Forging Right-Angle Bends

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Lesson #25.

Definition: Forging Two Right-Angle Bends to a Desired Dimension

Intent: The student will learn how to make two right-angle bends with sharp outside corners in square stock, maintaining a small radius on the inside corner, with the corners a prescribed distance apart.

Tools: Basic forging tools: a hammer weighing about 1 1/2 pounds is recommended, steel square, center punch, twisting wrench (just in case).

Material: 1/2" x 1/2" square stock, 30 inches long.

In this lesson we will make two right-angle bends as noted in Figure #1. From the end of the bar that is visible to the outside of the next corner is 5 inches. The measurement from the outside of the first corner to the outside of the second corner is also 5 inches.

Step #1

In this step, you will be marking the bar in preparation to forge the first right-angle bend.

The target of this lesson is not only to form a proper square corner, but to make it in a desired location. Once completed, the measurement from the end of the bar to the outside of the first corner should be 5 inches. Make a heavy center punch mark on the bar 4 3/4 inches from one end. When forming the corner using this mark as a reference, the desired outside dimension will be achieved. This mark must be visible at a yellow heat in order to control the bending and forming of the corner.

The center punch mark denotes what will become the center of the bend when viewed from the side of the piece. Refer to Figure 1. The small diagonal lines between the inside and outside corners were originally center punch marks that were deformed when the corner was formed.

Step #2

The area that has been marked with a center punch should be heated to a bright yellow. Using water poured from a can, quickly localize the heat to a 2-inch long area, with the center punch mark in the center.

Safety note: Care should be taken to keep the hand away from the steam generated when localizing the heat.

With the bar lying perpendicular to the long axis of the anvil and the heated area located just beyond an anvil edge with a minimum of 1/4-inch radius, make an initial 90-degree bend by directing downward hammer blows to the end of the bar. If the bend was properly made, the result should look like Figure 2 when the piece is viewed from the perspective shown. The material should have no twist, have an inside and outside radius, and the center punch mark should be located in the center of the bend. A common error in learning this technique is to make the initial bend too sharp. This almost always results in a shut, or fold, in the inside corner. Twist can be removed by placing the bar in the vise (at an orange heat), appropriately positioning a twisting wrench, and making the necessary corrections.

Step #3

In this step you want to start transforming the bent corner into one that has a small (1/16-inch) inside radius, while the outside corner becomes a sharp 90-degree angle. Heat the corner to a bright yellow by placing the piece in the fire with the corner pointing downward into the center of the fire, and the end you are holding at a 45-degree angle.

Once the metal is at forging temperature, start forming a sharper corner by first hitting the area noted in figure 3A with light, rapid blows, followed by similar hammer blows delivered to the area noted in figure 3B.

It should be stated that the downward blows where the material is backed up by the anvil are more effective than blows delivered towards the hand. Therefore, more blows are required when striking towards the hand. Some references state 4 blows towards the hand for every 3 towards the anvil, but the important point is that the center punch mark remains in the center of the bend while the corner is progressing. Resist the temptation to upset the piece while the corner you are trying to form is against the anvil, as this only results in upsetting the material adjacent to the corner and does little to form the corner itself.
CONTROLLED HAND FORGING

Continue to deliver blows as described above, being careful to keep the areas on either side of the corner straight and free from twist as described previously. Correct these conditions as they are occur, for they will only worsen and make forging the corner more difficult. If possible, make corrections before returning the metal to the fire so that progress, rather than corrections, can be made at the highest temperature when the bar is next removed from the fire. Once the piece has cooled to an orange, it is time to once again heat the piece to a yellow and continue forging until the outside corner is sharp. There is a small inside radius of 1/16-inch, and all material has been forged to its original size of 1/2 x 1/2-inch square. When this has been successfully completed, the piece will look like the representation in figure 3C.

It is important to note the resulting dimensions of the bar at this point. The measurement from the end of the bar that is visible to the outside corner is 5 inches. Remember the initial reference center punch mark of the centerline of the corner was made 4 3/4 inches from the end of the bar. Understanding the movement of the material is key to forming these bends to a required dimension.

While the bar is cool, locate the bend for the second corner 4 3/4 inches from the outside corner of the first bend as shown in Figure 3D.

**Step #4**

Take a bright yellow heat and reheating as needed, repeat the process described in Steps 2 & 3. Refer to Figure 4. While forging the corner, the material near the corner upssets—that is, it shortens and therefore becomes larger in cross-section. This can be corrected by forging the stock to its original size, being careful not to reduce the section below its original dimension.

As stated previously, resist the temptation to upset the piece while the corner you are trying to form is against the anvil, as this only results in upsetting the material adjacent to the corner and does little to form the corner itself.

Once the outside corner has become sharp, make sure that the surrounding material is at its original dimension, the outside corner is sharp, the inside corner has a radius of 1/16-inch, the angle measures 90 degrees when checked with a square, and does not contain any twist.

Allow to cool and check dimensions of the piece. The result should match the dimensions and photograph in Figure 1 at the beginning of the lesson.

**Note:** When a bar cools it shrinks. Once formed, the measured dimensions will change as the material cools. Allowance for shrinkage is achieved by leaving the dimension longer than the finished dimension. For this scale of work, leaving the dimension 1/16-inch long while the piece is visibly red will result in a cold measurement that is very close to the intended measurement.

This degree of accuracy is not always needed, but knowing how to control the work to achieve a desired result is a valuable skill.

**Targets:**

The dimensions will meet the requirements of Figure 1.
The material will be free from twist.
All stock will be 1/2” x 1/2” square.
Uses for this technique—Primarily gate and grille frames.

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**Weathervane Bearing**

_Doug Hendrickson_
_Lesterville, Missouri_

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**Figure 4.**

The horizontal member must be balanced at this juncture, then braze it to the 1/16 black pipe.

Braze stub to the 1/16 black iron pipe.
Pack with grease when assembling.

Press-fit a short length of 1/16 copper pipe into the 1/16 black iron pipe here to act as a shim (due to differences in the sizes of the copper and iron pipes, the copper pipe will just fit inside the iron pipe).