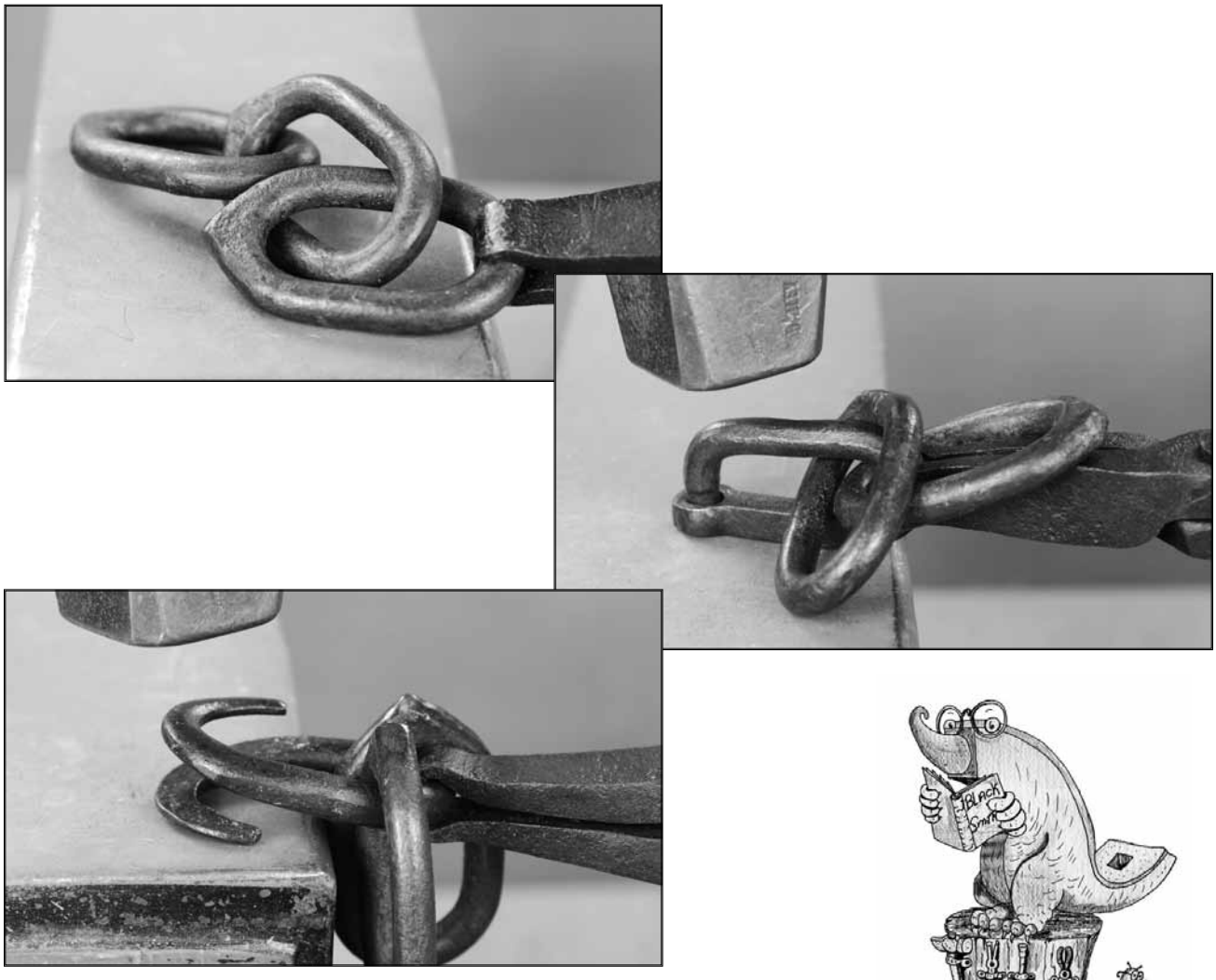
CALIFORNIA BLACKSMITH ASSOCIATION *presents*

BEGINNER TO ARTIST

JOE KOCHES MEMORIAL CONFERENCE • FERNDALE, CA • APRIL 30TH—MAY 2ND 2020

CBA - Chain-Making Competitions
Thursday Evening, April 30th
Training Tutorial



Making chain may be a little basic for this book, but it does lead in nicely to some chain repair links which definitely fall within the scope of the book.

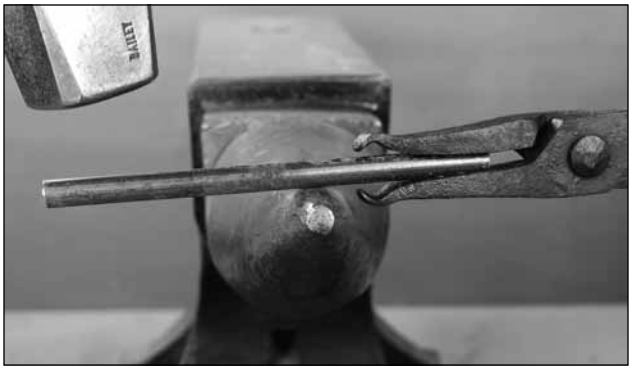
Starting stock is 6-inch lengths of ⅜-inch round bar.

With the middle of the bar hot, bend the bar into a 'U' shape over the bick or horn of the anvil. Strive to get both ends equal with each other.

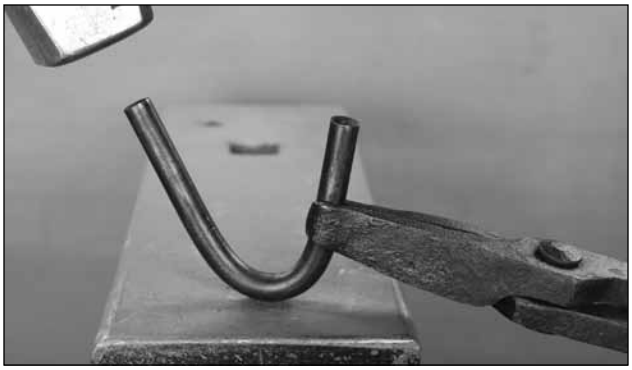
If you practice, you will get to know your measurements and can make the bend in the pritchel hole of the anvil if you prefer.

If the ends don't align, leave the 'U' shape open, and with the bend resting on the anvil, tap the longer leg. This action should shorten the long leg, close the 'U' and leave both ends aligned.

Move another bar close to but not into the fire as you place your 'U' shaped bar, ends first, into the fire.

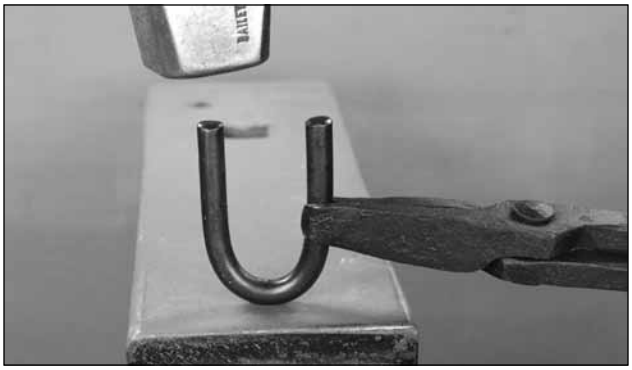


1 Bend the bar either at the bick or in the pritchel hole



Keep the link open if the arms are unequal length

Get as far as you can, working from the top, then turn the link over



Hammer on the long arm to shorten and close the link

Keep an eye on the length of the arms, try to keep them of equal length. Stop if they get out-of-whack.

Nothing good ever follows from continuing with a project that has a twist in the stock.

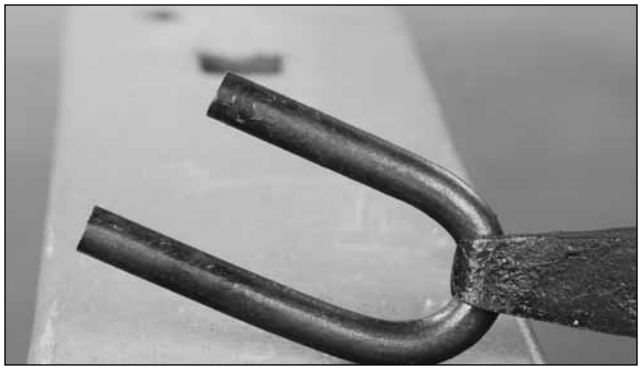
Nothing good ever follows continuing to forge a bent or twisted bar. Take any twists out of the link by using or the pritchel hole and a pair of tongs, or two pairs of tongs.

If the U is formed, but the ends do not align,open the link and tap the longer side down.

Heat both ends and pull the link from the fire, holding the bar at the bottom of the 'U' bend.

If one end is cooler than the other, forge the cooler end. Hopefully the hotter end will still be workable when you have finished with the cool end.

Use the vise or the pritchel hole to take out the twist



This isn't good either. Change the shape from a U to an open V and tap the high side down

Place one end on the step of the anvil at a 45-degree angle horizontally, close to the nearside edge. The other leg should be nearly touching the nearside face of the anvil.

The edge of the step should bisect a line from the outside corner to a point about ⅜-inch from the end of the bar.

You are now going to make a *Chain Step scarf.*

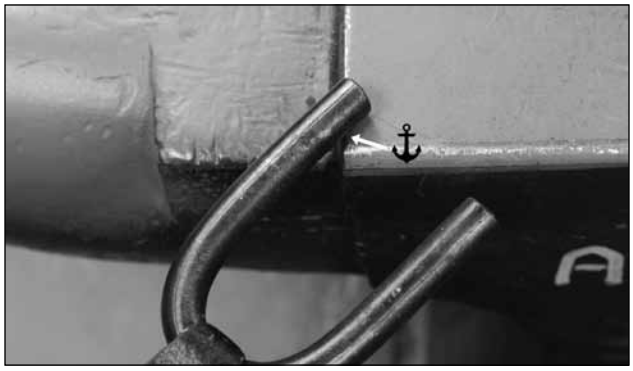
Draw down the end of the bar in such a way that it develops a taper that looks like a flag on the bar.

Strike the end with a moderate blow and create a shallow shoulder. I like to hold my hammer at a slight angle, to match the angle of the proposed scarf taper.

Move the outside corner out 1⁄16-inch to ⅛-inch, as you pivot around the inside corner of the shoulder and give the end another blow.

Move the outside corner again the same distance and repeat the blow. At no point do you move the inside corner of the shoulder.

Repeat this process until the end of the taper is quite thin and will blend easily into the weld that you are going to undertake soon.



Hold the top corner in line with the step.

Pivot around the bottom contact point

Hold your hammer at a slight angle to the anvil face

Turn the link over, so that the steps of your scarf are facing up and scarf the second end of the link.

At this stage you are ready to close the link in preparation for forge welding.

As you practice, the aim here is to have enough heat left at the end of forming the two scarves that you can close the link in the same heat.

Keep hammering and pivoting to create the slope of the scarf

Turn the bar over and scarf the other end

The scarf looks like a flag on the end of the bar

Note that the original scarf is step side up

A chain-step-scarf on one end of the bar

Bend the ends so that they overlap each other

If that is not the case, then take another heat and close the ends. Move to the face of the anvil to close any gap between the two scarfs, overlapping them together so that the shoulders of the scarves match up.

If needs be, return to the bick to align the two shoulders of the scarfs.

Heat to near welding, brush, flux and return to the fire to bring back to welding heat.

It would be nice to finish the weld in one heat, two at max, so take the link to the upper welding temperatures in order to buy a little extra time at the anvil as you weld.

First weld the two ends together on the flat face of the anvil - working from both sides, then move to the bick to dress the inside and outside seams of the weld.

Bend the second arm around the bick

You might need to level the ends so that the points are aligned

Tap the ends together

Weld on the flat face of the anvil first

Get everything flat in readiness for fore welding

Here is my effort, I'm heading to the bick to continue welding

Working on one side of the apex to the weld, turn the apex of the link slightly towards the heel of the anvil and continue to weld two seams; the one that you can see, and the other resting on the bick.

Turn the link to the other side of the apex and repeat the move, welding both the top and bottom seams of the weld at the same time.

Don't force the weld. If you need another heat to finish the weld, then take it.

Have the apex tilting towards the heel of the anvil as you work

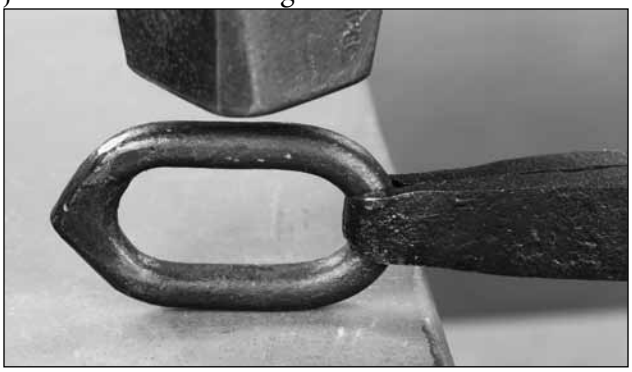
Weld the upper and lower seams at the same time

Move to the other side of the apex and repeat.

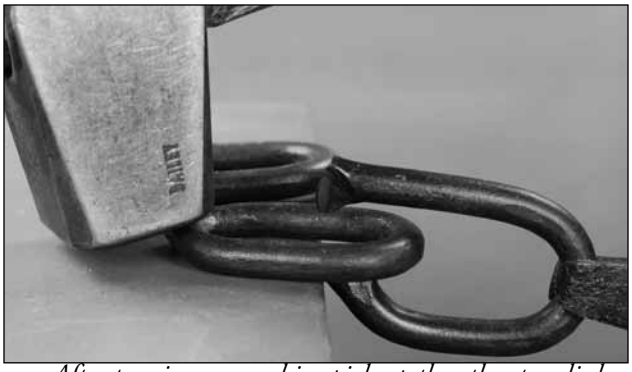
Typically, you will end up with a pointed outside corner at the weld site. I like this look as it speaks to its handmade history. But don't leave the corner and have a bad weld. If the weld needs dressing, use the material stored in the corner to fill the gaps.

Dress the sides of the link on the face of the anvil and brush the result.

You will make two single link pieces and then join those two links together with a third link.



If your link is a little wonky, dress it on the face of the anvil



After turning one end in, pick up the other two links with the turned end down

Keeping the links on the turned side will be an advantage in the next step

With the third link, have the two single links resting on the face of the anvil somewhere near the heel, away from the area that you have been working on to weld.

Bend and scarf the third link. Turn one end in and then move to the other two links resting on the heel of the anvil. With the turned end of the third link lowermost, slip the two finished links onto the open link.

Turn the second end in and close the gap. Note that the welded links are beneath the tong jaws.

The trick now is to weld without letting the other two links get the better of you in the process

I try to keep one link either side of the tong jaws as I continue to weld on the bick

Close the final arm on the third link. Try to keep the fully welded links on the bottom as you close the end of the third link at the bick.

Having a finished link resting above the tongs will lead to the link bouncing and getting in your way as you attempt to close the open end.

Protecting the first two links from the fire, bring the third link up to a welding temperature and weld. You may have to flick the first two links out of the way as you weld the third link.

Brush the links while you still have the heat, dipping your brush in the slack tub as you brush can sometimes help pop off stubborn scale pieces, giving you a better looking finished product.

There are many ways to make a length of chain, but I usually make a series of 3-link sections, and then join two together with a 7th link.

Joining two 7-link sections requires threading some of the (now cold) links onto the tong reins to keep them out of the way.

At some stage, you are going to have to work of the end of a longer length of chain, and having a crane that pivots by the edge of the forge can help keep the links out of your way, both in the forge and at the anvil.

For longer chain, create several 3-link lengths and the use a 7th link to join 2 lengths together

Repair Link

For the second project of the chain chapter, you are making two links of chain from 6-inch long pieces of ⅜-inch round bar, and a repair link from a piece of ⅜-inch square stock.

The repair link will have an included mortise formed by punching and drifting an eye.

Draw down a length of ⅜-inch square bar on the bick

Here the repair link applied to two links of chain

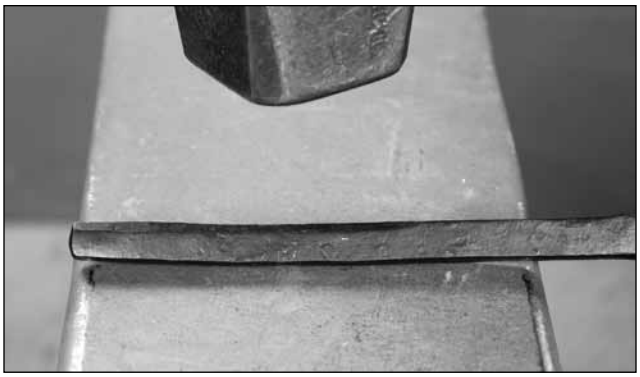
Draw down a 4-inch length to a 5/16-inch square cross section

For punching the eye, you'll need either a 7/16-inch wide slot punch and a round drift. I use a tapered round drift as I find it suits my needs better than a parallel sided drift. You will also need a hot-cut chisel and a pair of ⅜-inch tongs.

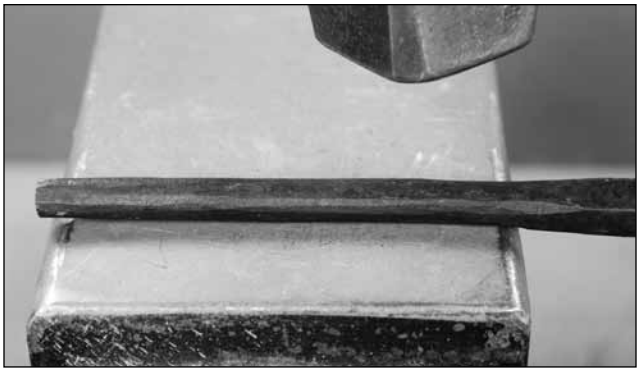
As we have already looked at making chain, I'm going to focus on the repair link.

Start by drawing down a section of the square stock and forging it into a ⅜-inch round cross section.

I estimate a need of around 4-inches (finished) of drawn square stock that will be further forged to a length of 4½ to 5-inches of ⅜-inch round stock, the remainder of the bar being left ⅜-inch square.



Dress the forging and take to octagon and then to round



Take care to blend the transition gradually back to parent stock dimensions

Aim for a 4½ to 5-inch length of ⅜-inch round bar when finished

Once you have drawn down the end of the bar to a round cross section, you have a choice of working methods; your decision may be made for you depending on the room in your forge pan.

1. Sever the material that you think that you need from the parent bar and punch the mortise.
2. Punch and drift the mortise before cutting the repair link from the bar, my preferred method.

I prefer not to cut the project away from the parent bar until after I have finished the link. Keeping the project on the bar makes it much easier to punch and drift as well as turn the link to thread the mortise.

Cutting the link away from the bar also creates a problem with the corners of the cut bar creating 'rabbit's ears' during drifting, but it may be a needs-must situation, depending on forge room etc.

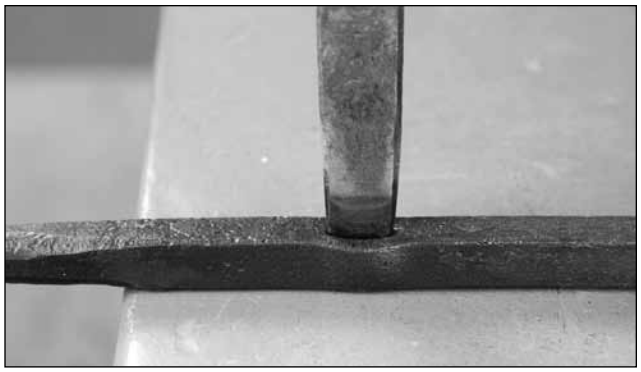
I'll show both methods in the photograph progression to cover to all eventualities.

You need 1¾-inch to 2-inches of unforged square stock on the end of the forged round stock, to complete the repair link. I find that a length of 6½-inches from the end of the bar to the start of the mortise is about the right length of material for the link.

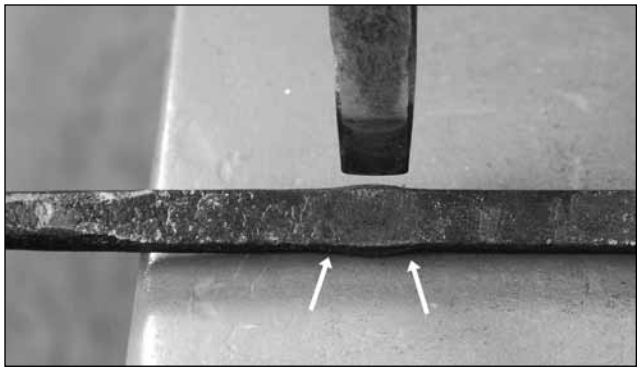
Punch from both sides of the bar pushing the resultant swelling to the middle of the bar, rather than to one side. This leaves a more uniform look.

Use the swelling created by punching from the first side to landmark the punch on the second.

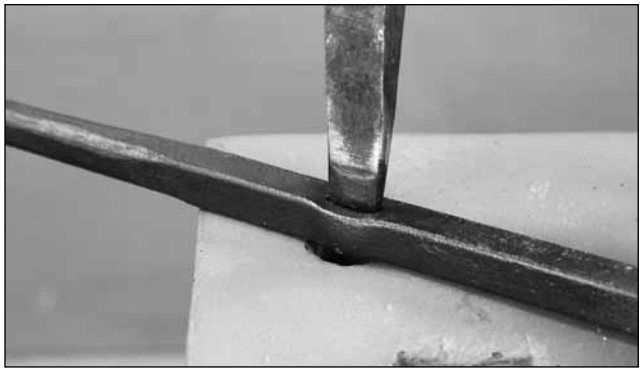
Clear the slug over the pritchel hole.



Punch to slightly past halfway from one side of the bar



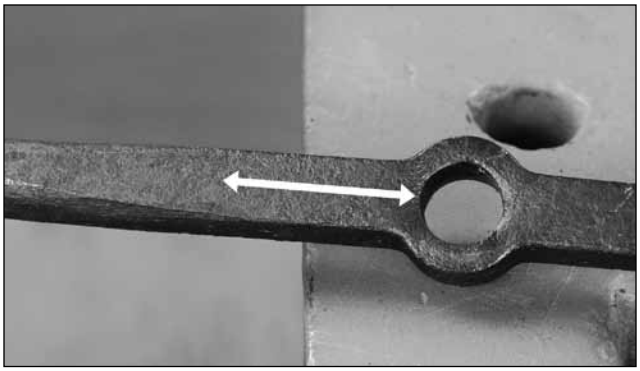
Use the swelling created by the initial punching to locate the punch on the second side of the bar



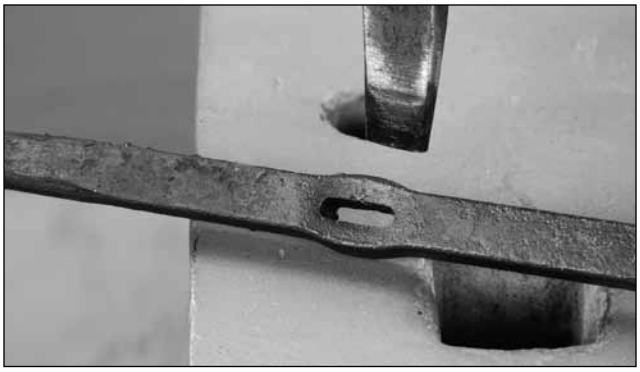
Clear the slug over the pritchel hole of the anvil

My preference is to use a tapered round drift to finish the mortise, working from both sides of the bar and teasing the hole into its final shape.

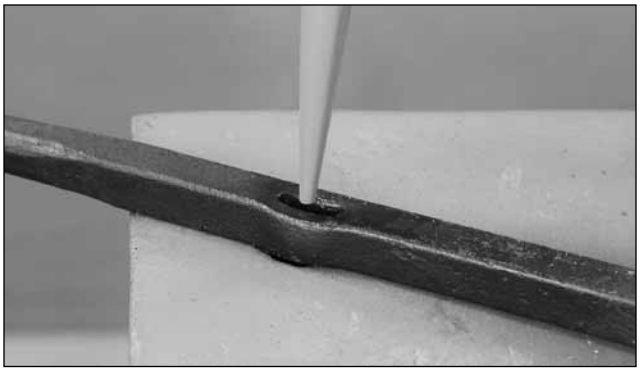
Work over the pritchel hole if it is of the correct size, otherwise use the hardy hole and move around all its edges for support as you drift.



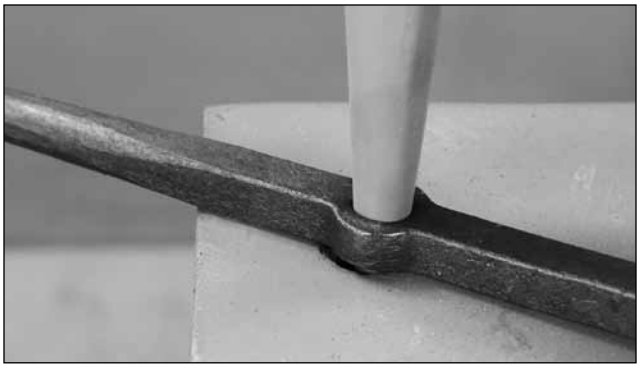
I like about 6½-inches of length from the start of the mortise to the end of the round bar



My slot punch is slightly over ⅜-inch wide



I use a tapered drift when drifting the mortise, but that's personal preference



Work from both sides of the bar as you drift

If you cut the project from the parent bar, you have a couple of options. You can cut the bar straight across and be left with a flat end, or you can use a curved chisel (or hardy cut-off) and leaving a curved end. Both methods have their shortcomings.

The size of your slot punch and drift must reflect the size and shape of the round end of the repair link and your choice of curved chisels.

If you have used a flat straight chisel for the cut, you can either hot rasp the end now or wait until later. Delaying rasping until after you have drifted the mortise might be more appropriate.

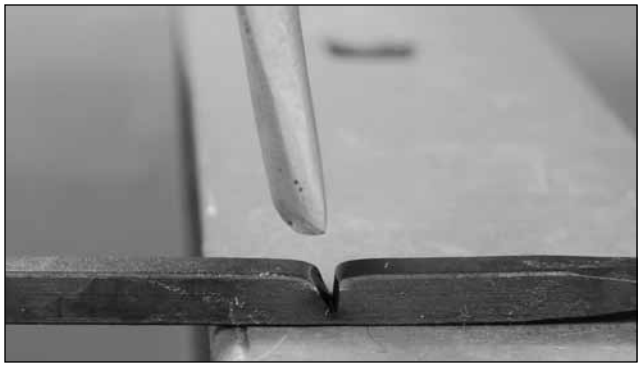
My slot punch is about 1/16-inch thick and a little over ⅜-inch wide. When placed along the centerline of the bar it will leave 5/32-inch on either side of the punch.

If you cut the project from the parent bar, theory suggests that you should leave that same amount from the edge of the punch to the end of the bar. Theory and practice don't always align, and this is one time when they don't.

The end of the bar, having minimal support, is stretched and thinned by the drifting action of forming the eye. To allow for this, pad the measurement from the edge of the punch to the end of the bar - not by much, a 1/32-inch or so, a little more if you are going to hot rasp the end.

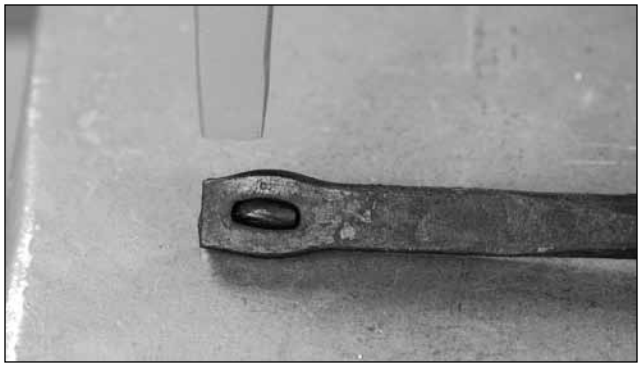
A curved chisel can prevent 'rabbits ears' on the end o the bar post drifting

Using a tapered drift, open the hole working from both sides of the bar as you go



Sever the piece from the bar 2-inches past the transition area if you cannot pass the bar through your fire

This is my result thus far



Leave an allowance at the end of the bar for cleanup and drift movement when you punch

Once the mortise is formed, you will need to bend the end of the round bar to slightly past 90-degrees.

Push out about 1⅜-inches past the centerline of the bick to locate the first bend.

Clear the slug over the pritchel hole

Lay off about 1⅜-inch from the center of the bick

Make another bend in the bar sending the tenon towards the mortise. Make the bend around the area of the bick that best represents the inside diameter of the chain to be repaired- 1-inch in diameter.

There should be no square stock contained within the bend, allowing the chain to move freely.

Control the bend by working both on the nearside and offside of the bick as required.

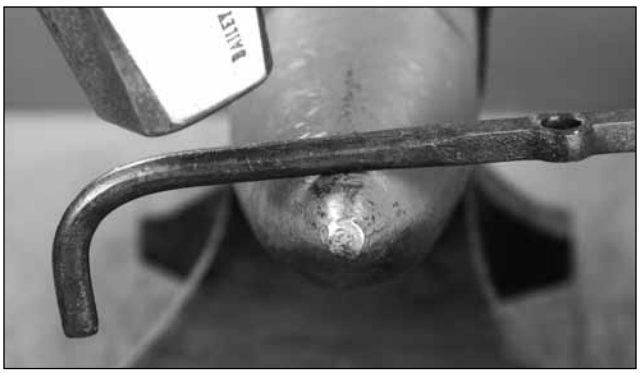
The over 90-degree first bend in the bar will help locate the end into the mortise.

Close the link and give the whole thing a brushing. Cut the repair link from the bar using either a curved or a straight chisel. There is no set way the end should look, curved or flat, so long as the end doesn't interfere with the joined chain when applied.

Dress the repair link on the face of the anvil if required.

Bending the bar to slightly past 90˚ makes it easier to thread the tenon into the mortise

Finish the bend over an appropriate part of the bick, leaving an ID that matches the chain link



With an allowance for the material needed to make the bend, turn the repair link

This is a far as I go on the bick before moving to the face of the anvil

Taking the bend past 90˚ can make it easier to catch the bick when you turn the link over

Close the link on the face of the anvil and give it a good brushing before returning to the fire

Sever the repair link from the parent bar if you haven't already done so.

Rasp the cut end to either flat (with chamfered edges) or round (as shown) depending on preference.

Re-open the link sufficiently to accept the chain links with either a pair of tongs or at the bick and give it a good brushing.

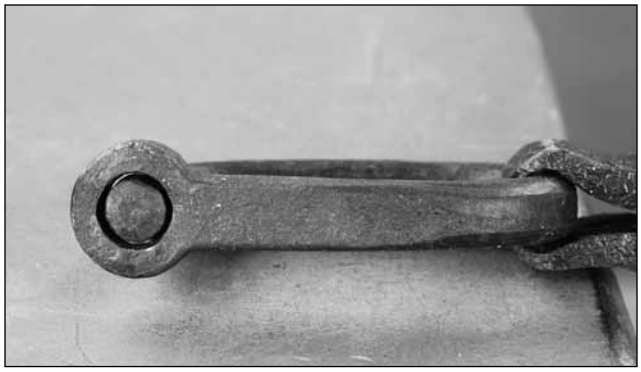
The repair link should be somewhat similar in size to the repaired chain.

A variation on this theme is to create a hammer-finished tenon on the end of the round bar section. Forego the drawing down of the square bar at the bick, moving straight to creating a round bar.

This move leaves the round bar oversized and able to accommodate a tenon of the requisite size for the mortise.

Sever the repair link from the parent bar and hot rasp the cut end either flat or curved

The repair link should be of a similar size to the chain being repaired



This is the end after hot rasping, showing the fit that I am looking for in the mortise

Here I've added two links of chain to show the application of the repair link

Open the repair link at the bick or with tongs, ready to apply the two ends of the broken chain

A variation is to create an appropriately sized hammer-forged tenon on the end of an oversized round section

Split Link

For this exercise, you are tasked to make two individual links of chain and a split link to join them. The split link is another form of a repair link, used in the field to repair broken chain.

To forge the split link, you are going to have to make a bottom tool from a 4½-inch length of 1¼-inch square mild steel bar (for a 1-inch hardy hole) and an appropriately sized heading block covered in Volume-1.

Within the USA, Bob Menard of *Ball and Chain forge* (www.ballandchainforge.com) has available for sale the heading block pictured below.

You will also need four pieces of ⅜-inch diameter round bar, 6-inches long as the remainder of your material needs.

Two pieces of the ⅜-inch round bar will be needed to make the chain links, one piece for the repair link, and the fourth will be used to make a positive form to drive into the bottom tool, creating the depression needed to form the split link.

Fire management is going to be very important to you as you complete this project. Don't lose sight of the fact that you will need to forge weld two chain links at some time during the exercise.

On the 1¼ square bar, mark the end of the taper with a centerpunch at the 1½″ point. This mark stops you getting carried away with the taper as you work.

Draw down one third of the 1¼-inch square bar into a blunt taper, say ⅝-inch square.

This actually translates to ⅝-inch plus when drawing down over the bick or offside edge, and results in ⅝-inch square end when dressed.

The split link being applied to two chain links for display on my project board

This is the blank that you are aiming for 1⅜″ plus tall and about 1⅞″ to 2″ square on the face

This commercially available heading block is from Bob Menard of ballandchainforge.com

Draw down the first ⅓ of the bar into a blunt taper over the bick

I like to work over the bick, but I know that some will prefer the offside edge of the anvil . Turn the bar through 90˚ after each hit to control the taper, keeping it square.

The heading blocks are parallel sided so any taper will fit. That said, too blunt of a taper and you won't get enough length of peg to make the bottom tool seat properly. Too sharp of a taper means that you have worked too hard.

Take the time to center the taper along the parent bar. This will make the upset go a little smoother by keeping the stock perpendicular to the heading block as you work to create the top half of the tool.

Chamfer the corners of the taper, stopping a short way into the parent bar before starting the upsetting process.

You'll be taking some high heats to get to a point where you can upset this large bar efficiently, the chamfered corners will help prevent burning the taper as you take the heats required in the upsetting process.

A corner has the most surface area with the least amount of mass and will heat up quickly, and become prone to burning.

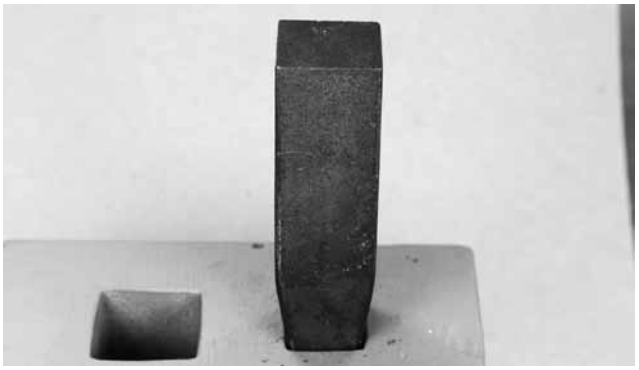
With a solid fuel forge, I feel that I can draw down and dress the taper in one or two heats. I aim for one.

Upsetting the bar.

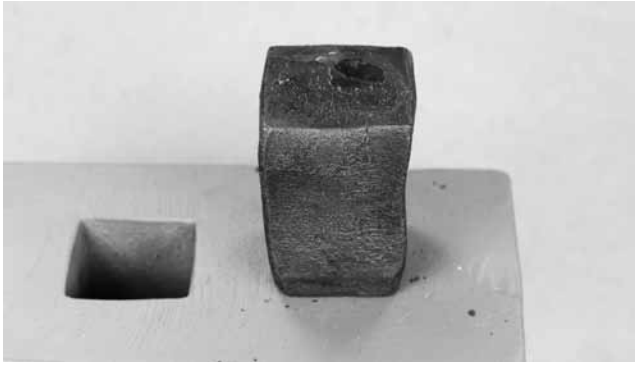
More heat translates into less effort required. You will also spend less time working with a properly heated bar.

The stock will not upset evenly due to the fact that the bottom of the heated material is being both chilled and captured by the heading block.

Dress the taper on the face of the anvil


Stand the hot bar vertically in the heading block

Chamfer the corners in preparation to resist fire damage as you take the high heat needed for upsetting the bar


Upset the bar, working from either side of the heading block. Stop when the bar bends or flares too much

This capturing and chilling of the material prevents the lower section of the material from upsetting easily.

If you do not take steps to address this issue, the bar will upset more at its top and less at the bottom. This is not an outcome that you want, the bottom swage should have parallel sides post upsetting.

As the sledge will have it greatest effect at the point of impact and less effect lower down (as the bar is chilled and constrained), I'm going to heat the bar, so that it is cooler at the top and hotter at the bottom. To that end, I put the piece in the fire taper first.

Place the heated stock into the heading block so that the stock is perpendicular to the block, and rain upon it heavy blows from your sledge.

The peg will be driven down the square hole of the swage block a little. This action creates a parallel-sided square shank to the swage, which can be a good thing.

My sledge travels in an arc and not straight up and down, and I tend to pull the upset material towards me. To counter this, after half-a-dozen blows or so, I walk around to the opposite side of the block to work.

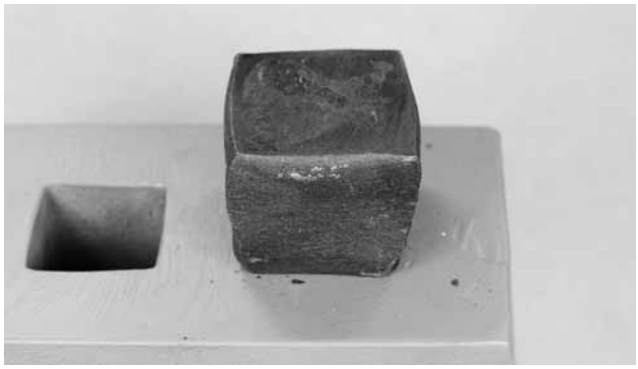
Working from both sides will help even up the effect that the arc of the sledge has on the work.

Use the bottom of the upset material as a gauge when looking for the time to go back to the forge. If the bottom looks overly chilled by the heading block or the top is starting to flare out, it's time to re-heat the bar.

Take the time to square the sides of the bar before putting it back into the forge – but only if

Dress the sides as they begin to flare

A final dressing of the sides and then top of the bottom swage



Stop upsetting when the sides flare too much

Then let this cook on top of the fire face down, peg up

the top of the bar is quite hot, otherwise do it at the top of the next heat.

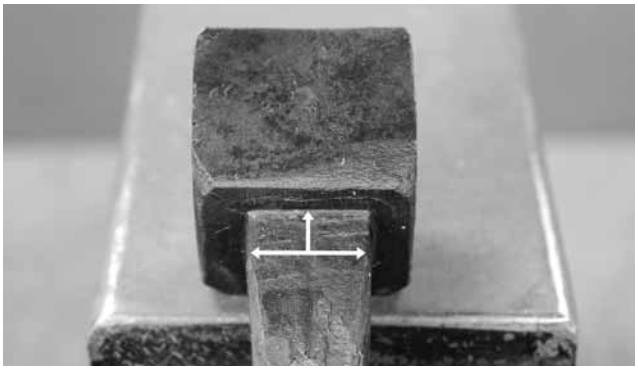
Dressing a cool bar can result in fish-lips being formed on the top surface of the stock.

Keep the peg held horizontally as you dress the block.

Once the sides have been dressed so that they are square with the world, continue to upset the material until you reach your desired dimensions.

Stop upsetting when the block is 1¼″ tall and about 1¾″ to 2″ square. I don't mind if it is taller than that—but it can be no shorter without becoming a pain to use.

Once you've got your bottom swage roughed out, place it peg up, block down, on top of the forge and slowly heat the block. Turn your air-blast down a little so that you do not burn the face.



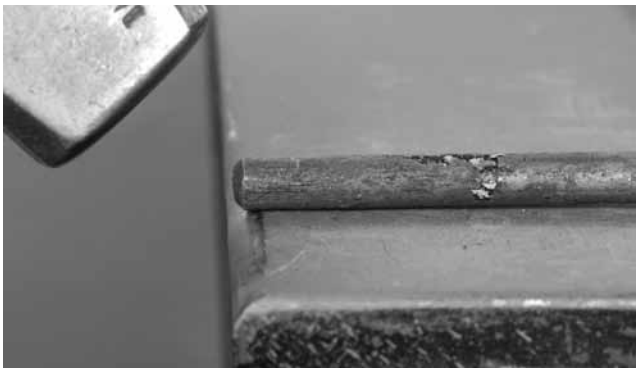
I'm hoping that you can see a section of parallel sided stock that was forced down into the heading block

I use a gas forge and make bottom tool blanks in sets of four

Put the end of one of your 6-inch long pieces of ⅜-inch round bar into the fire.

Quickly chamfer the edge at the side of the anvil and turn the end to form a U-shape, equal in size to the chain that you're making, over the bick or horn.

My chain has about a 1-inch ID at either end.



Quickly chamfer one end of a 6-inch bar and go to the bick

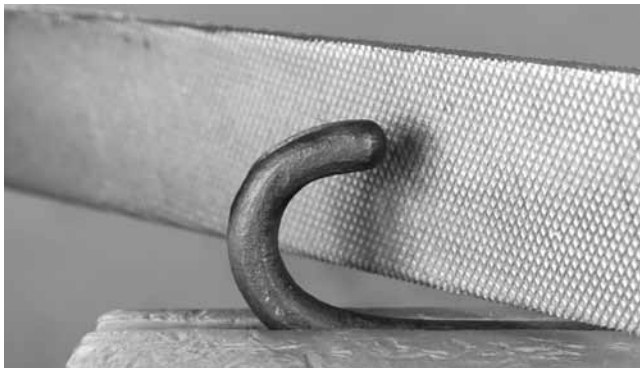
Turn the end over a 1-inch diameter section of the bick

Turn the piece over and finish from the top of the bick

Clamp the bar horizontally in the vise and rasp the end to a half-round. Consider coating the hot end with a little table salt (as a wetting agent) and quench! It should Pop! as you quench the end.

If you clamp the bottom of the U-shape vertically in the vise, you may not be able to rasp all parts at the end of the bar.

Hopefully, the bottom swage has heated fully as you made this 'tool'.



Hold the part horizontally in the vise as you hot-rasp the end to a half sphere shape. Quench on completion.

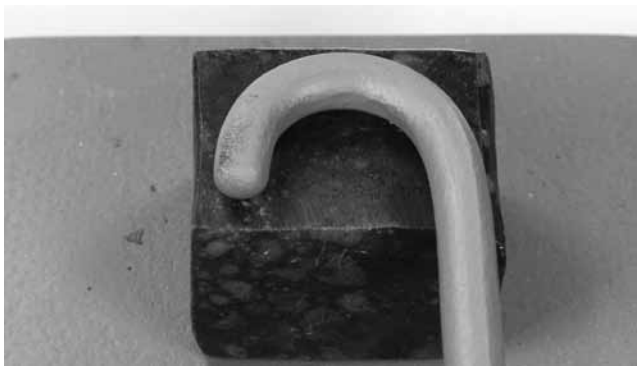
Place the hot swage into the hardy hole.

Drive your positive form into the swage. You want a shallow depression at the half round end of the U-shape, and a much deeper depression where the U-shape meets the parent bar.

The ⅜-inch diameter rod will be flattened on one side as you drive it into the swage block. I like this as it means that the indent will be slightly oversize of ⅜-inch.

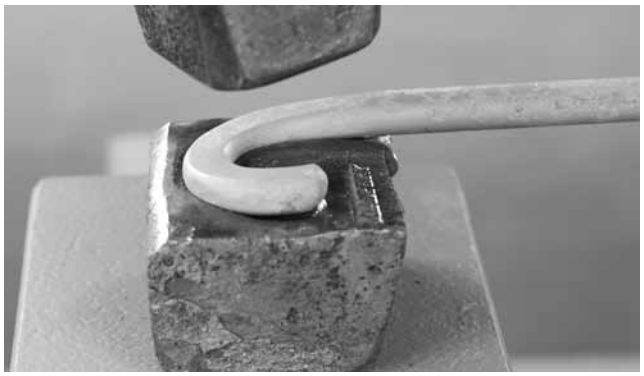
Drop your tong hand and chamfer the edge of the depression so that you do not gall the split link as you are forming it in the swage.

Give the swage a good brushing and casehardeen it to prevent excessive wear.



Heat the block and drive in the positive form.

Knock off any sharp edges from the swage



The depression should be the deepest on the straight-away and shallowest on the free end

The swage is fit close to the positive form to allow angled hammer blows during use

Changing gears, you can choose to now make the split link or the chain links.

As I've covered the chain links earlier, I'm going to focus on the split link.

Shown is a Box Store variety of a commercially available split link.

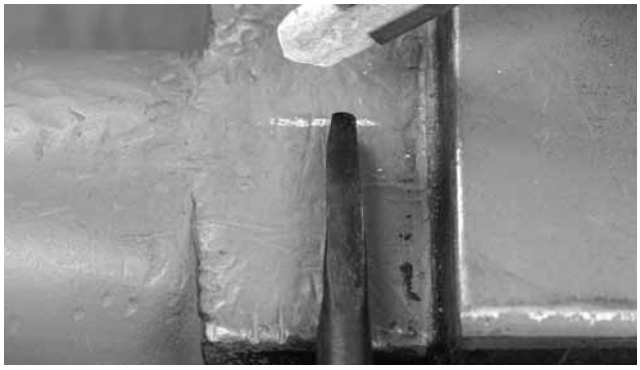
Draw a 1¾-inch long square taper to one end of the 6-inch long, ⅜-inch diameter, mild steel bar.

Dress the taper and forge to an octagon cross section.

Record both the square and octagon lengths on the step of the anvil for reference when working the other end of the bar.

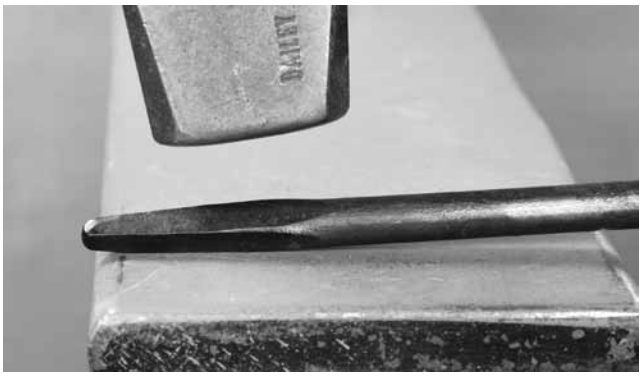
Don't bother making the taper round, as it will be further forged in the bottom swage.

A commercially available split link



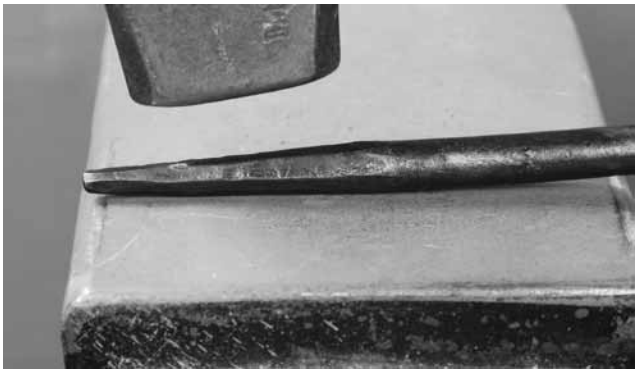
Record the actual length of taper on the step to aid in making the 2nd end equal

Draw a 1¾-inch long square taper to the end of the bar



Dress the taper and take to an octagon cross section

Do as much as you can on the bick before moving to the face of the anvil



Your taper should be around 2-inches long at this stage

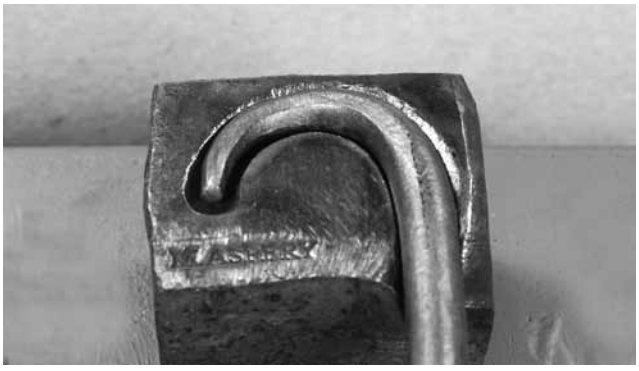
Turn the tapered end around the horn leaving it slightly open of a perfect U-shape, but do make sure that it is about 1-inch ID.

I've shown this bend below as the second bend on the bar, to demonstrate that the ends go to the same side of the bar, and do not form an S-shape.

The taper should fall along the centerline of the depression in the bottom swage and not fit to one side or the other of the depression.

Turn the taper around the bick

Leave the end slightly open of 180˚



The taper should run along the centerline of the depression - and fit not quite to the end

Flatten the taper into the bottom swage depression.

Flatten slightly more length of material than you think that you need (shown by the arrow in the photograph below).

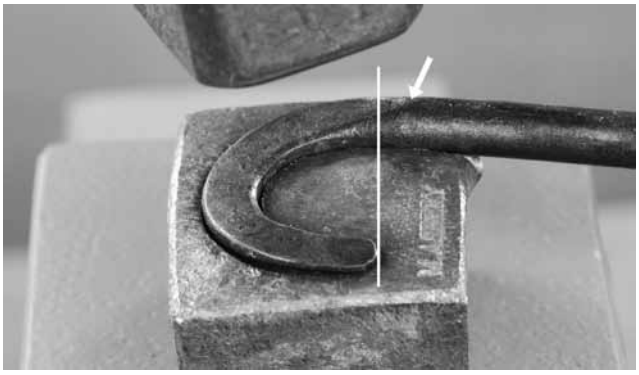
I prefer to have the end of the taper tucked in on the finished product, and not proud of the remainder of the bar.

Stop hammering when you see the depression filled or risk the chance of getting 'flashing' along the edge of the curve.

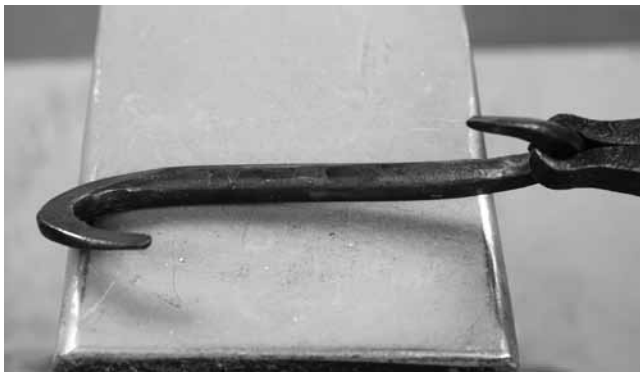
You will also note that when dealing with the second end, it is staggered or offset from the first end.

The offset ends help me when I turn the final link ready for application.

Control the two ends as you turn the link.



Flatten the link. I like to bring the forging up the bar a little, shown by the arrow



The ends are offset from each other. This is an advantage when turning the link

It is much easier to correct any problems now, as you are turning the link, rather than later, after the link is formed.

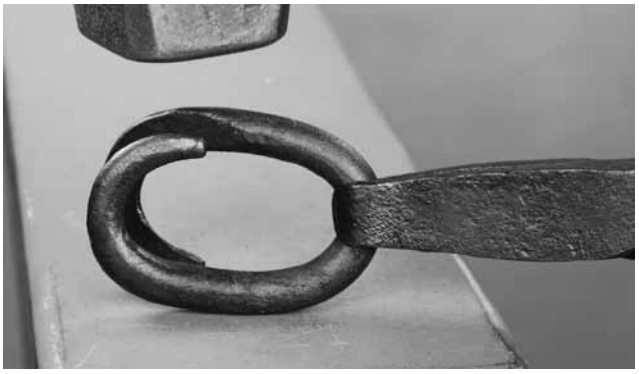
Tidy the ends and sides up at the bick and on the face of the anvil and either put it to the side of the forge, or if you have the chain links made, apply the links and set the gap.

I close this demonstration piece just slightly to stop the links from being separated, but open enough that people can see the details of the split link.

Give the links a good brushing - use a little water on your brush to pop the stubborn scale off the welds.

Wax, and keep it on your display board.

Turn the link over a 1-inch part of the bick



Dress the sides in if they need a little adjustment

Keep your eye on the two ends to ensure that they align

Set the gap to prevent losing the two chain links then brush and wax for display