Lesson #11- Drawing Down- Part One

**Definition:** Reducing the cross-sectional area of a bar.

**Lesson:** Resizing a 1/2-inch square bar into a 1/4 by 5/8-inch rectangular bar by hitting the bar “on the flat.”

**Intent:** This lesson is a first practical experience in hand forging. The student’s primary mission is to strive for good technique: proper fire maintenance, good heat selection and use, and relaxed and effective hammering.

After familiarity with the process, the student should be comfortable working a bar linearly, from one end to the other, with minimal reheating of finished sections.

The student will also practice correcting twist and crookedness in the bar and gain experience working to given dimensions.

**Tools:** Basic tools are needed. Include a straight edge and a double caliper. Lacking a double caliper, two outside calipers can be substituted. Set one caliper to 1/4 inch, the other caliper to 5/8 inch.

**Hint:** An easy way to repeatedly set your calipers accurately is to set them to an unworked bar of the target dimension. Collect an array of short bar sections that become your shop’s standards for setting caliper dimensions.

**Material:** 1/2-inch square mild steel about 24 inches long.

**Method:** The bar is heated in sections and each section resized by hammering flat on the bar face. Each section is finished before moving to the next. Corrections to the bar are carried out as needed. When half of the bar is resized, it is turned end-for-end and the resizing continued from the middle where the work left off.
Step One

Review the earlier discussions on hammer selection, the ergonomics of forging, fire maintenance and shop safety.

Place the bar horizontally in the neutral part of the fire.

The tip of the bar will heat more quickly. Place it beyond the fire's hot spot and let the heat of the bar radiate to the end.

1. Bar placed in the fire horizontally, with the tip beyond the hottest part of the fire.

To speed heating, keep the fire built up on the sides and keep the bar covered with loose coke. You should still be able to monitor the heat of the bar through this coke layer.

Heat no more of the bar than you can work at any given hammering session, perhaps three or four inches of the bar.

At a yellow or light welding heat, get the bar to the anvil where your hammer is waiting. The bar will never be hotter and never be softer than when you first take it from the fire. DO NOT WASTE TIME GETTING TO WORK.

Hint: Set your hammer in the same place on the anvil and in the same orientation, ready for each heat. This minimizes confusion and wasted time.

With the bar held horizontally and flat on the anvil, with the hot part in the middle of the anvil face, hit FLAT, HARD, and RHYTHMICALLY.

Hint: Regardless of the length of the heated section of the bar, only work on as much of the bar as you are able to completely resize in one or two heats—probably no more than two or three inches.

The first blow inevitably creates an offset or step in the bar on one side. Keep the bar horizontal.

Hit HARD four or five times on the top, then roll the bar 180° to work the surface that had been against the anvil.

Try to roll between hammer blows with no interruption of the rhythm. Keep the holding hand relaxed to help you quickly and assuredly manipulate the bar.

When you flip the bar 180° degrees, the offset created by your work on the first face keeps the bar from sitting flat on the anvil. This is unavoidable, but your first blows on the new side will push the metal down to contact the anvil.

Hold the bar horizontally. Resist any tendency to raise or lower the holding hand.

4. Step created by drawing part of the bar down. Bar is rotated 180° and kept horizontal as drawing continues.

As the re-forged section lengths you can sometimes hang the unworked section of the bar off the anvil face and still be working toward the middle of the anvil. This will help you keep the bar horizontal.

Take four or five blows on the new face, then work the edges of the bar. Smooth them and note the effect of your hammer blows. You may need to adjust the strength of the blow because you are hitting a narrower surface. On the other hand, if these edge blows become too light, you risk the development of an I-beam cross-section to the bar. See the discussion in Part Two of this article under "Forging Dynamics," in the next issue.

Work all sides of the bar. Alternate heavy flattening blows on the faces of the bar with blows needed to refine the edges.

Develop a rhythm. For example:

five hard blows on one face.
roll the bar 180 degrees and hit five hard blows on the opposite face.
roll the bar 90 degrees, work the edge.
roll the bar 180 degrees, work the other edge, and repeat.

Hint: The tip of the bar heats fastest and reshapes easiest. There is danger of over-thinning the end. Forge the tip when the bar is slightly cooler and offers more resistance.

If you reach an orange heat and are far from the target dimensions, put the bar back in the fire. Keep it soft.

Take a second heat on this section and continue forging.

Note: If you have been unable to complete a section of the bar by the end of the second heat, think about why this is the case. Are you not hitting hard enough? Perhaps you are spreading your efforts over too much bar? Did you start at a yellow heat to maximize softness and available time? Are you wasting time through ineffective hammering or taking too long to get to the anvil?

Intelligent analysis and self-correction are the foundations of progress as a blacksmith.

If you near finished dimensions at an orange heat, make a check with the calipers and continue working to a dull red. The bar is much stiffer now and resists shape change. That is fine for lighter, smoothing blows.
The calipers should just slip onto the bar and glide over the surfaces without rattle or feeling sprung open. With practice you get a sensitive feel for dimension by use of these simple tools. Remember, unless the caliper points are opposite each other on the bar, they will not measure accurately.

As you smooth, pay more attention to the texture your hammer leaves. If you:

a) Maintain a clean, scale-free anvil face
b) Do not overheat the bar
c) Work all sides of the bar, and
d) Work all sides down to a dull red heat,
You can achieve a clean, hammered surface.

Often it is convenient when forging a long area to keep the hammer hitting in one spot on the anvil and work the bar back and forth beneath it. This can be particularly effective when working toward a smoothly hammered surface.

Hint: You may notice that the side of the work held against the anvil (if the anvil surface is clean) often appears smoother than the flat you are hammering. The broad flat of the anvil naturally creates a smoother finish than the hammer. Use this to your advantage, working each flat equally against the anvil as the bar approaches dull red.

Use the available heat wisely. The first part of the heat when the bar is softest is for the major shape change, the latter part of the heat is to refine the shape, smooth the surface, straighten the bar and get it ready to put back in the fire.

If this is your first experience at the anvil, the actual dimensions you achieve are almost irrelevant. You have been focusing on and learning much else. If on your first try you have resized a section to an even rectangular shape with straight sides, this is a significant achievement, but it is only the beginning.

After one or two repetitions of this lesson, set goals for yourself. Check each section as you complete it with the calipers and hold yourself to their target dimensions before considering a section complete. This is mostly a matter of self-discipline.

Final evaluation will wait until after the bar is cold.

If you have completed the first section, you can now heat the next area. Work in a linear fashion, one section complete before moving to the next. This is a key to efficient forging.

In preparation for another hammering session, before the bar goes back in the fire, straighten it as best as you can. Put your hammer in its “ready position,” put the bar back in the fire and finally wipe the anvil surface clean of scale.
Step Two

When reheating, push the finished bar section through the fire into a cooler part of the coals. Concentrate the heat on the area you will be working.

With another yellow or light welding heat on the bar, continue forging the next heated section. Remember your rhythm: hit HARD on the bar face four or five times, roll the bar and hit HARD on the opposite face. Forge the edge, dressing it straight. Roll the bar and forge the opposite edge, and repeat as needed.

After each session at the anvil, check dimensions. If oversize, keep forging. If undersize the bar can be upset to thicken it, but that is another technique and another lesson. For now, take note of your mistake and resolve to do better on the next section.

Keep the bar straight as you work. It makes manipulating the bar less awkward.

As you feel more comfortable with the reshaping, set some goals as you work. Determine how much of the bar you can complete to final dimensions in one or two heats. Once you can do that consistently, push your limits and see if by hitting harder or faster or using a higher heat you can get more done. Discipline yourself; challenge yourself.

As more of the bar is reshaped, watch for twist.

Note: Twist is the result of not holding the work flat on the anvil. The holding hand (left hand for the right-handed smith) rotates, raising the edge of the bar slightly off the anvil. When this slightly raised edge is struck, the bar twists. If not corrected, multiple, small repetitive errors create a major deviation from flat. Knowing how twist develops allows you to correct it as you forge compensate with a purposeful cant to the opposite side.

Step Three

When half (or a bit more) of the bar has been resized, the end that you started on will be at a black heat. Further cool that end in the slack tub.

Hint: If you find that the end you hold gets uncomfortably hot as you work, cool it periodically in the slack tub. If this problem is chronic, you are taking too long to reheat the bar, allowing more time for heat transfer. Remember:

a) Heat in the hottest, neutral part of the fire.
b) Keep the fire built up around the work.
c) Cover the bar with loose pieces of coke; and
d) Do not let the fire grow bigger than necessary.

Flip the bar end-for-end so that you are now holding the resized end in your hand. Continue to work down the length of the bar starting where you left off in the middle, reforging section by section until complete.

Targets

Shape targets

The bar must be straight. Without experience it is difficult to judge this by eye. Use the straightedge as an eye-training tool.

Put the bar in the vise with one flat up. Hold the straightedge on the flat of the bar and peer along the contact edge backlit by a strong light source, like a window. In even the best work you will not notice full, light-blocking contact. What you should see is an even pattern of contact from one end of the bar to the next.

Sometimes the straightedge rocks or pivots on a high spot. If a corresponding low spot exists opposite, then you have identified a bend in the bar.

If the straightedge pivots on one flat and at the same relative place on the opposite flat, you have identified a bulge in the bar. This is more of a dimensional issue than a straightness one.

Take note of the width of any gaps between the straightedge and the bar. The eye can see light through an opening as small as a thousandth of an inch. A gap that is more than 4 or 5 thou-
sandths can appear huge. We want to keep overall dimensional tolerance to plus or minus 1/64 of an inch. Use the feeler gauge to check the gaps. How small a problem can your eye easily see? If you have such a large gap, check the area with your calipers. Does the gap exist because of a bend in the bar? Or does the gap exist because the bar is too thin at that spot? The bend can be corrected easily. The thin spot will need to be upset. For now it is best to “split the difference,” thinking about straightening the bar along an imaginary axis line so the mass is equally distributed around that axis, regardless of “thicks and thins.”

Before doing any corrections, sight down the length of the bar and test your eye judgment. Can you see the problems that the straightedge picked up? If not, keep looking, using the straightedge to guide you. Occasionally turn the bar and look from the other end.

Hint: Changes in thickness, a twist or an uneven edge of the bar can cause the eye to see a bend where none exists. Addressing these problems is rarely a neat, step-by-step process. You will often work back and forth among bends, twists and dimensional problems.

Do not become wedded to the straightedge and feeler gauges. Use them to train your eye so that you do not rely on them any more, but the straightedge, in particular, will never be completely discarded.

Test all four flats of the reshaped bar. The bar must be free of twist.

Bends and twists are first cousins. Some bends are localized twists and a twist in the bar can easily deceive the eye into “seeing” a bend. Eliminate twist before doing your final corrections for straightness. The goal is to learn to see twist without aids, but until that time make use of a pair of “winding sticks.” A couple of straight sections of bars 1/4" by 3/4" and 8 or 10 inches long will suffice.

Lock the workpiece in the vise, grabbing it on the edges with the face of the bar above the vise jaws. Balance one winding stick on the upper face at one end of the bar and the other on the other end. Sight over these sticks. Are they parallel to each other? If not, the two areas where they lie on the bar are not in the same plane, i.e., the bar twists. Move the stick at the far end of the bar a couple of inches toward you and sight the sticks again. Continue testing the whole length of the bar. Without the winding sticks can you see these twisted areas? Test yourself— it is the only way to learn.

Dimension targets
In a simple resizing exercise such as this, you should be able to work to plus or minus 1/64" in width and thickness of the bar. In other words, there could be as much as 1/32" of an inch dif-
Texture targets
One of the hallmarks of skilled work is the quality of the hammered finish. On your resized bar you want a smooth, even texture. No one hammer blow should jump out as distinct from the rest. Likewise, the surface should be free of loose scale and from evidence of overheating. Comparing your work to the photos will be the best initial guide to evaluating its texture.

Time targets
For your first efforts, time is largely irrelevant. Going through this exercise a few times, you ought to be able to reforge two inches of the original bar to final size in two heats.

This article will continue with Part Two- Straightening- in the next issue of the Hammer's Blow.

17. Winding sticks placed on a bar.

18. Sighting winding sticks to locate twist.