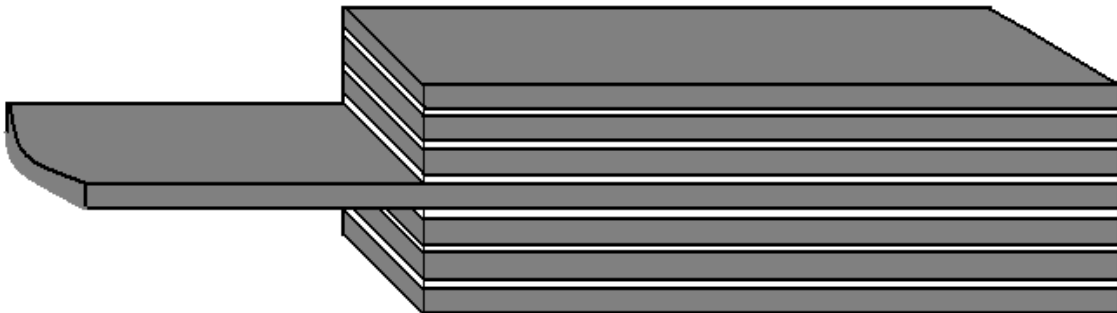


## Damascus (Pattern Welded) Steel

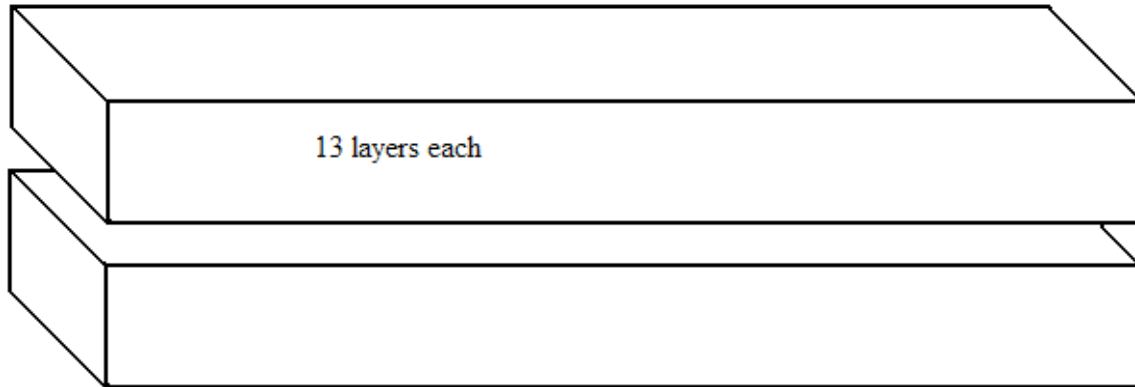
Laminated Damascus steel had its origins in the early days of the iron age. It was found that by folding and welding iron in a carbon fire you could produce steel, a hardenable iron product capable of producing superior tools and weapons. Nearly every culture in the world developed some form of laminated steel, including Vikings, Malaysians and Japanese.

Forge welding is the core technique involved in creating Damascus steels. It is a solid-phase bonding technique that uses heat and pressure to make the weld. To make Damascus steel the current method is to stack alternating pieces of steel, each with a contrasting composition, heat the billet in a fire and at the proper temperature apply pressure to make the weld.

In my method of making Damascus steel, I usually start with thirteen layers – stacking them by alternating seven pieces of 1084 steel with six of 15N20 steel as shown in the drawing below. 1084 is a high carbon content steel while 15N20 has a high nickel content allowing for high visual contrast between the metals in the finished blade. These pieces are usually one inch wide by five to six inches long, with the 1084 being a quarter inch thick and the 15N20 being a sixteenth inch thick. The center piece of 1084 is left long to use as a handle. To hold the stack together I run a bead of weld along each end with an arc welder.



Once the billet is prepared, I fire up the gas forge to about 2700 degrees and heat the billet thoroughly. Flux is added to the billet to remove contaminants within the layers and to prevent oxidation of the steel. At 2700 degrees the pieces of the billet will weld to each other under light pressure such as hand hammering (this is called forge welding). Once the pieces are welded together we have a solid piece of steel. At this point the piece is hammered out (drawn out) to twice its length, cut in half, cleaned on a grinder, stacked and arc welded together with a handle, and the forge welding process repeated. This process doubles the number of layers – in this case from 13 to 26 as shown in the drawing below.



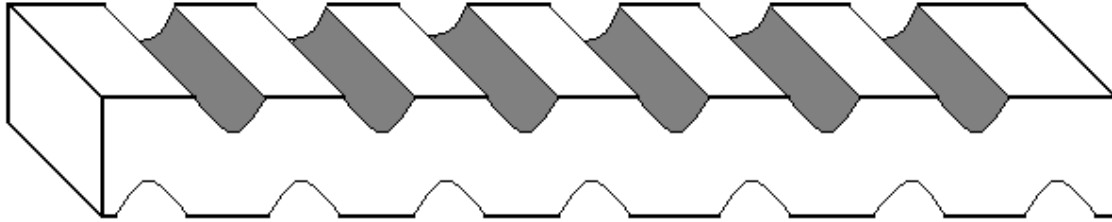
The third time I weld I usually cut the billet into three pieces and forge weld them together – increasing the number of layers from 26 to 78 layers. Then two more doubles and welding results in a billet with just over 300 layers. Because of the necessity of cooling the billet between each doubling (necessary to cut the billet in half, grind it clean and arc weld up the next billet and handle) this process usually occurs over several days with each individual forge welding process taking one to two hours.

At this point we have a solid billet, usually about one inch square and ten to twelve inches long, of about 300 layers. If we were to make a knife from this billet, the steel pattern would be Random, reflecting the distortions resulting from hammering the steel to shape the blade. Other more interesting patterns are possible, and the possibilities are endless.

When the Damascus billet is finished, it is forged into a knife. Once the blade is forged, it is ground on a grinder and then hand finished to produce the finished blade. At that point, the blade is etched in ferric chloride acid to reveal the pattern of the steel laminations (the 1084 is etched deeper than the 15N20 due to their different composition). This process and subsequent polishing reveals the Damascus steel pattern, after which a guard and handle are added.

### Ladder Pattern

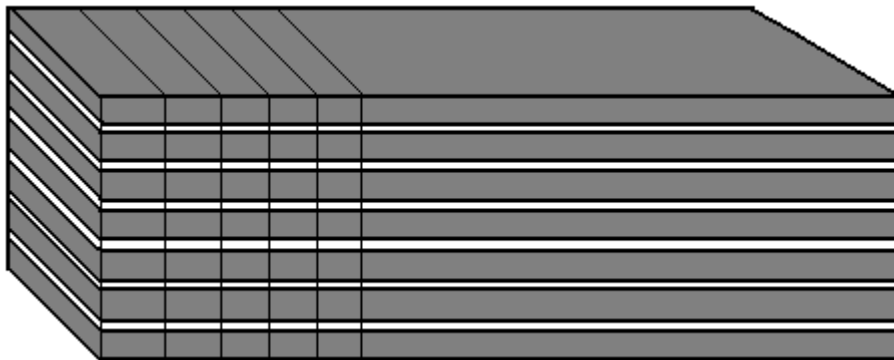
The ladder pattern is made by filing or milling grooves across both sides of the billet to approximately one-third of the depth. If the billet was 300 layers, this would cut through about 100 layers, as shown below.



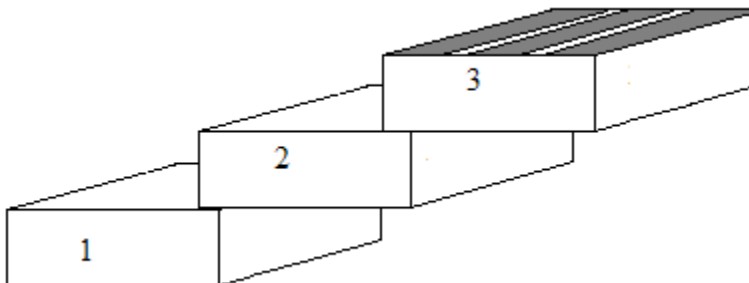
The billet is then reheated to welding heat and flattened, bringing the layers exposed by the grooves to the surface for display in the finished knife.

### Vertical Pattern

The vertical pattern is made by starting with a 1-1/4 inch square billet of about 75 layers. This billet is then cut into 3/8 inch slices (see below).



The resulting slices are then rotated so that the layers go up and down, overlapped as below, welded together where they overlap with a drop of weld, and forged welded into a solid piece.



After forging, this piece is now about 1/4 inches thick by 1 inch wide and as long as the number of slices you welded together. When a knife is made from this new billet, the resulting pattern is one of vertical lines from the spine of the knife to the edge.

### Water Drop Pattern (also called Bird's Eye pattern)

The water drop pattern is made by drilling various sized (or all the same size) holes on the surface of both sides of the billet about one-third of the depth. The spacing of the holes can be random or regular, depending on the effect desired. Once drilling is finished, the billet is reheated and flattened, bringing the layers within the holes to the surface for display in the finished knife.

### Twist Patterns (also called Maiden's Hair)

Starting with a billet of 312 layers, the billet is heated and rounded into a long cylinder about eight inches in length by one and one-half inches in diameter. This cylinder of steel is then heated and twisted (think of a candy cane twist) at a density of about one twist per inch of length. The billet is then reforged into a square billet from which a blade is forged. Once the blade is finished and polished, the Damascus pattern appears on the side of the knife as lines running from the edge to the spine of the knife at forty-five degree angle.