Lesson #15 - Forge an eye on the end of a bar.

Definition: Altering the centerline of a bar.

Intent: To learn to forge a well-rounded eye to a specific diameter.

Tools: Anvil, hammer.

Material: 3/8" square x 24" mild steel.

Note

The reader is referred to two earlier articles in the Controlled Hand Forging series: (1) Bending Bar Stock by Jay Close, Hammer's Blow, Vol. 11, #2, Spring 2003, (2) Drawing, Punching and Bending by Peter Ross, Hammer's Blow, Vol. 11, #3, Summer 2003. Read these articles. They detail the forging dynamics and the process of bending bar stock. The directions in this lesson are not as comprehensive as the two previous lessons.

Step One

The formula to determine the length of material needed for the eye is:

\[ \text{Inside diameter of the eye} + \text{thickness of the stock} \times \pi = \text{length of stock}. \]

OR

\[ 2" + .38" \times 3.14 = 7.5", \text{ or } 71/2". \]

The numbers for this lesson are written using decimals. If you prefer to use fractions, 3 1/7" is used for \( \pi \) and 3/8" for stock size.

Tip: If you are overwhelmed by the mathematics, the same information can be gleaned from a full-sized sketch of the finished eye. Use a piece of wire or string along the median circumference of the sketch to get the needed stock requirement for the bend. Or step it off with dividers set at, say, 1/2 inch. Lifting dimensions from a drawing is an important skill to develop. Many forms—such as scrolls—will not readily submit to a mathematical approach.

Center a punch mark 7 _"_ from the end of the bar. There is more than one way to hold the bar while center punching. It may be placed in the corner of the anvil's step, or set on the vise with the jaws opened to slightly less than the diameter of the bar.

Step Two

Heat the entire 7 1/2" portion of stock, plus about another inch, to light yellow.

(a) Place the punch mark at the far rounded edge of the anvil with the punch mark facing to the side where you can see it and keep track of it.

Be certain to keep the bar stock horizontal and flat to the anvil face.

Strike next to the bend—not near the tip of the bar, and bend the bar down 90°. As you do this you will probably note two counter bends.

(b) The portion of the heated bar on the face of the anvil will likely have lifted slightly off the anvil in a counter curve. This is caused by the edge of the anvil acting as a fulcrum. As you strike down on one side, the bar levers up on the other. Forge down this unwanted counter bend without reducing the bar dimension.

If you have directed your bending blows near the bend itself, you will likely notice the tip of the bar curving up. The inertia of the bar's end is tending to keep it stationary as the remainder of the bar is forced to bend. The result is a curve like a reversed "J". Do not straighten this! Use it in the next step.
Step Three
Go to the anvil horn quickly to use the same heat as in Step Two.
Flip the bar over with the bent portion pointing up.
Raise the hand holding the bar high so you can place the tip of bar horizontally on the anvil horn.
The tip should extend over the horn about 1/4". You have a head start if the tip already has a slight bend (see Step Two).
To make it curve, strike the hot bar that extends beyond the horn. You are working on the side of the horn that is furthest from the smith. Do not pinch the bar between the hammer and horn, as that will not bend it. That will only reduce its dimensions by drawing it out.
Continue to feed the bar across the horn in short increments of about one half of an inch. Never strike the bar twice in the same place. Continue working in this manner until the hammer blows approach the point of the initial 90 degree bend of Step Two.
Inspect your progress frequently. Are you bending a sufficient curve? Is the curve too tight? You may need to go back to an already bent section of the eye for correction. Alter the position of your holding hand—raising it or lowering it—so that the correcting blow is as near vertical as possible.
Sometimes the eye seems to spiral like a coil. Pay attention to how it contacts the horn and how you hit it. Remove the coil effect with a flattening blow or two on the anvil face.
Note: A common error is to hold the hammer at such an angle that the hammer edge strikes the hot bar making unwanted dents. Only the hammer face is to strike the hot bar.
Depending on how the eye is forming, you may find it necessary to flip the eye so the termination is on the top-side of the horn. In this orientation the bending hammer blows will come on the side of the horn nearest the smith.
Note: Making such a bend is really a matter of approximations and on-going corrections.
With experience, this step can be completed in one heat.
However, the beginner should work for control and accuracy, not speed.
The eye is now formed, but may need further refinement.
Troubleshooting and corrections
- Look at the eye you have formed. Make mental notes if it is not true to your specifications. It may exhibit “kinks” where the
The curve is too tight and "flats" where it is too gentle.  
- To remove a kink, with the eye heated to a light orange, place the high spot of the kink on the top of the horn where the horn is wide enough to support the eye on either side of the kink. Sometimes you need to angle the work on the horn to get such a bridging effect with a small diameter. Strike the top of the kink, then make a note of any change of shape, i.e. not enough, too much, or just right. 
- To remove a flat spot, place the flat spot on the top of the horn so that the flat spot is supported. Gently strike the eye on the far side of the horn slightly past where the bar contacts the horn. 

Check your progress. Is the adjustment better, worse or just right?  
These techniques are also used to adjust the tip of the eye to meet the parent stock. 
- You may need to raise or lower the holding hand as needed to present the correction conveniently to the hammer. 
- The handle and its alignment with the eye may need correction. If so, first straighten the handle so you can accurately read its relationship to the eye. Once the handle is satisfactory, assess its alignment to the eye. The handle must point straight to the center of the eye. 
- If the eye is out of alignment, proceed by heating the area of the initial 90 degree bend. Lay the handle across the anvil with the bend on the far rounded edge and the eye placed so that any offset is up. Forge it down into alignment and then make any small corrections to the eye and handle that may be needed. 

**Targets:**  
- The eye has a 2" inside diameter, and has an error of no more than 1/16".
- The end of the bar that forms the eye is to touch the bend at the handle.
- No twists, kinks, or flat spots.
- The handle is to point directly to the center of the eye.