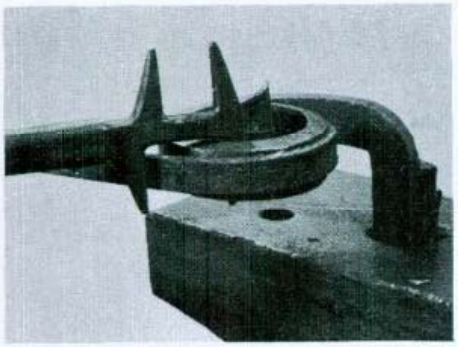
K

Relax your grip, and lower the scroll from the raised tip of the tool to the level of the main part.



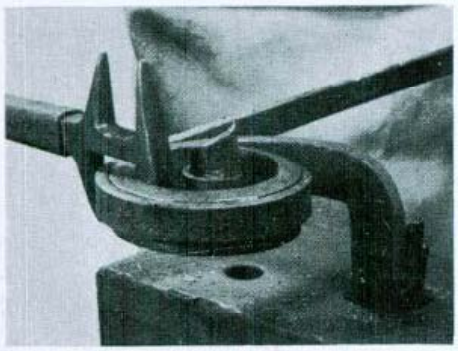
L

By now the cold end of the scroll will grip the scroll tool by itself. Continue forming the scroll, forcing the metal close to the scroll tool with a scroll wrench. Very small scrolls can be bent cold by this means.



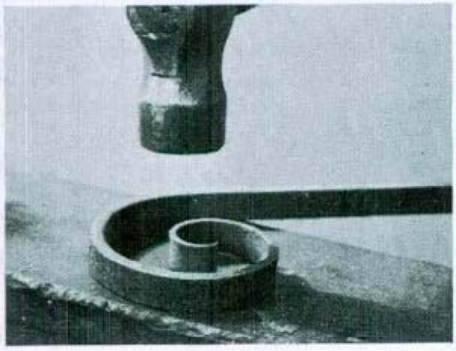
M

Move round the anvil as the scroll is formed so as to work in a comfortable position.



N

Continue in this way until the scroll is finished. It is sometimes a good idea to mark the scroll tool with chalk to show when the scroll is the right size.



O

A well made scroll tool will produce a scroll which is almost flat, but the scroll will require a little trueing up at the finish.

Lesson 9 'C' SCROLLS

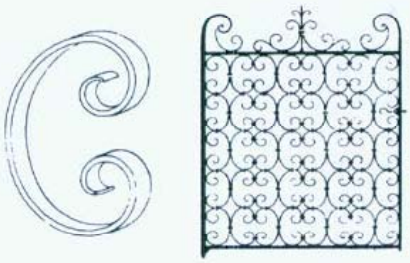


Fig. 24

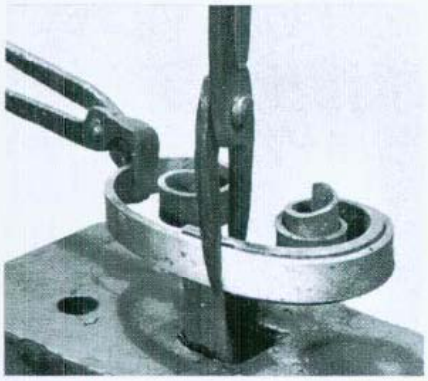
'C' scrolls are often needed in large numbers for gates, grilles, fire-screens and so on. To make them quickly it is necessary to have a scroll tool exactly the right size which finishes at precisely the centre point of the scroll. Otherwise the end of the scroll tool would foul the first scroll when the second was being made.

For measuring it is convenient to have the end of the scroll tool bent down at right angles with a fairly sharp outside corner.

First find out by measuring how much metal is needed to make each 'C' scroll, allowing for the drawing out. Next cut off all the pieces to this length and centre-punch mark them in the middle. Draw one to the correct length, chalk it, and draw all the others to it as a pattern.

Take a RED heat and scroll. The centre-punch mark should come level with the corner of the scroll tool to within $\frac{1}{8}$ inch.

This means the scrolls will be sufficiently alike to fit together with little cold setting.



A

Here is a 'C' scroll being completed on the tool.

Lesson 10 'S' SCROLLS

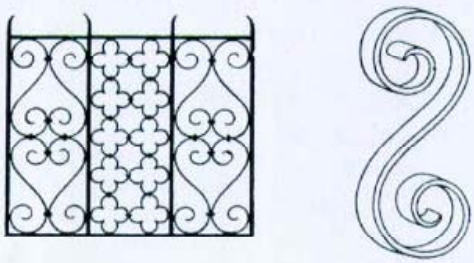


Fig. 25

'S' scrolls also are often used in large numbers. A scroll tool of the same type as used for 'C' scrolls is best, even though there is no danger here of the first scroll of the 'S' fouling the tool as the second is made.

Both 'C' and 'S' scrolls are used in pairs or greater numbers in repetitive designs. It is the best practice to fasten them together with collars; this is described on page 39.

However many scrolls are wanted, start by collaring them together in pairs and then fix the pairs together. To do this, first make a frame whose inside size is the over-all size of one scroll.

Offer the scroll to the frame, and adjust the scroll until it fits. Then make a second frame to fit a pair of scrolls. Press the scrolls into this frame and fix the collars.

A

The frame shown is not part of the design, but merely a jig to ensure the scrolls are accurate, and to keep them together while the initial collars are put on.

Project 19: Collars

Material: a couple feet of 3/16" x ½" H.R.
12" or so of the stock you'll be collaring together

This is a good stock for collaring the ¼" x ½" used in the Brian Brazeal Trivet project. Avoid using stock that is the same weight as the stuff you're collaring- once the corners are forged, it will look much heavier, and weirdly out of proportion.

These instructions are for basic collars made of flat stock- there is a world of collar stock shapes you can explore, but know that other shapes require custom tooling to forge them without flattening the cool details...

Generally:

You first must make a mandrel to form the collars on. Fold 2 or 3 inches of the stock you'll be collaring to make it the right size for the number of pieces each collar will hold together. Then forge a bit of a taper on the folded end so you can get the (cooled, shrunken) collars off the mandrel.

Calculate the length needed for each collar by adding up the lengths of the sides it will go around, then adding one thickness of the collaring material for every 180° of turn (ie. add two thicknesses). This calculation for the bends is consistent for any bends you make.

You'll want a flat or cave-like fire with a firm surface of small coke for collar making, or you'll be spending half your time digging for lost collars...

Make sure you get your scarf sorted out, forged on opposite sides, and driven home in the right order.

Use the vise where ever you can to make your bends tighter.

Spend some time on the step of the anvil getting the corners nice and tight.

Make twice as many collars as you think you'll need for your first project. Then pick the best ones to actually use.

Before you start putting the collars on, get your elements (scrolls, frame, etc) all wired together with tie wire. Just before putting a collar on, remove the tie wire from that joint only.

You'll want scrolling tongs to pry the collars open in preparation for installing them. Practice stringing the collars on efficiently before you actually put any on (it's awkward!).

Collars should only go on *hot*- as they cool, they'll tighten.

Collars should have the're joint on the inside of the work...

Collars can cover butt joints, or be used to hide your MIG welding...

Lesson 11 COLLARS

Among the various methods of fixing scrolls together collars are important. They not only contribute to the design but are often the only satisfactory way of doing the job.

Men who are not skilled at making them often shun collars as being troublesome and expensive. But if they are made by the right methods with forethought and skill, no one need fail to master them.

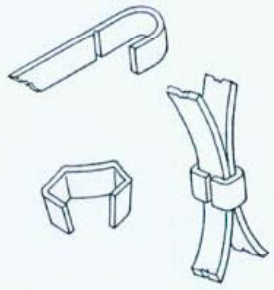
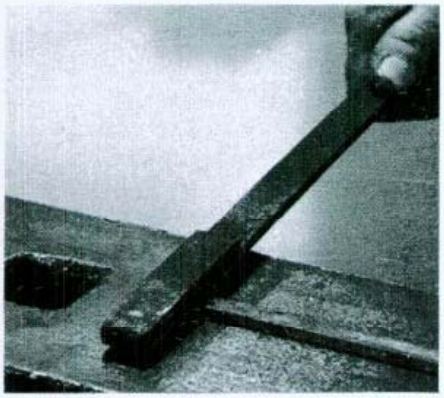


Fig. 26

Collars are frequently needed in fair numbers, so it is worth taking trouble to have all the details right before you begin to turn them out.

First select or make a mandril, a piece of iron convenient to hold, the end of which is the same size as the two thicknesses of scroll which the collar will grip. The mandril can be either a plain piece of bar twice the thickness of the scroll bar, a larger piece of bar drawn down to this thickness; or, for light work, a piece of scroll bar bent back on itself, as shown in the first photograph of this lesson.

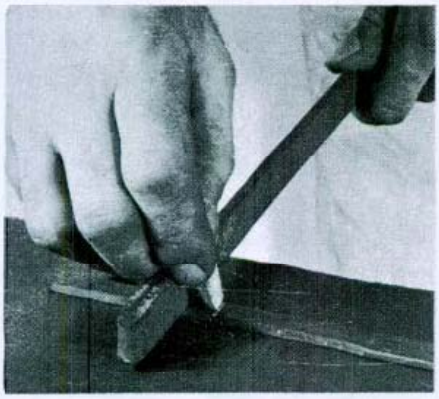
Next find out the length of the piece of metal required to make each collar. Make a trial with the actual bar from which you intend to make the collars, fitted to a pair of the actual scrolls in hand. Although measurements are needed for a start, they are not to be trusted as all bars vary slightly from their nominal size, and different qualities of iron or steel stretch a different amount when bent at the corners.



A

The measuring can be done in one of two ways.

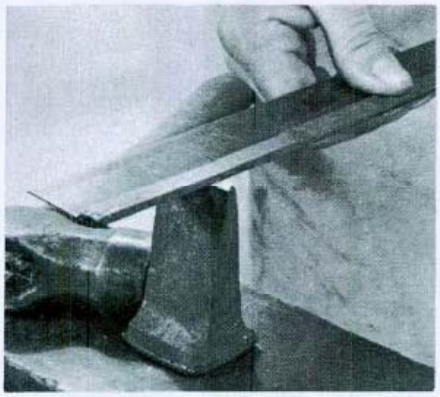
The mandril can be laid in the collar bar as shown here and rolled along four quarter turns, and twice the thickness of the collar bar added by eye.



B

Alternatively a piece can be marked off to a measurement of twice the thickness plus twice the width of the mandril, plus twice the thickness of the collar bar.

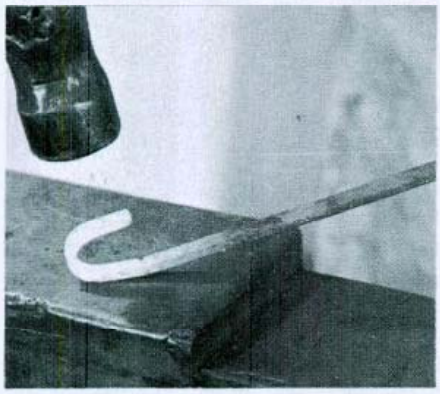
Whichever method of measurement is used, set a pair of dividers to the length before making up the trial collar.



C

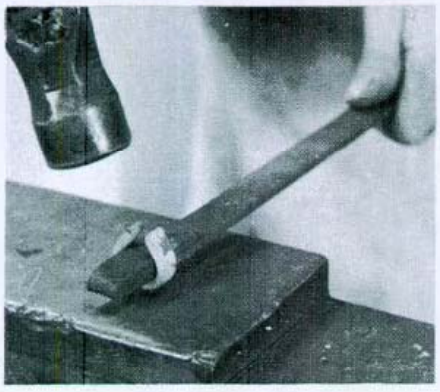
Notch the collar bar halfway through on a hardie.

The operations which follow are done more quickly than they can be described, in order to make best use of the heat.



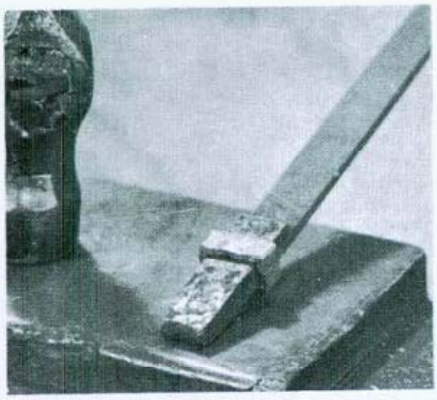
D

Take a NEAR WELDING heat, and bend the collar round over the anvil bick with the cut on the inside. Take care not to draw the collar on the bick. Close up to a 'U' shape bringing the end in line with the cut.



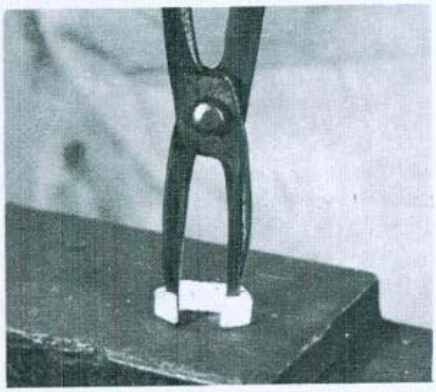
E

Lay the mandril on the flat in the middle of the 'U' and close the ends of the collar over it. The end of the collar should meet on the side of the work, as here, and not on the front, back or corners.



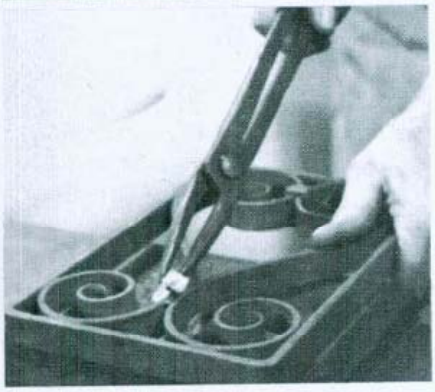
F

Forge the collar clean and square on the mandril. Tap it off the mandril and level up the edges. All this can be done in one heat, but the beginner need not be ashamed of taking two. Now examine the collar and decide if any obvious alteration should be made in the length.



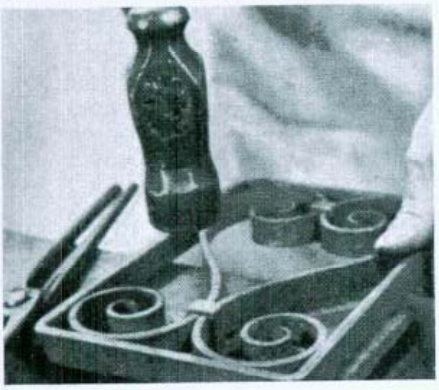
G

Heat the collar on the tip of the poker and open it out by putting the round-nosed pliers inside and pulling the handles apart.



H

Thread it on the scrolls.

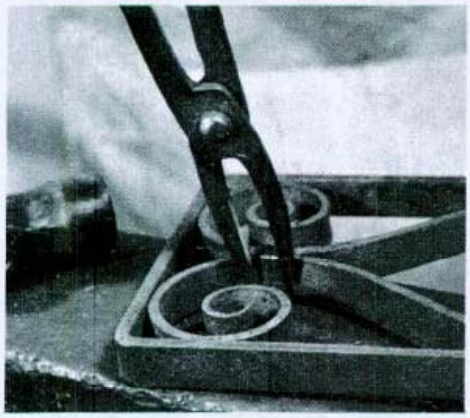


J

Tap it down with the hammer.

K

Pinch in the sides with the bow pliers.



L

If required, line up join with pliers.
Now examine the job with the greatest possible care. Decide if any alteration in the original length would be an advantage, and if so, make another trial.
When finally satisfied, mark off on the metal all the pieces you will want for your collars, and notch as much at a time as you can conveniently handle.

Project 19a: Brian Brazeal Trivet

Material: About 10’ of ¼” x ½” H.R. for the elements and frame
2-3' of 3/16" x ½" H.R. for the collars

Generally:

This project is based on a trivet made by Brian Brazeal and owned by Wayne Parris. When Wayne was teaching Level II at Vista, he thought it was a great design to copy and use to learn the skills of scroll jig making, C- and S-scrolls, and collaring. I (BH) redrew it to make the scrolls Golden Ratio, and to actually have a pattern on paper.

See Projects 17, 18, and 19 for details on each aspect of this project. You'll also want to have done Project 16: Williamsburg Bending Wrench. This project is a chance to tie all these skills together, and to make a simple piece of forged-to-dimension grillework!

The drawing is full-size, with a little over half the trivet shown. The center scroll is an S, with matching Cs on either side. Eight collars hold it together.

The frame is a circle with a 10" inside diameter, and the ends meeting flush. This requires about 32" of stock, several pairs of tongs, a bending wrench, a form to shape it on, and a friend to help you do it. At the Blacksmith Barn of the Antique Gas and Steam Engine Museum, we have piles of lineshaft pulleys laying around. They are conveniently sized in diameters to even inches and half-inches, so it takes only a few minutes with a ruler to find a good form to use!

Make the frame before you make your scroll elements, then adjust the scrolls to fit correctly.

Place the scrolls in the frame so that one of the collars will cover up the joint.

Make sure you wire everything in place before you start collaring it together.

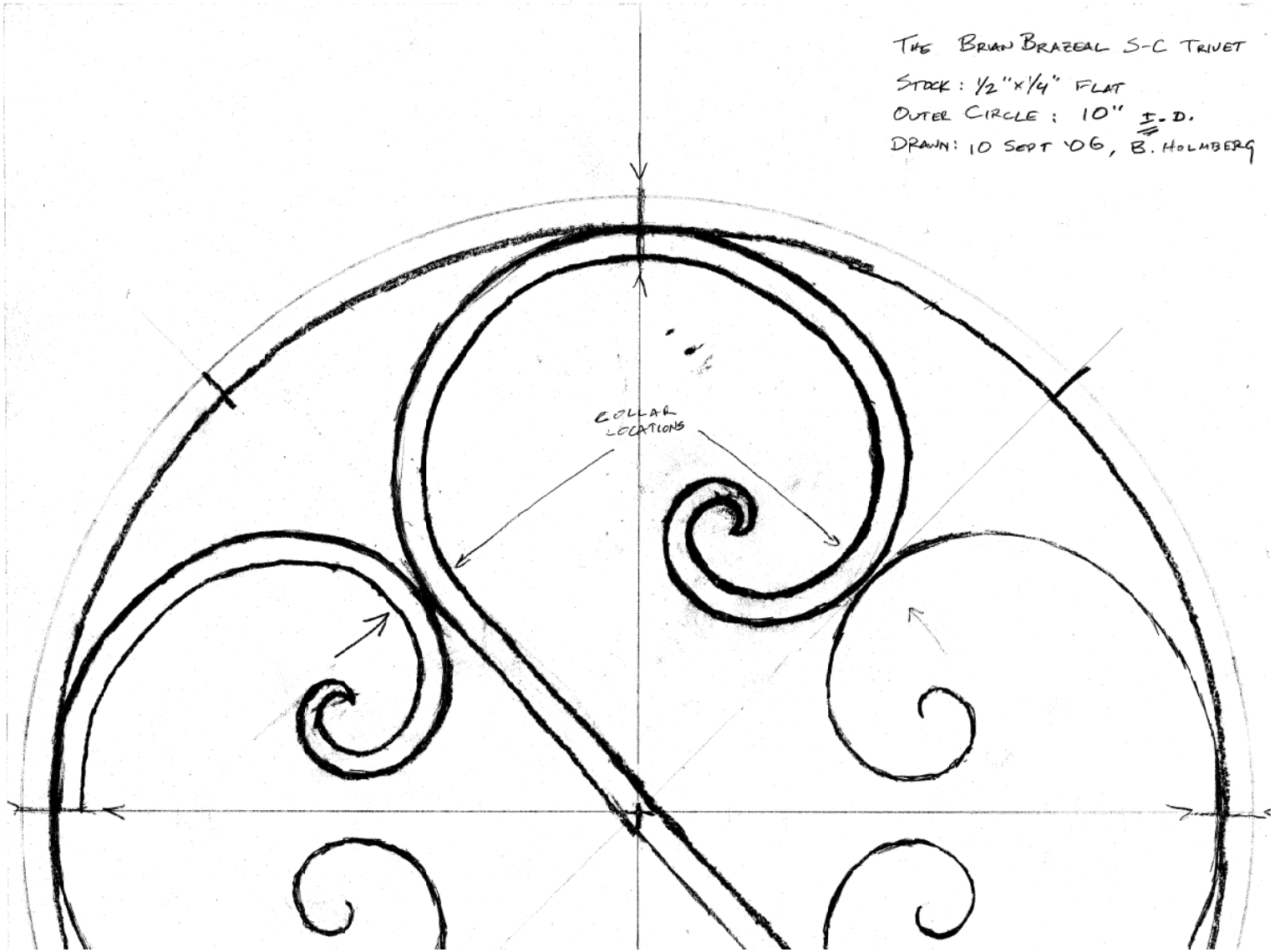
Enjoy the payoff for all the work you put into that *#&@!!! scroll jig!

THE BRIAN BRAZEAL S-C TRIVET

STOCK: 1/2"x1/4" FLAT

OUTER CIRCLE: 10" I.D.

DRAWN: 10 SEPT 06, B. HOLMBERG



Project 20: Welded Basket Twist

Material: 30" of 5/16" round or ¼" square H.R.

Generally:

You don't need to cut the bar in 4 pieces, then weld 'em back together (unless you like that sort of thing...). Put a dent (rounded anvil edge...) in the center of the bar, and fold the bar in half (the the dent on the *outside*- it makes the fold tighter and neater). Repeat in the other direction, and you'll have 4 lengths stacked in a square, but *connected* for easier welding!

If you are putting the basket twist on a bar as a handle (ie. Project 26: San Luis Obispo Rake), just forge weld the 'easy' end (all folds...), forge a scarf from the weld, and scarf weld it (Project 4) onto the end of the bar. Now you have a nice handle to hold onto while welding the other end closed!

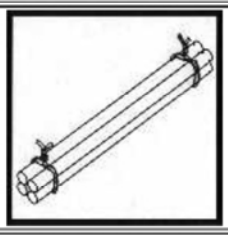
For the SLO Rake (Project 26), You'll want to weld about 1" of length on the end that welds to the long bar, and about 1 ½" of length at the top to have enough material to forge out into a nice loop or hook. That leaves 5" of material in the middle that will become the basket twist.

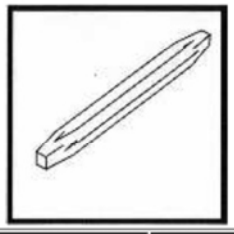
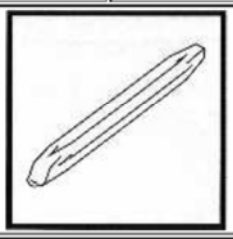
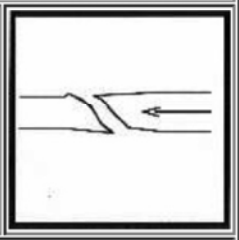
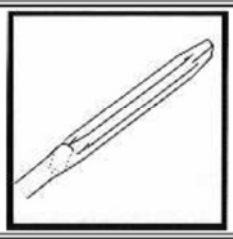
There are a number of ways to adjust the basket once you've made it, like careful use of scrolling tongs. My favorite, though (learned from Tal Harris at the John C. Campbell Folk School), is to heat the whole basket up and just use a hammer to forge it to a nice, round, sausage shape as if it were a solid piece! You don't need to hit it hard, and it will shrink the diameter a little, but it works really well!

Steve Maranhao came up with a nice variation. He used square stock, and layed out all the measurements for the weld areas and handle areas before folding it up. He then twisted the 4 5" sections that were between the welds (same # of turns on each section, and in the same direction...). The final handle was quite impressive! [I should note that this brilliant idea was borne of our not finding the right material in the shop for the project. We were improvising with what we had. Steve named it the 'SLO Vista' variation, but he might have meant the *'slow* Vista' variation...]

Basket Twist

Demonstration by Jock Dempsey.
http://www.anvilfire.com
September 22, 1999

guru : 20:29:24	Tonights demo will be the basket or "blacksmith's" twist.
guru : 20:29:50	
guru : 20:31:14	I do several simple variations on the twist. Forge welded, arc welded, four bar and five bar.
guru : 20:32:51	For the four bar twist I start with four 6" (150mm) pieces of 1/4" (6mm) round bar. 
guru : 20:34:29	There are several ways to hold the pieces together while welding. Soft iron wire as shown, a hose clamp in the middle or tape when arc welding.

guru : 20:35:29	The first step is to forge weld about 3/4-1" (20-25mm) of the ends together.	
guru : 20:37:35	Then scarf one end AND the bar it is to be welded to. We have a trick for this on the five bar (later).	 
guru : 20:38:52	The scarf should be slightly convex so that flux and dross will squeeze out of the joint while welding.	
guru : 20:39:49	These pieces can be wired together if the scarf is long enough OR welded by the dropped tongs method.	
guru : 20:41:01	I weld my 4 bar handles to 7/16" (11mm) round and the 5 bar to 1/2" (13mm) round.	
guru : 20:43:13	Dress the joint and then forge the end to the shape of your choice. I use a hook but I've also used ball ends. If you weld enough mass it could be an animal head.	
guru : 20:44:35	Then take an even heat and twist the bundle up tight as shown	
guru :	Some folks count turns, other give angles. I just twist it up until it looks right	

20:45:20	Some folks count turns, other give angles, I just twist it up until it looks right.		
guru : 20:47:15	Next take a gentle even heat, clamp in a vise and UNTWIST while pressing down lightly but firmly. If you are fast the twist and untwist steps can be done in one heat.		
guru : 20:48:54	You should NOT have to tap downwards with a hammer. The initial twist stretches the outside of the bars and when untwisting the basket should open up on its own.		
guru : 20:50:15	The baskets on the left were done this way while the other was done by taping downward and twisting (Per many books including Bealer).		

Project 21: Leaf Hammer (and tooling)

Material: 5" of 5/8" square or ¾"-7/8" round tool steel (hammer)
7" of 5/8" or ¾" round tool steel (slotter)
short pieces of about 5/8" and about 1" round scrap steel for drifts
store-bought hammer handle (made for 8-16 oz. ball pein is best)

For the hammer, 4130 or 4340 or similar is ideal. Older sucker rod will do nicely. You can always use old car spring, but don't be surprized when the cracks show up.

If you use 4000 series steel (sucker rod...), quench in water; if you use spring or other high-carbor steel, quench in oil.

For the slotter, use what you can find. You can even make it from mild steel and use Super Quench to harden it.

Generally:

All hammers start with the eye. You'll need a handle that you are trying to make an eye for, first. Then you'll need to make 3 tools before you can form the eye: a slotter, a drift to drive through, and a second drift to flare the eye.

Make sure you spend the time calculating the correct size for your slotter before you make it. Don't let the business end get narrower than 1/8".

Watch the color of the metal around the eye when you are drifting! If you keep hammering the drift into a black eye, you will form cracks that will come back to haunt you later!

Make your drifts very smooth and rounded.

Once you have the eye, see the images in Project 22: Water Leaves for details on what the hammer should look like. The final head should be about 6-6 ½" long, with a straight pein at one end, and a cross pein at the other. The peins should have very soft edges all around, and a diameter of ¼"-3/8". The peins should be polished to at least 400 grit.

Harden your hammer head appropriately, and temper it from the eye until the ends are dark yellow to bronze. A great way to temper is to heat up two big blocks of scrap to orange, and make a sandwich of them with the hammer eye in the middle (and the hammer heads sticking out). You'll get a nice, slow temper through conduction, leaving the eye soft and tough! If the heat is moving faster towards one head, shift the hammer on the hot blocks. When the temper is perfect, cool the head in water to stop the conduction.

The Slot Punch ~ punching & drifting a hammer eye

by Mark Aspery, Springville, California

There are many ways to punch and drift a hammer eye:

1. Punch a round hole and then stretch it with ever increasing sizes of drifts.
2. Pre-drill two holes in the stock and punch out the web in between.
3. Slit and drift.
4. Slot and drift.

Slotting and drifting

A slot punch differs from a slitting tool in that is has a flat business end. It works in the same way as a traditional blacksmith's punch, shearing out a slug.

I prefer to slot when I can, as I feel I get a cleaner inside of the hole (no rag), and I have less tendency to wander off the centerline than I do when I slit. If you wander off the center line when you slot punch the hole, you may want to consider marking both sides of the bar and punching from each side to meet in the middle. That will reduce the error, although you may get a little rag in the center.

There is a math formula for calculating the size of the punch per drift for an *upset* slot, such as you would use when making a square blocking (a square or rectangular hole in the bar) – a formula we do not require with the *non-upset* slot. For the *non-upset* slot, such as this, the length of the slot punch end should equal the width of the drift. In this way, the drift moves only the sides of the slot.

The first thing I do when I am about to make a hammer is to buy the handle or haft, as it is sometimes called. That allows me to make a decision for the size of stock required to make the drift. In my area, the handle that I like has a 1 1/16" + x 5/8" end.

I know that a 7/8" round bar will yield a drift of a size 1" x 5/8". I do not upset the 7/8" material in the hopes of getting it to stretch to the 1 1/16" measurement. I draw the eye (flatten the resultant swelling caused by the slotting and drifting process) with the drift in place and that stretches the eye a little.

Before I make the slotting punch, I make the drift. The final width of the drift will dictate the width of the punch. A drift consists of three parts: the main body, a taper to the business end and a shorter taper to the hammer end. Having a taper to the hammer end allows the drift to fall through the stock after the main body has passed through. The main body of a hammer eye drift is nothing more than a round bar flattened on two sides to create a type of oval.

When a drift resizes/shapes a slot, it generally does so by pushing the material surrounding the slot outwards. Generally,

Check the stock after the first blow with the punch to see if it is correctly aligned with the barstock.

Drift (upper) and punch shown from the front and side.

Progression.

such pushing of the sides will not pull the ends of the slot into the drift. If the slotting punch is as little as a 1/16" over size, you will see the excess length of slot in the finished piece. If the slot is slightly under length, the drift will stretch the slot to fit.

When I want to look at efficiency in punching, I look at an Ironworker™ or a punching press. The punch is larger at the business end and tapers back from there. The typical blacksmith punch is entirely the opposite, with the smaller section being right at the business end of the punch.

By manufacturing the slotting punch from a size or two smaller barstock than the required width, I know that at least two sides will have clearance behind the business end. The other two sides of the punch increase in taper from the end to the main body. You certainly could forge these sides to make them parallel, but I have not found the need; in fact they start the drifting process. In the example given, the drift made from the 7/8" round bar is 1" in width. I make the slotting punch from a 3/4 round bar. In this way I have a 1/8" clearance on each side.

The end of the slotting punch is about 1/8" thick. That gives me enough material to stand up to the use/abuse it will get and yet is small enough to not drag in the surrounding material as I punch the hole.

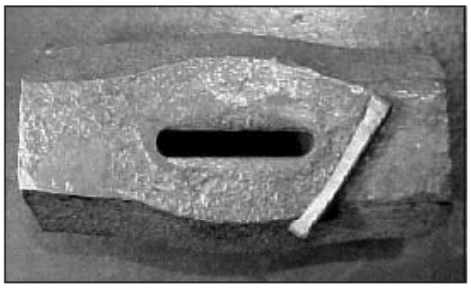
The examples shown in the pictures are off-cuts from some jackhammer bits that I had lying around. I chose them for two reasons: to show that the slotting punch will work in a high carbon steel bar and to show that the slotting punch will not drag the eye in material that does not have a great deal of support around it, such as hexagonal or round bar.

The flat end of the slotting punch allows you to see very early on in the process if the punch is aligned correctly. I have seen other punches that have a point fashioned on the business end. With the point method, it is harder to correct after you have made a bad start. It is easier to correct a bad start with a flat end, but the punch will have a tendency to bounce until you get a bit of a slot started. The trade off is worth it to me.

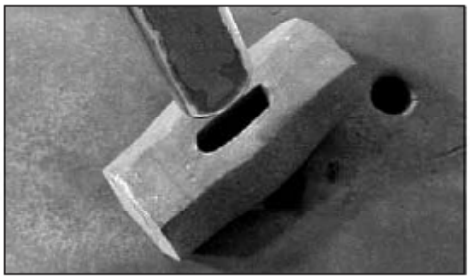
I punch from one side until I feel or hear the anvil. I cool the tool after every four or five blows during this process. Once I feel the anvil, I turn the steel over and place the punch over the dark spot that resembles the end of my punch and shear out the slug. Don't try to shear out the slug with the steel too hot, as the slug will just stretch in the hole and not shear cleanly.

The business end of the drift used to resize this *non-upset* slot is the same size and shape as the slot. I give the end a crown to assist in placement. The sides of the taper have rounded edges.

Checking the location of the punch with the business end of the punch shown.



Slot shown from the back after the slug has been sheared out.



Starting to drift over the hardie hole.

If a round-ended drift were used in this slot shaped hole, it would merely bully its way through the slot and create a hole that looked like a double-ended keyhole. Round-ended drifts are suitable for resizing an *upset* slot or a round punched hole.

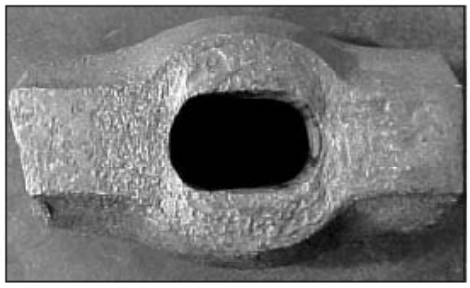
If I were to continue to drive this round-ended drift through a slot, it would catch on the corners it created and might stretch the hole. I drive the drift through over the hardie hole. The stock being 1" wide, I hold it so that the hole lies along the diagonal of the hardie hole.

When you use this method, move the stock after every blow. First pull it into one corner and then push it into the opposite corner. In this way the sides of the hole are supported and the steel doesn't get pushed down the hardie hole.

The concern now is to look at the heat in the critical area. As you drive the drift through the stock, watch for a dark ring of chilled metal around the drift. The rest of the bar may be at a bright heat, but the eye is cold and further drifting will cause cracks. Remove the drift. It may be that the rest of the bar has sufficient heat to reheat the eye without going back to the forge.

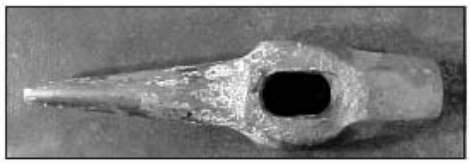
Drift first from one side and then from the other until the drift is passed all the way through. I do not cool the drift between uses, as a cold drift restricts my forging time by chilling the eye too quickly. If needed, I use a pair of tongs to position the drift.

Drifting from either side with a size bigger drift in order to create an hourglass shape to the hole finishes the eye. This larger drift does not pass through the stock, but reshapes either side of the middle of the eye, thus allowing the handle to swell when you drive in a wedge and keep the hammer from flying off the haft. That is one of the last things I do to the hammer. I save it until last in case I have an errant blow in forging the rest of the hammer that causes the eye to become pear shaped. ♣



The result of the drifting process. The larger drift to create the hourglass shape to the eye has yet to be applied.

Drifting almost complete.



Round punch made from jackhammer bit material. A portion of the swelling caused by the slotting and drifting process has been removed by forging on the sides with the drift in place. Tool was annealed in lime and is shown forged and hot rasped only.

Project 22: Water Leaves and Bottom Tools

Material: 12" of ¼ x ¾" H.R. or 14 ga. sheet steel for leaves
8" of 5/8" square H.R. for the bottom tool
½" round to use in forming the bottom tool

Generally:

This is really a form of stake repousse- forming a piece of flat stock into three dimensions over metal stakes with a metal hammer. Most of the hammer blows should actually fall over *air*, rather than against the bottom tool.

You need to make a bottom tool first. See the illustrations for the shapes you need to make. A single piece of 5/8" sq. can be used to make a 'J' tool in one end and a 'Y' tool in the other end, with space between for clamping it in the vise.

Each tool end uses about 2" of material- more is superfluous.

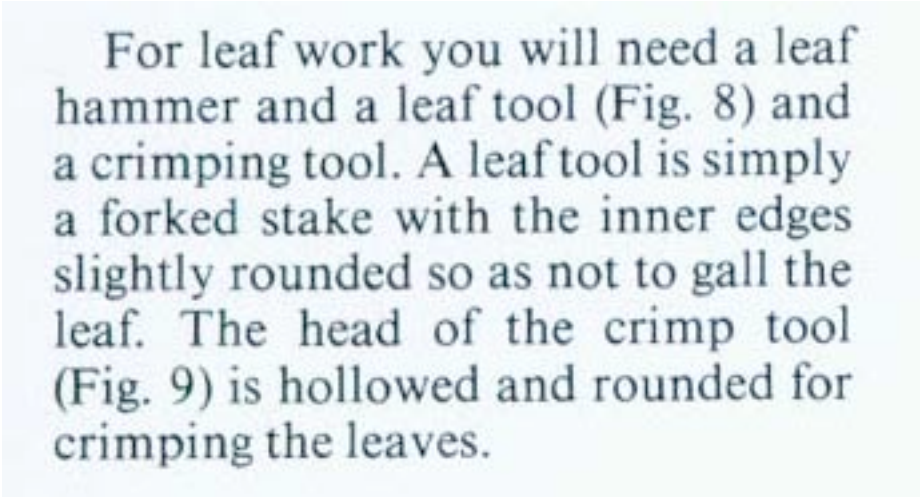
The 'J' is made by clamping the 5/8" sq. in a vise with 2" sticking up, folding it hard to the shape of the vise jaw, and driving a bar of ½ into the surface to make a nice, deep groove. Make sure the edges are *all* filed or hammered to make them soft and rounded.

The 'Y' tool is made by hot cutting a slit 2" long through the end, opening it up to about 120°, and filing and hammering it all soft and round. Pay special attention to the base of the Y when you file; it should have a smooth, round cross section.

Because you will be hitting in the air around these tools, you don't need to harden them. If you want to use them on softer metals (copper, bronze, etc.), polish the working surfaces to at least a 400 grit.

The leaf blank can be cut from 14 ga. sheet steel, or forged from ¼" thick flat stock. If you use sheet, you'll have to cold chisel it to shape. If you use bar stock, work to get it nice and thin (leave the edges thick at first, to prevent burning).

Before you crease and curl the leaf, forge a bevel on the edges of the leaf to make it more life-like.



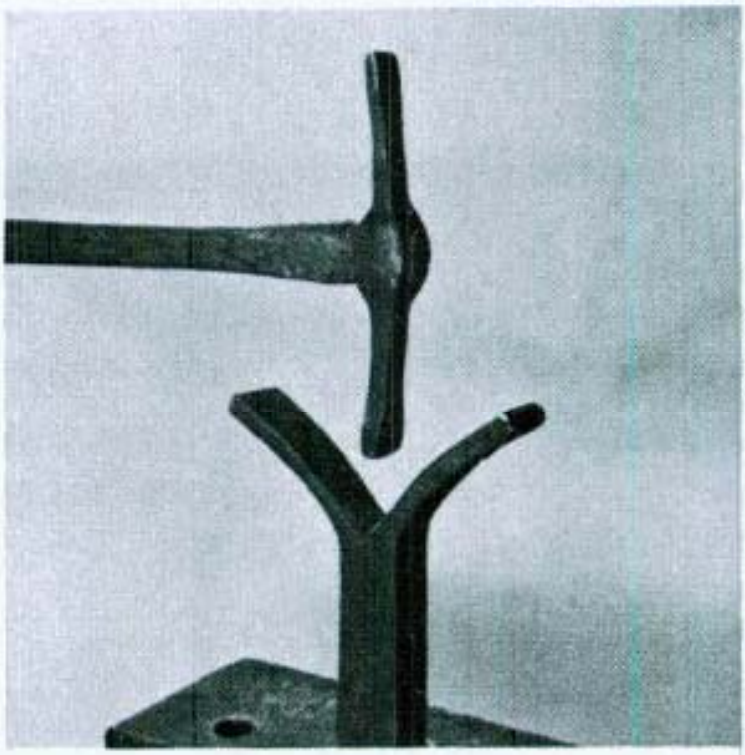


Fig. 8

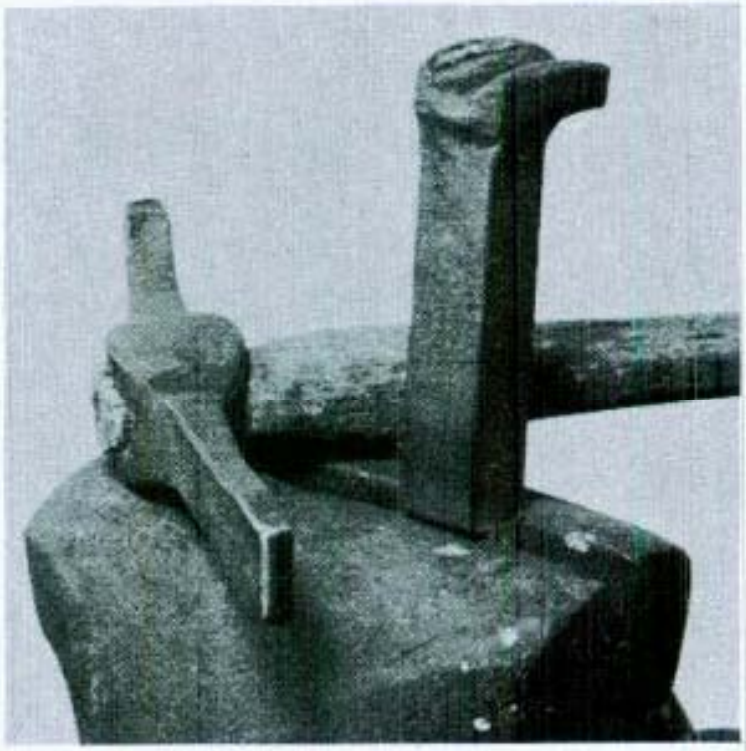


Fig. 9

Lesson 14 **WATER LEAVES**

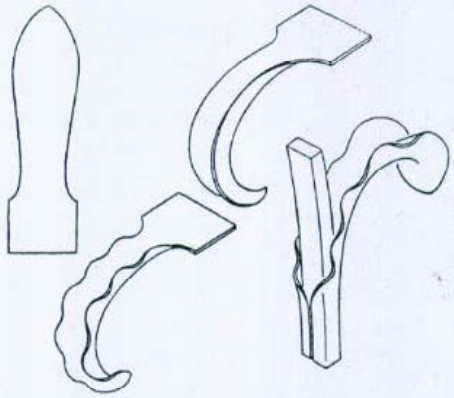
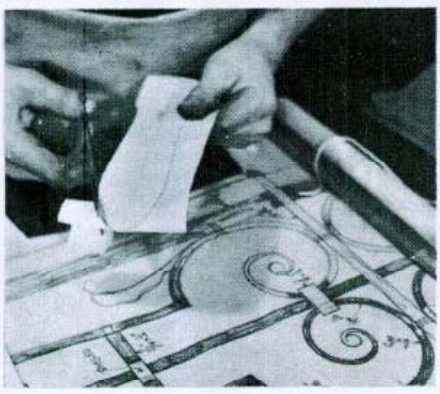


Fig. 29

Water leaves are usually made of 14 s.w.g. metal, a little under $\frac{1}{8}$ inch in thickness.

A

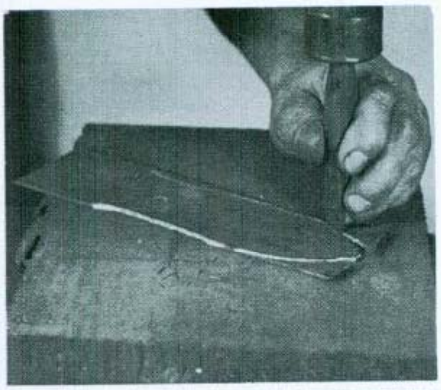
Measure the length of the leaf from the drawing with a piece of string. Measure from the tip along the underside of the leaf as the metal will stretch, but is not appreciably shortened in making the leaf. This will be a rough guide to the length of metal you will need.



B

The width of the leaf plate where it is to be welded on to the bar must be the same as the distance round the bar. The widest part of the leaf is usually the same width.

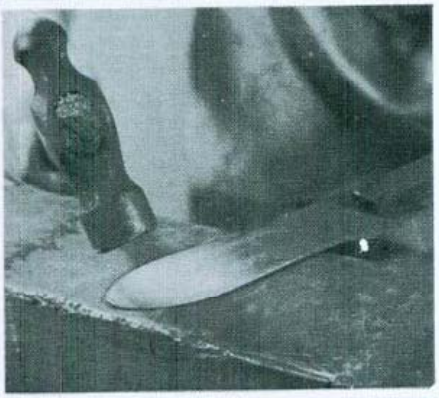
Cut out a paper template. Fold this and compare it with the drawing. If there is any discrepancy make an allowance by eye in marking the metal.



C

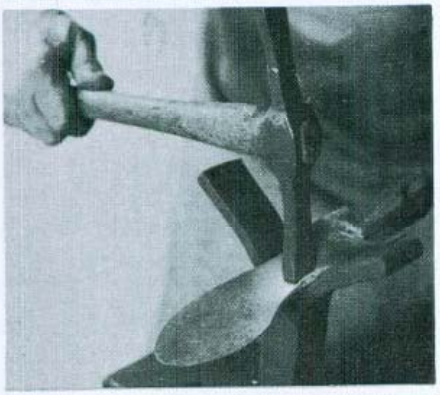
Cut right through the metal with a cold chisel to the shape of the paper template. Use an old piece of plate or an anvil saddle to avoid spoiling the chisel's edge.

File or grind the rough edges smooth.



D

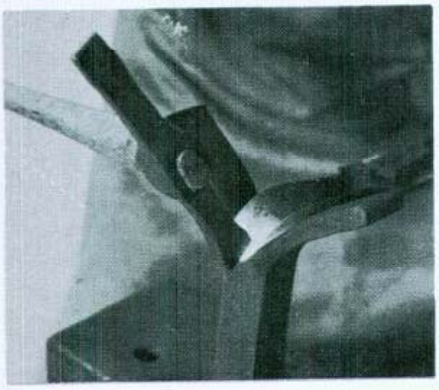
Thin out the edges of the leaf.



E

At a RED heat bend the leaf between the leaf hammer and the leaf tool to a 'U' section.

Keep the leaf straight at this stage.

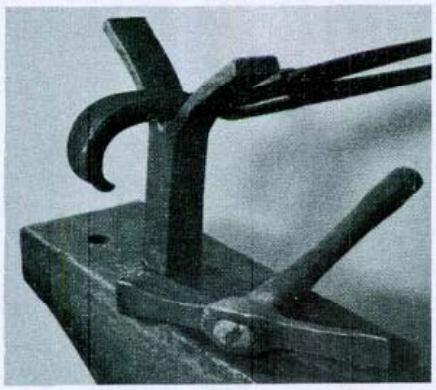


F

Take a short BRIGHT RED heat and begin to curl the leaf at the tip.

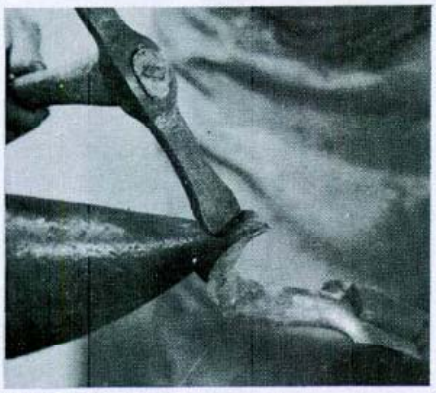
G

Take another heat and extend the curl.



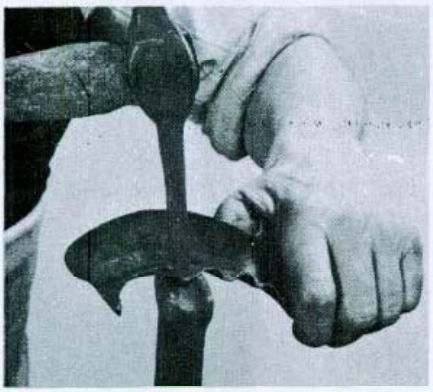
H

This is the result to aim at, shown cold. At this stage the curve should be greater than in the finished leaf, as the crimping will uncurl it slightly.



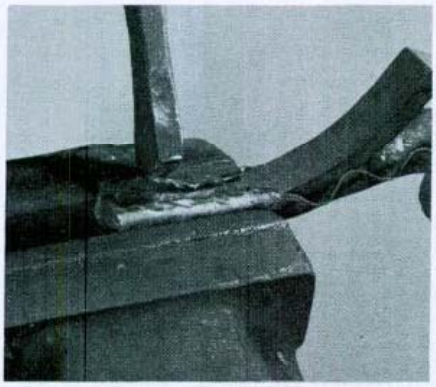
J

The tip of the traditional water leaf is twisted to one side or 'blown over'. The twist is worked over the end of the bick with a leaf hammer.



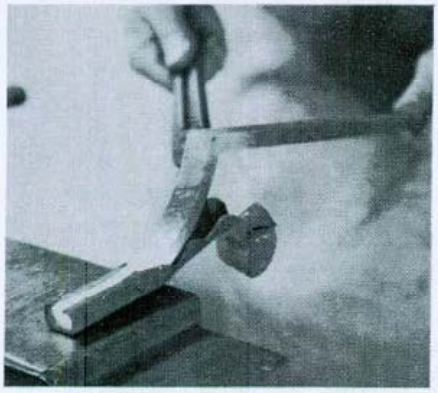
K

Note the number of crimps in the drawing and mark each depression on the leaf with chalk. Make a slight dent at each mark with the leaf hammer over the crimping tool (see Introduction, Fig. 9). Compare the dents on each half of the leaf to ensure that they align, then form the crimps, first from one side then the other, working them down to the flute of the leaf. Hold the leaf at an angle to the crimping tool, so that the crimps form diagonally, but always use the hammer in line with the tool.



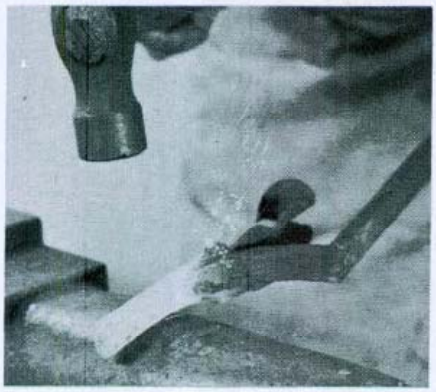
P

Now grip leaf and bar by the edges and fold the base of the leaf right round. If the leaf has been cut as in B of this lesson there will be a gap between the folded edges of the leaf equal to the amount taken up by the corners. This is correct, as the metal will stretch in welding. The bar should be slightly tapered so that the leaf can be slipped off again.



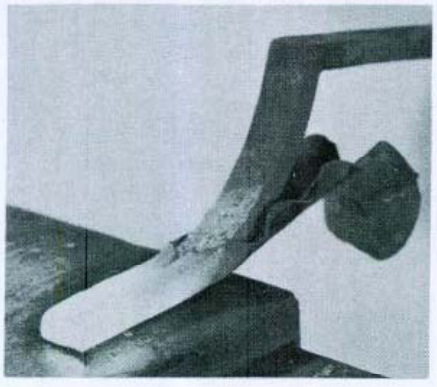
Q

Now weld the two together. First remove the leaf and take a FULL WELDING heat on the bar. Then slip the leaf back, tighten with a hammer and heat both leaf and bar to welding heat. If they were assembled cold the leaf, which is both thinner and more exposed, would burn through before the bar was hot enough. A little silver sand protects the leaf from wasting in the fire.



R

Weld quickly with fairly heavy blows. Do not draw the tip more than necessary or it will have to be upset again in order to weld it on to the next piece.



S

Here, leaf and bar have gone together perfectly, the heat clearly penetrating right through.

Project 23: Forged Round to Square Blocking

Material: 15" of 3/8" x ¾" or 3/8" x 1" H.R. to practice holes in
7" of 5/8" or ¾" round tool steel for the slotter
4" each of ½" round and ½" square H.R. for drifts

You can do these holes in thinner stock, but it's harder to get a nice upset to a round hole, and easier to overstretch them in drifting. Learn on stuff at least 3/8" thick (1/2" is even better).

Generally:

This is really about how to make two different shapes of pass-through holes in a bar (round and square). Pass-thoughs are a key skill for making things like gates and fences- done this way, they look really cool.

We're going to make holes for ½" bars to pass through. All of your tooling must be made to measure for the size bar you'll be putting through the hole!

The general process here is to punch a slot in the bar, upset the slot to form a circular hole, drift it round if it's not perfect, then drift it square and shape the outside a bit. If you don't drift it square, it's a round pass-through (in case you need to make old school jail bars?).

The first set of pages (CoSIRA) covers the process well- note the temperatures used!

The later pages include Mark Aspery's discussion on how to make a slotter of the correct size. If you don't calculate the size correctly, your hole will either be too sloppy, or you'll have to stretch and thin the sides of the hole to get it big enough (making it weak and sad looking).

Also make nice, smooth, well-tapered drifts in ½" round and ½" square to form up the hole.

One big tip: if the hole is off-center, or starts stretching more on one side as you drift it, then partially quench the thinner side to stiffen it before you drift it, and you'll pull more metal from the thicker side!

If you want to have square blockings on the diamond, remember to square (diamond?) up the outside edges of the bar appropriately.

After making a hole or two, try to measure how much the bar changes length with each added hole, and figure out how you'd measure and punch the holes to have them come out a particular on-center spacing...

Lesson 15 SQUARE BLOCKINGS FOR GATE RAILS

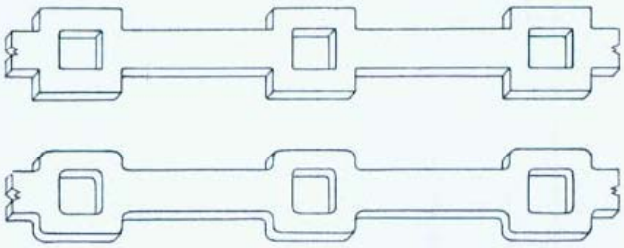
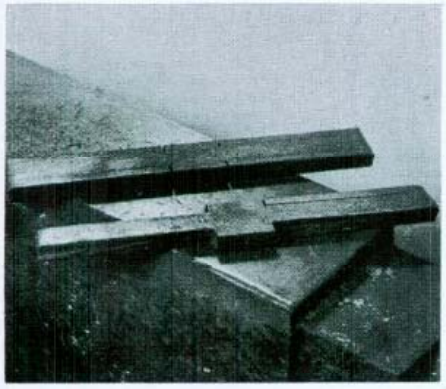


Fig. 30

Square blockings are used when it is desired to reduce the width of the horizontal bars in a gate between the holes where the vertical bars go through them.

When the design calls for sharp square corners the blockings are cut from flat bar giving a look of precision to the work. Where a small radius on each corner is allowable the blockings are punched, upset, drifted and worked up. This gives a more rugged appearance.

Cut-square blockings are either sawn down or cut with a sharp hot set to the required depth. The sides are then cut away with the hot set, and the raw edges levelled up with a square-edged set hammer. The holes are drilled and filed out square. A series of blockings to measure should all be marked out on one bar, allowing a little for draft on the levelling up. Sometimes it is necessary to upset one which has been drawn too much, or vice versa.

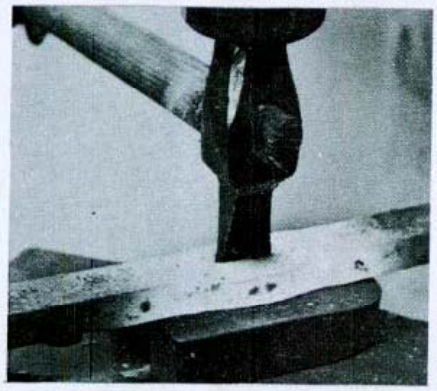


A

When the required length of the bar is greater than can be conveniently handled in one piece, make the blockings in two or more lengths and weld these together.

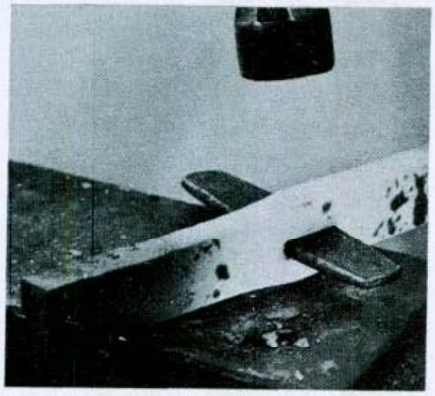
B

To make forged blockings, first upset the bar slightly and slot-punch the hole.



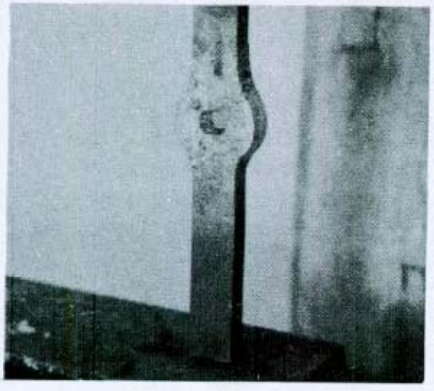
C

Drive out the burr over a bolster.



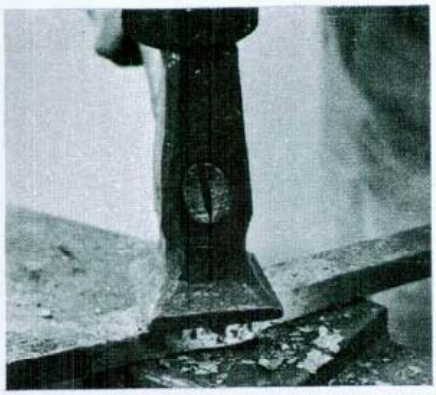
D

Put a drift in the slot and level up the uneven swelling caused by the punch.



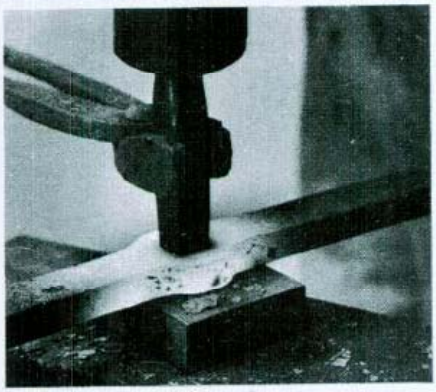
E

Take a NEAR WELDING heat, localise it with water and upset the metal about the slot until the hole becomes round.



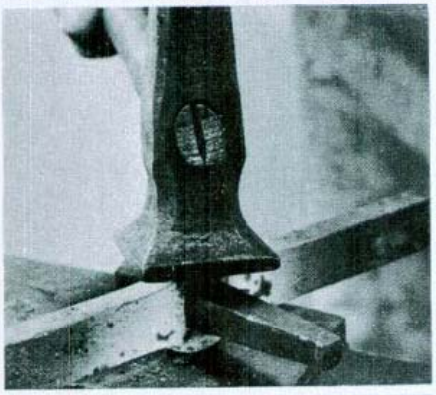
F

Level up with a flatter.



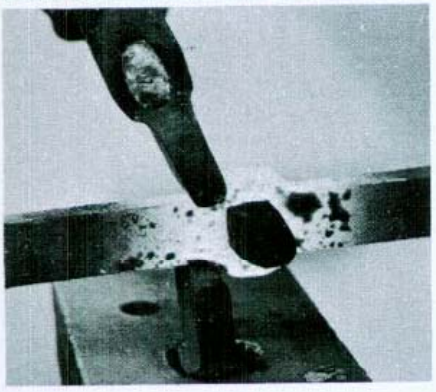
G

Place a drift in the hole with great care, so that it is both square and central, and drive it in gradually from each side in turn, but do not drive it right through yet.



H

With the drift still in place, flatten the side slightly.



J

Now drive the drift in a little farther and forge the shoulders to a small radius, between top and bottom fullers.

To finish, level up the bar beyond the shoulders, flatten the sides a trifle more; knock out the drift, flatten the faces again and finally replace the drift and drift out to the correct size.

Square & Rectangular Blockings

by Mark Aspery, Springville, California

Blockings are used when you want a square or rectangular bar to pass through another bar. Both styles of blockings are formed by upsetting the slot-punched hole and then drifting it to a new size and shape.

First the math. There is a math formula that will get you in the ballpark with regard to the size of the slot punch needed for the final drifted hole. Starting with the square blocking, let's work through the math that will help us calculate the dimension of the slot punch needed.

You know the size of the square bar that you want to pass through the blocking. Let's say it is ¾" square. Take a circle that has the same diameter as one side of the square. That will give you a ¾" diameter circle. Now work out the circumference of that ¾" diameter circle.

$$C = \pi \times d$$

Where **C** is the circumference, π is approximately equal to 3 and **d** is equal to the diameter of the circle, which in this case is ¾".

$$C = \pi \times d = 3 \times \frac{3}{4} = \frac{9}{4} = 2\frac{1}{4}\ inches$$

From here you have to work backwards from the final tool. You know from earlier projects that slotting punches about ⅛" thick work well in that they stand up to the rigors of use and yet are small enough not to drag the eye. With the upset eye, the circumference of the slotting punch is equal to the circumscribed circle, in this case 2¼".

We know that the slotting punch has two half-round ends that when added together must make a circle, and we know the diameter because the tool is ⅛" thick. Therefore you have a ⅛" diameter circle.

When you take the circumference of this smaller circle away from the circumference of the larger circle (2¼"), that will leave you with the combined length of both sides of the tool.

So, first the circumference of the small circle:

$$C = \pi \times d = 3 \times \frac{1}{8} = \frac{3}{8}\ inch$$

Subtract the ⅜" from the 2¼" and that will leave the combined lengths of the two sides. From there you have to divide the result in half to give the length of one side.

$$2\frac{1}{4} - \frac{3}{8} = 1\frac{7}{8}\ inch$$

Divide the result by 2 to get the length of each side.

$$1\frac{7}{8} \div 2 = \frac{15}{8} \times \frac{1}{2} = \frac{15}{16}\ inch$$

So now let's add all that together to get the total length of the tool. You know already that it is ⅛" thick. You have two half-circles each of ⅛" diameter and 1/16" radius, and the length of one side is 15/16". The length of the punch will be the sum of the radius of the first and second half-circles and the length of one side.

$$\frac{1}{16} + \frac{15}{16} + \frac{1}{16} = 1\frac{1}{16}\ inches$$

So the slotting punch will be ⅛" thick by 1 1/16" long. As this slot will be upset, it does not matter that the length of the punch exceeds the width of the drift as in non-upset slotted holes.

OK, we are ready to go to work. Make a slotting punch to the above dimensions.

Use a piece of material 1¼" x 1¼" and a convenient length for upsetting on the floor anvil. First you need to conduct a test to determine how much the bar will stretch, shrink or if it will remain unchanged. You should be able to give it a rough guess. You know that the slot will be 1 1/16" long and that it will eventually be a ¾" square. That means the ends of the slot have to come in 5/16". So the overall bar length should shrink by at least that much. Make two punch marks in the center of the bar, one at the 4" mark (one side of the slot) and one at the 1" mark (a datum).

Using a pair of dividers, set the legs at the distance between the two marks. I know that it should be 3", but the dividers will be a more accurate way of determining the change in measurement. You can offer this pair of dividers up to the 1" mark and the edge of the hole after you have completed your test to find out how much they did move. You will be conducting this test by taking measurements from one side only as the stock will be quenched from one side only. In other circumstances, you would take a measurement from both sides of a forging to get an average.

As you are working on what is, in effect, the end of the bar, I am presuming that you will place the other end on a work stand that is on your side of the anvil.

Take a light welding heat at the 3" to 4" mark and slot punch the hole. The side of the slot punch nearest you should rest on the center punch mark made at 4". That means that the slot is between the 4" mark and the end of the bar.

Take a heat around the slot and quench out the end of the bar to within 5/16" from the start of the slot. Why 5/16"? You will be upsetting the material around the slot and eventually turning the slot into a circle. The sides of the slot need to be able to move. They need at least their

own width to do that. As the bar is 1¼" wide, and you have taken ⅛" out for the slot, that should leave you with 9/16" on each side. Try to keep the heat to just around the slot. Don't get it too hot further up the bar or it will upset at the same time as the slot. If you are working in a gas forge, you will have to quench both above and below the slot (to within 9/16" or so) before upsetting the slot.

If this is a production job, I would use a rose bud on an oxy/fuel system and get the heat that way.

If, per chance, the slot is off to one side or the other, mark the thin side on the edge of the bar away from the hole. You will be referring to this mark later.

Turn the bar 180° after each time that you throw it into the floor anvil. That will help keep the upset even. Upset the hole until it becomes round. Take care as you approach the round stage, for the hole will tend to collapse rather than upset. One side will look significantly better that the other due to the slot punching process. Using a round drift, reshape the hole to a perfect round. Don't try to stretch it too much.

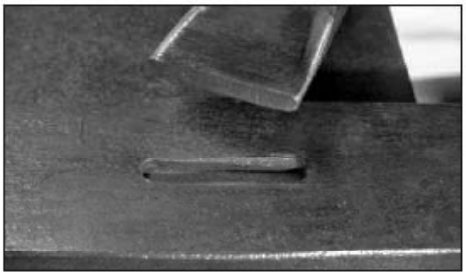
At this stage the bar may not be straight and level. If you leave the bar in that condition and you apply the square drift, to which side of the bar will you align the side of the drift? Lock the bar in the vise, and using a straight edge, align the bar on either side of the hole.

Now you are ready to apply the square drift. If your slot was off to one side, the thick side of the hole wants to go down in the coals. By leaving the thin side up and uncovered by coals there will be a difference in heat to the two sides. If you work quickly with the drift, the thicker, hotter side will now stretch in keeping with the thin cooler side. Maybe, if you are quick enough, you will now thin the thick side and bring the hole back to the center.

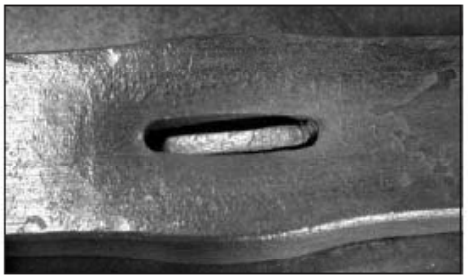
If you are working in a gas forge, you will have to quench the thin side to achieve the same effect. The disadvantage of quenching is that the cold side now acts as a heat sink and sucks heat away from the rest of the eye. That will cut down your forging time on the anvil per heat.

Drive in the drift from both sides. I like to have flat sides to the blockings. In order to get the flat sides, I need to forge them in. I don't want to stretch the eye, so I forge them in lightly (so as not to penetrate the whole of the bar), and I start to flatten the sides quite early in the drifting process, certainly before I have driven the drift fully through the hole.

Using your dividers, check to see what happened to the length of the stock between your center-punch marks. Knowing this alteration in length, you can apply it to the layout as you mark each hole.



The slot after a few blows and the business end of the slot punch.



Result of the slotting process. The slug is left in for demonstration and should be removed by the smith.

The result of the first upsetting. The original slot on left is shown for comparison.

The result of the second upsetting. Note the shape of the hole in the back differs from the front.

Correcting any deviations with the stock held in the vise. Sometimes two hammers are required.

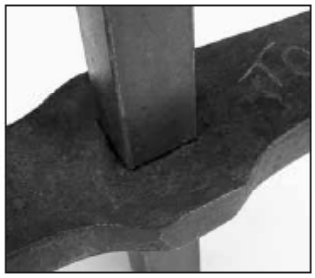
Check for alignment of the sides on either side of the hole. A piece of scrap plate was used.

Starting to drift. Note that the sides of the drift are parallel to the sides of the bar.

Starting to dress the sides of the blocking. Use light blows so as not to stretch the hole.

Return to drifting the hole. Remember to work from both sides of the material.

Refine the edges still further.



The square blocking complete with a taper to the end of the bar and a tenon drawn.

The blocking fitted to a hinge style. ♣

Project 24: Copper Repousse and tooling

Material: 5-6" square of 20-24 oz. copper sheet (or whatever...)
couple feet of 5/16" and/or 3/8" round H.R. to make tooling
Plywood and screws
design to make, on paper
rubber cement
400-600 grit wet/dry sandpaper

Generally:

This is not a very complete picture of how to do repousse and chasing, but gives you a taste of what's involved. Technically, repousse is working the metal from the back, and chasing is working it from the front. Realistically, you are likely to do a little of both on many pieces.

Repousse (working from the back) generally leads to greater variation in depth, and chasing (from the front) to greater detail, but less depth variation. There are, however, many exceptions to this.

Repousse/chasing can be done with a variety of backing materials, from hard (plywood) to medium (lead, pitch) to soft (carpet, modelling clay) or even very soft (air!). Softer backing equates to more depth and less detail; harder backing to less depth and greater detail. On some projects, you may want to switch from stake forming over air for depth to filling the piece with pitch before chasing in the sharp details.

You'll need to make several top tools from small round stock. You'll definitely want a couple of butchers in different widths and flatters in a few shapes. Depending on your design, you may want thin or thick fullers, ball-ends, or texturing tools.

Repousse tools should be short- only 4-4½" long. This is because when you use them, you are working on cold metal (so length is not needed), and you look at the bottom of the tool while striking the top (a shorter tool is easier to accurately strike blind).

Your tools should be filed smooth and then polished with at least 400 grit paper- the shine you end up with is mostly a product of the shine on your tools.

Before starting, transfer your design by rubber cementing it on the copper, then using a fine center punch (or small nail...) to transfer it to the metal as a series of dots. Then anneal the copper by heating it in the fire 'til it just glows, and quenching it in water.

As you work, you'll put dislocations in the copper crystals, slowly stiffening the metal. The upside to this is that you can get finer detail in the harder metal; the downside is that you can go too far, and harden it until it cracks! If you move the metal a lot, anneal it again. But avoid annealing it near the end, because you want your final product to be harder than your thumb!

Middle Age Passion In North Carolina

by Jan Aijian, Visalia, California

No, I am not leaving my husband for a fiddle playing hillbilly. I have however, at this point in my life, recently entered the strong currents of passion found amongst those who love to work with metal. Last September, Mark Aspery gave me a preliminary introduction to repoussé and subsequently encouraged me to pursue a class in it. That suggestion led to my discovery of the John C. Campbell Folk School and to becoming the happy recipient of a CBA scholarship for a one-week class in April. Big, big thanks, CBA, for this opportunity!

The school was started in 1925 in the Appalachian Mountains of North Carolina to encourage the preservation of various skills and crafts: wood turning, painting, wicker seat weaving, all the blacksmith skills, harmonica playing(!) and many others. The setting is beautiful and soothing to the soul. In the mornings I walked a trail through a wooded area, taking my Starbucks mug to get filled in the coffee room. Then sitting on the deck, I watched the sun rise over the ridge. Each lodging is unique, quaint and very comfortable.

My course instructors, Mark (fondly nicknamed "Tool Man") and Mindy Gardner are from Illinois. They drove a fifth-wheel trailer filled with 11 treadle hammers! Since they had never been to the school before, they were unfamiliar with the route they chose. Our entire class was highly amused hearing them give their account of unwittingly causing much consternation to a motorcycle club wanting to race on the same twisting mountain roads they shared.

Mindy was our instructor in repoussé and chasing. Mark, a fine blacksmith, came as her *tech support*. He helped us get started making the tools we would need for the various projects Mindy laid out for us. He brought precut 4" lengths of S-7 steel. The basic shapes were forged, then heated to a yellow heat and quenched in oil. A more precise shape was then finished on belt sanders and polished.

I had the least forge experience of the class. Two men in their late 20s make their living as blacksmiths; the rest had intermediate levels of experience. For that reason it took me longer to make my tools. Despite obvious hammer marks, I'm thrilled with what I made. I now have a modest assortment of chisels, fullers, butchers, a ball tool and a flatter.

Mindy demonstrated at the treadle hammer. I wish I could have deflated one to bring back on the plane. I did not have previous experience using them, so I can't really compare with others models. Nevertheless, I found it very user friendly. Mark had installed safety chains on all of them so it was impossible to smash your hand while using them.

With some initial tools finished and beginning demonstrations for the first project over, we got started on a large oak leaf. We were to get the hang of using the tools, which were held like a pencil over the work. Mindy would circle the class telling us repeatedly to finesse the use of the hammer, rather than stomping on the pedal and punching through the work. I did that, punched through, on a Ginkgo leaf I made. The metal was worked hot only at the beginning of a project, to texture it, and at the end, to twist it. When it was cold, a lead *cookie* sitting on the anvil, rather than pitch, was used to maintain shape. Of course, we were all admonished to wash our hands after handling lead. Working with lead cookies is Mindy's preferred method. She doesn't get quite the depth that pitch would provide, but what she did was truly beautiful, and

certainly less messy. But CBA wouldn't exist if we were all concerned about staying clean! In addition to some leaf shapes, we also worked on a feather, working toward as true-to-life a presentation as possible.

The cleaning up process for these pieces was quite an arduous task, done by hand. Various grades of abrasive pads were used, so you just got to sit around and visit while you worked to get off all the oxidation. It being such a laborious task, you'd better enjoy it if repoussé is your chosen line in metal work.

Next came the coloration process, once you got your piece cleaned down to the bare metal. We learned that different colors could be achieved by different temperatures applied with a small propane torch. A great degree of patience is required here as well. It was so easy to have a lovely purple just elude you by holding the flame a few seconds too long on one spot. If you wanted to try again, cleaning would be required, then heating again. Many of us burned our pieces multiple times while trying to learn this technique. One man in the class had specifically signed up for the class to learn this "coloring." He became very frustrated and decided he "liked the look of the plain steel better anyway."

The cumulative skills acquired on the preliminary projects were then used on a final effort. We were to create a small plaque or tile, about 4" square. It had to be small because of time constraints. The edges had to be filed smooth. Texture was given by three trips between the forge and anvil, watching for scaling, then hammering it in. I drew a mother bird with a chick under her wing on a piece of paper, then glued it on to the square with rubber cement, which was peeled off after the first pass with a small chisel. Two butchers with different angles were used to begin to push the metal down around the edge of the bird, followed by a flatter. A ball tool was used to start pushing the chest out from behind. To bring the edges of the tail out, a fuller was used from the back. I had to use some of Mindy's numerous tools since what I had made was inadequate for the detail I wanted on the bird. Of course, all this hammering made the tile warp in all kinds of ways. Positioning the bird's body over the hollowed out hole in the top of a stump and hammering gently on the edges brought it back.

I wanted only the background colored. Once I finally achieved that without the burnt look, I just cleaned the colored parts off the bird with the Dremel wire brush. With the brass brush attachment and some heat, I colored the baby bird and the mother's beak brass.

Mindy is not the sort to pat you on the back and say, "Good job!" just to make you feel good. Remember the tactic of encouragement from your elementary school teachers? Having discerned disinclination for easy praise on her part early on, I was nevertheless feeling like a giddy school kid when my teacher repeatedly praised my first effort at repoussé.

I rank my experience at John Campbell Folk School a ten out of ten. The food was way too yummy, and I didn't try turning down the desserts. The stories told and music shared were stellar, though I couldn't partake enough in that aspect due to my being in the blacksmith shop most of the time. The scenery was beautiful, and the individuals sharing it – all a kick. I certainly want to take another classs and take my husband. He is not a blacksmith, but the setting and people alone would have tremendous draw for him. My classmate who hoped to learn coloration, comes every year with his wife, who does quilting.

I was in a state of exhilaration the entire week, but keeping those long hours in the shop on a continuous basis did me in physically. All day and into the night, except for meals, till bedtime, I worked away.

I have only been a member of CBA a little over a year now, so I'm not sitting on a whole lot of experience. I went to my first Spring Conference in Watsonville for just one day. That night, over dinner with a friend, I effused profusely about my experiences of the day. After listening to me she said sagely, "Wow Jan, it sounds like you found your tribe!" Indeed, I have. ♣

Some Examples of Repousse Tooling and Products

B. Holmberg, 2010

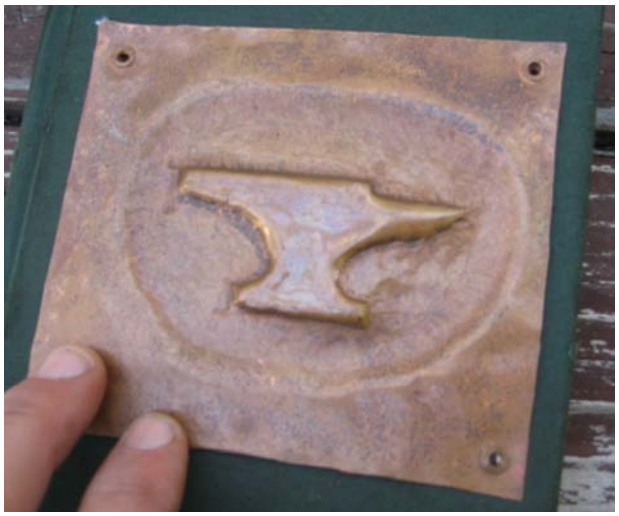
A selection of repousse tools. This should give you an idea of the size of these top tools (skinny and short!), as well as the numbers needed on typical simple projects...

A **butcher** is one of the most useful top tool shapes for working on a plywood or pitch backing material. It has a straight front side, and angled or radiused back side. The tip should be radiused (not sharp) to avoid ripping the metal. In use, the butcher is driven down into the metal, then slid forward a tiny bit with each hammer blow, pushing a wall of metal in front of it. Butchers let you get substantial relief, even against plywood, and produce fairly sharp details.

You'll probably want butchers in a range of widths to be able to do various shapes and get into tight spots...

Flatters (left) are used to, well, flatten the metal (often useful for increasing the sharpness of positive features). Different shapes let you get in and around your design.

Fullers (right) of various widths can act like your finger to push the metal where you want it. Very narrow fullers can be used to form distinct lines in your work. Make sure the edges on all your tools are radiused, and the faces well polished. If you don't, you'll get scratches, rips, and cracks in your work!



A small example of copper repousse done on a plywood backing. Note that even against plywood, it's possible to get over 3/16" of relief in the copper (mostly by using butchers).

This piece was worked first from the front (mostly with butchers to get height variation). It was then removed from the plywood and annealed again, then mounted upside down and worked from the back to tighten the shapes on the inside of the anvil. It was then flipped over again (but without an anneal) to refine and sharpen the details, mostly using flatters around the outside of the anvil. This is a typical approach when working on plywood.

A couple of reminders:

- When using plywood backing, the copper should be screwed before working.
- Be sure to use a light hammer (under 16 oz) for this work.
- Swing your hammer as loosly as possible for hand health.
- Wash your hands before eating, etc- copper is toxic.
- Stop and stretch occassionally- this is tendonitis-tempting work.

Project 25: Dan Dole's Letter Opener

Material: 12" of 5/16" round H.R.

All you get is a picture!

If you don't have 5/16" round, use 3/8" round.

Generally:

This is a nice design with some easier forge welds. And it's a great chance to work on your blade forging skills without having to worry about heat treating or other 'real knife' issues. I think of it as a mini-sword...

Forge a scarf in one end, then make a bend about 4" back that makes the scarf touch the main shaft.

Forge weld to make a loop. You probably don't need an upset at the weld site.

Put the weld in the vise, stick a rod through the top of the loop, and twist ½ turn. You can vary the size and shape of the two spaces in the handle by having the handle stick up more or less in the vise when you do this.

Weld the cross-over (use the horn).

Draw the remaining stub out to a long tapered blade blank. This should be thin (1/8"-3/16" thick) and narrower than you want the final blade to be (because adding the bevels adds lots of width...).

Forge a double bevel on the blade. Do all four surfaces of an inch or two of length, straighten, then do the next couple of inches.

A good double bevel is more easily forged on a broad bottom fuller. The blade edge should be parallel two, but slightly below, the axis of the fuller. As you hammer over the axis, the blade metal is squeezed into the wedge-shaped space between the hammer and the fuller.

Another advantage of using a fuller is that, as a smaller hunk of metal than an anvil, it'll heat up faster. This means it'll cool that skinny blade metal less, and you'll get to work longer each heat!

A good blade takes time and thoughtful effort to develop. You need to watch the shape carefully as you go, and correct minor problems before they get bigger. Try to see how well you can forge the blade, and how little you need to file/grind it to it's final edge!

Final length should be a good 11" or more.

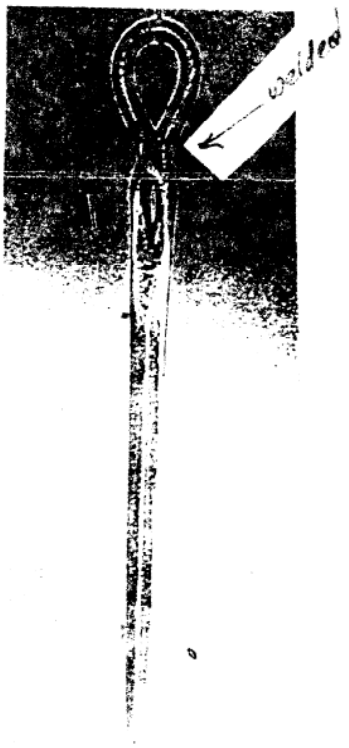
12" 5/16" DIA

BASIC II

9/24/94

Dan Doles letter opener

9/30/94



Overall length - 11"

5/16" HR round.