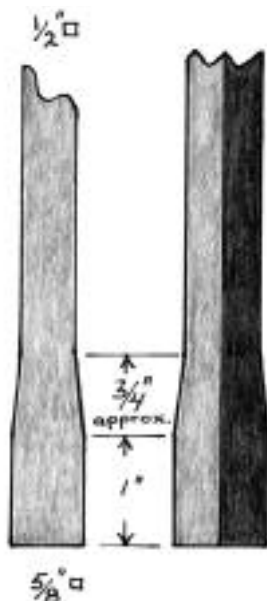


Upsetting



The finished shape

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Lesson Number Eight—Upsetting

Definition:

Upsetting increases the cross sectional area by deforming existing material instead of adding material.

Upset 1" of the end of a 1/2" square bar by 25% (drawing of finished shape)

Intent:

The student will learn the basic principles for upsetting the end of a bar efficiently, practice the methods, and be able to produce accurate results.

Tools needed: basic tools only, including a square

Materials:

14" of 1/2" square mild steel

Method:

The bar is hammered end-on. This shortens the bar and causes it to swell where it is hot.

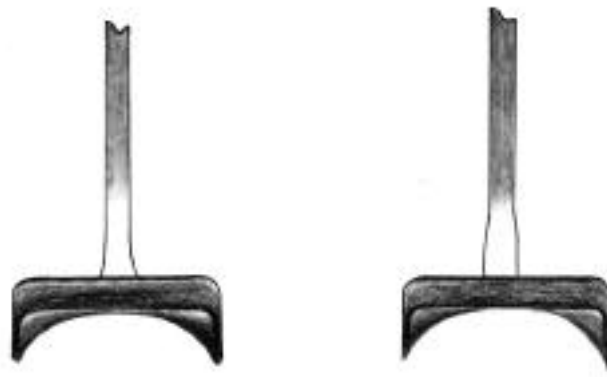
In order to work efficiently, the following conditions must be met:

1. the bar must remain straight.
2. the bar must be at a very high heat
3. the bar must be hit hard

Managing these factors is more difficult than it might appear. This is one process where almost everything works against you. Since hot steel bends so easily, it is very likely for a bend to start even while striking on end. Once even a little bend starts, almost all upsetting ceases and the blows simply cause more bending (If you have ever tried to drive a nail once it has bent even a little bit, you will understand the situation).

Very little is accomplished unless the bar is at its softest. At a medium orange heat or below, results are almost negligible. Therefore, it is crucial to start at the highest heat and work quickly.

As a practical example, try to make a small section of rope swell by pushing from both ends. If you hold too far apart, the rope will bend. It only swells when you keep everything straight and localize the work area. Also, compare the resistance between upsetting and bending the rope. It will bend with much less force. This illustrates the necessity of following the three requirements when working steel.



Upsetting with lighter vs. heavier hammers

Factors to consider when upsetting:

1. The size of the hammer affects the results. A light hammer can be used faster, but since it has less mass, the blows work only the very end of the bar.

A heavier hammer will have a deeper effect.

If too heavy, the hammer cannot be used fast enough; adding extra heats. For this exercise, a hammer between 1 1/2 and 2 pounds will be adequate.

2. The length of the heat is very important. If too long a heat is taken, the bar will bend rather than upset.

3. The end of the bar affects straightness. Even though the end of the bar will deform during upsetting, how it looks at the start is crucial. If the end is not square to the bar length, the first blow will cause bending. Additional blows only exaggerate the condition.



A bar end that is out-of-square causes bending

If this continues, there is no easy way to correct the problem.

The likelihood of any smith holding and striking the bar perfectly plumb every time (or even once, for that matter) while working as quickly as possible is slightly less than winning the lottery. Most experienced smiths count on the bar bending frequently. There is almost no way to prevent this. The object is to notice bending as soon as it occurs and correct it right away. The sooner a problem is noticed, the simpler (and faster!) the correction can be made. This sometimes means only one or two upsetting blows between straightening, so the key to upsetting is to work quickly and make constant corrections.

4. How solidly the bar is supported will determine the effectiveness of each blow. A bar backed against the anvil will upset much faster than one supported in the hand.

A bar can be held in the vise for upsetting. However, there are some serious drawbacks to this method. For one thing, the vise will pinch the bar (especially at very high heat) and leave scars. For another, it is awkward to straighten a bar while it is clamped in the vise. Proper straightening is best done at the anvil, and it is quite slow clamping and unclamping the work every two or three blows. Finally, the vise is an effective heat sink, and cools the work appreciably.

5. You have the choice of holding a short bar with hot end up or down. If down, the length of the bar absorbs some of the blow, so less is accomplished. If the hot end is up, the blows fall directly on the heated end, which is good. However, it's much harder to hold the upper end steady if you grip at the bottom and strike at the top. You will also get many scale burns on your wrist. Holding the cold end up with the heated end down on the anvil face is the best compromise.

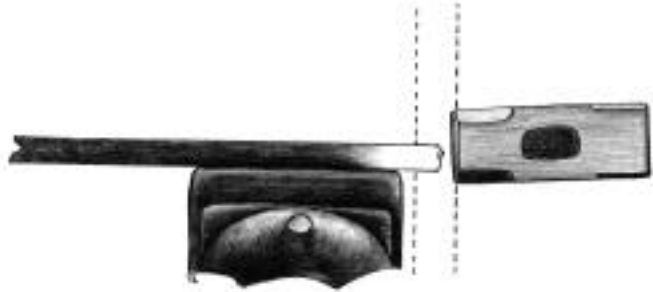
Note: it may be tempting to use tongs to hold the bar, enabling you to hold the hot end up after all. This sounds like it solves all the problems, but in fact it can slow down the quick changes from upright to straightening to upright so much that extra heats will be necessary. It is better to learn the proper hand grip method.

Step One:

If you are starting with a bar with an uneven end, you must square it first. To do this you will upset the very tip of the bar. Since only a small area is to be worked, you can usually do this

easily in one heat. Hold the bar so that the hot end projects beyond the far edge of the anvil an inch or two and strike the end of the bar. You will be hammering almost directly towards yourself and bracing the cold end of the bar against your thigh. Remember to keep straightening as necessary until the end of the bar is square to its long axis and the original dimension (in this case, 1/2" square). Check with your square if necessary.

Note: it is possible to start with a bar that has been cut hot on the hardie, but only if it has been cut evenly from all sides; leaving the resulting burr centered on the cut end. After the first one or two upsetting blows the burr will be gone. An uneven cut will leave an off-center burr and this will guarantee bending.



Bar and hammer in position.

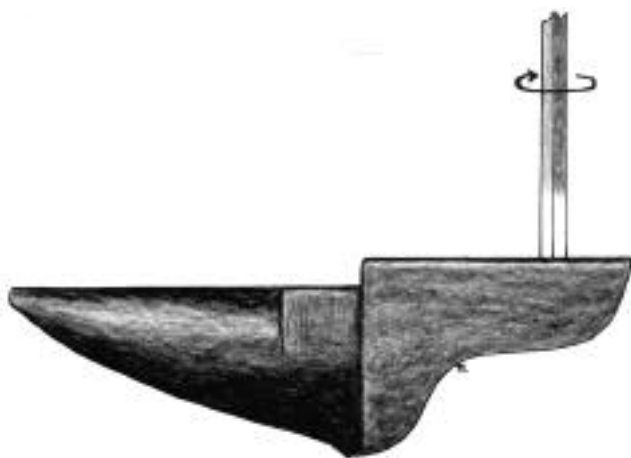
Now for the real work. Take a near welding heat on the end of the bar. It is important to heat only 1–2 inches. Even with the best of intentions, the heat is sometimes too long. In this case, quickly quench all but the area to be upset. The fastest method is to submerge the long end of the bar (along with your arm) in the slack tub. This works well with a short bar such as the one in this lesson. If you move the bar around in the water it will cool even faster than holding it still. Remember, wasting time at the tub means the bar will be much cooler by the time you are ready to strike. Best results come from heating the bar correctly so you can go directly to the anvil.

Target:

If you have taken a good heat, you should be at the anvil and ready to strike within 1 or 2 seconds. If quenching is necessary, try to take no more than 3 or 4 seconds from fire to striking the first blow (beginning of step 2).

Step Two:

Hold the bar upright on the anvil and strike the upper end two or three quick, hard blows.



Holding the bar on the anvil top

Look frequently at the hot end as you are working. As soon as you see the bar bending, stop upsetting and straighten, using as few blows as possible. Overzealous straightening can lead to drawing out the bar... negating your progress. You do not need to get the bar perfectly straight, but close.

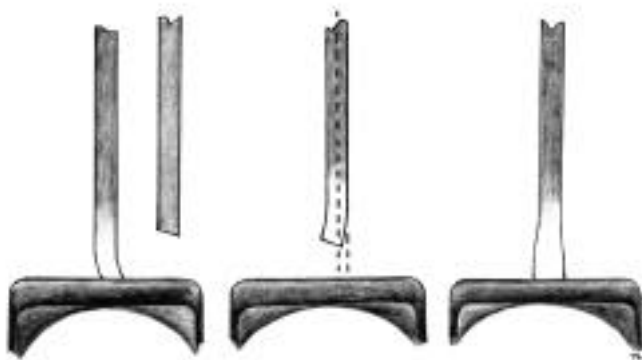
As soon as possible, return the bar to upright and strike two or three more upsetting blows. Continue in this manner until you have slightly exceeded the target dimension, taking additional heats if the bar cools below a medium orange.

Note:

While checking for straightness, remember also to keep watching the end. If you see the end of the bar going out of square, you must stop upsetting and correct as illustrated in step 1.

What can be done to minimize the time used in straightening? Many smiths will rotate the bar 1/4 or 1/2 turn between blows to keep minor mistakes from compounding.

Occasionally, a correction can be done without much interruption. If the bar end goes out of square and causes a bend, bending the bar in the opposite direction will address both corrections (straightening the bar, and squaring the end) at once. Remember, reducing the interruptions to actual upsetting means fewer heats to accomplish the goal. Every second saved counts.



Correcting an end that is out-of-square

Step Three:

Smooth and straighten the upset area, being careful to draw the bar just to size. A lower heat (dark orange to bright red) is best for this step.

Check the bar dimensions to confirm it is square in cross section, straight, and proper size (5/8"). Correct as necessary (see lessons on drawing, straightening, bending)

Target:

With practice this exercise may be accomplished in one heat, though a beginner may take two or three at first. The finished upset section should be within 1/32" of the intended 5/8 thickness and the bar should be straight and square.