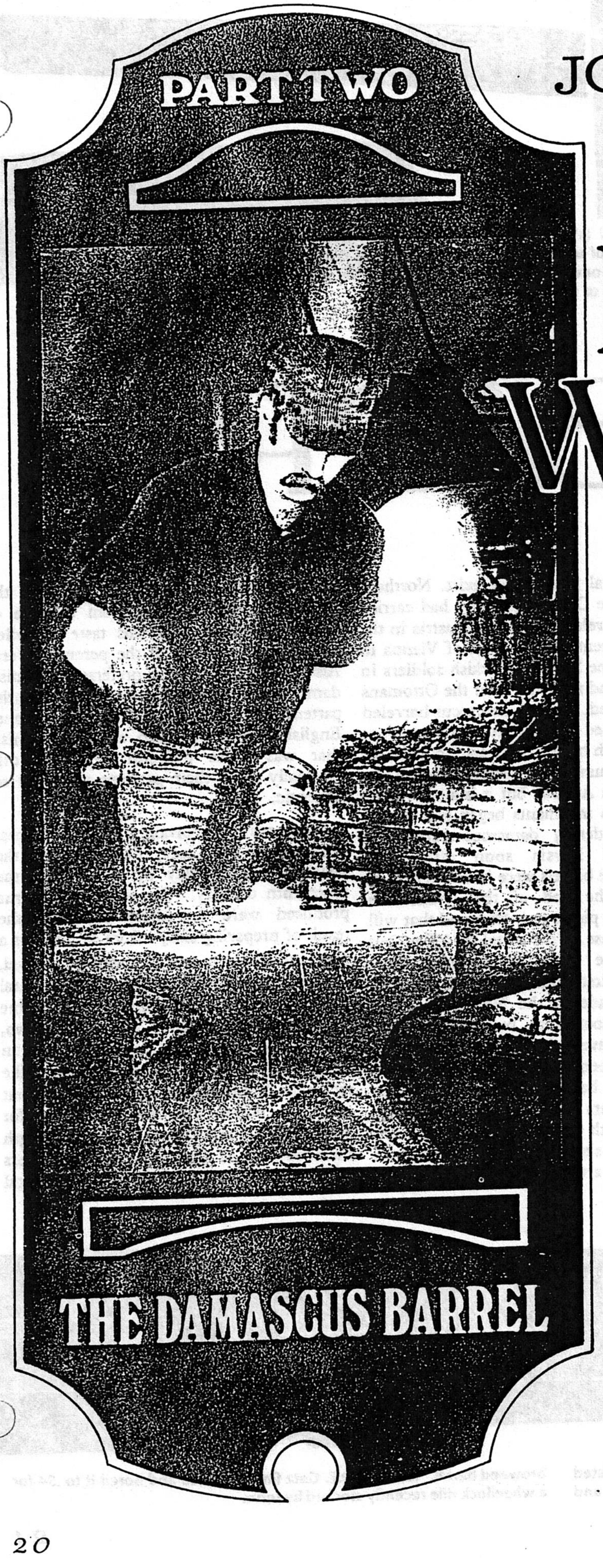


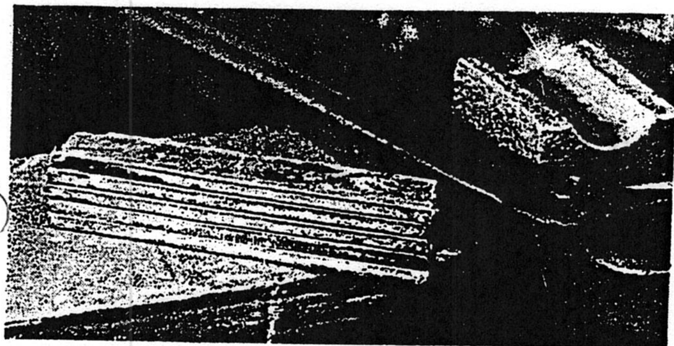
JOHN BIVINS:

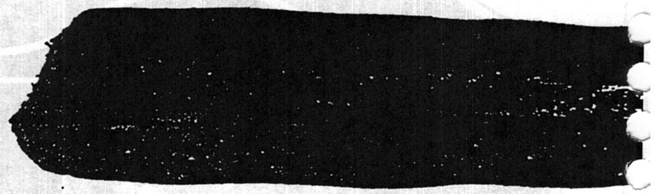
THE FORGE-WELDED

IN *RIFLE* 64, WE TOOK a brief look at the production of a plain-skelp rifle barrel, using methods typical of the eighteenth century and before. In this issue, we'll see how one young man working now has managed to successfully forge damascus barrels equal in beauty to fine originals.

Most of us think of shotguns when we think of damascus, but during the muzzleloading period in Europe, particularly during the eighteenth and nineteenth centuries, fine-quality rifles ranging from wheellocks and "jagers" to elegant London-made percussion sporting rifles were fitted with exquisite damascus barrels. A long-standing project of mine has been a late seventeenth-century-style buttstock wheellock, and I was determined to have a damascus barrel for it when I discovered a fellow a few years ago who was experimenting with the process. He'd made a small damascus cannon barrel, a sight that damned near left me speechless. I usually can find many reasons for wending my way to the Fall Nationals at Friendship each year, but meeting artisans following such pursuits are by far the most important reason to me for making that long drive. More on that later.

The term *damascus* when applied to gun barrels is actually a misnomer. True Damascus was actually a high-carbon steel that came into use some time during or before the sixteenth century. It had an international reputation for its use in sword blades, and the best of it was ultimately wrought in Persia. The actual raw material was at first made in India in the form of *wootz,* a primitive form of cementation steel actually made in the forge by using the charcoal fuel of the fire as a source for carbon. The charge comprised both wrought iron and cast iron; this alloy was brought to a heat above welding temperature, the mixture actually melting down. However, the forge fire couldn't be taken to a temperature high enough for a complete melt, and consequently the resulting alloy had areas of differing carbon content. When the steel was refined by forging, wrought into blades, and then etched, the differing amounts of carbon present showed up as "watered" pattern in the steel.





The "pile" is three layers of wrought iron and two of steel (above), welded together and drawn out (upper right). If skelp is to be made of untwisted piles, each pile is cut in two on the anvil hardy, stacked, and welded once more (right). Untwisted patterns were common in English damascus barrels of the eighteenth and nineteenth centuries.

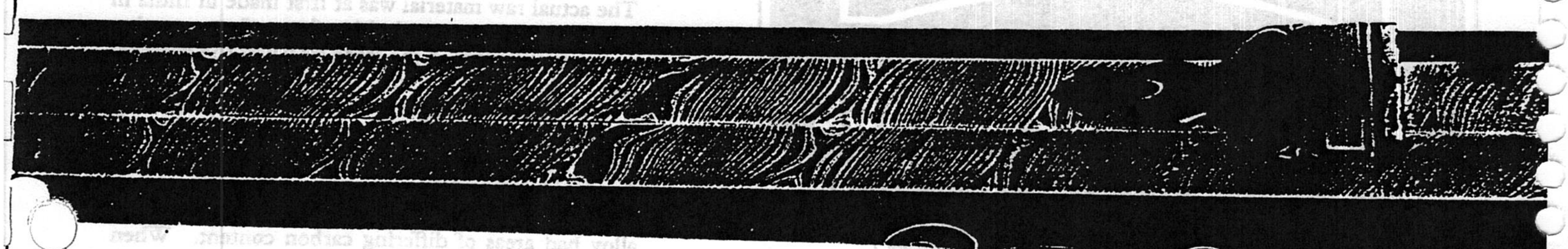
RIFLE BARREL

Damascus was difficult to work, possibly because of its high carbon content; it was prone to shearing under the hammer.

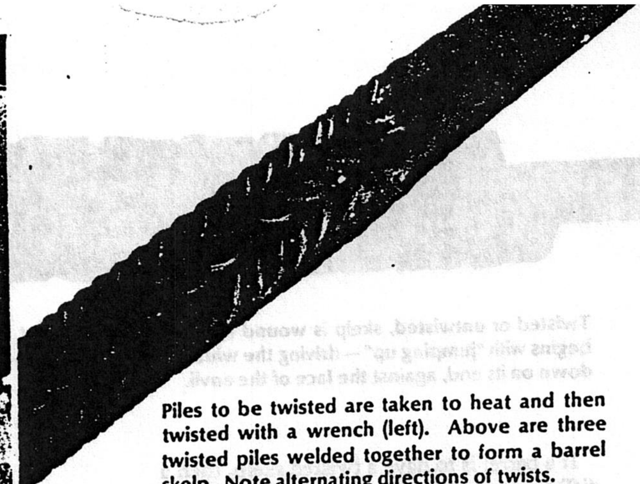
Quite in contrast with true Damascus steel was welded damascus such as that used in gun barrels, and it wasn't a steel at all but a welded material that combined sections of both iron and steel. For gun barrels, sixty percent iron and forty percent steel became a norm by the nineteenth century. The process of making welded damascus (used here with a lowercase *d* to differentiate from true Damascus steel) apparently originated in the Near East by the sixteenth century. Though it was thought to give good texture and strength to gunbarrels, the first motivation for the production of the metal may have been to create a more easily produced version of real Damascus. Of course, welded damascus containing iron wasn't particularly suitable for blades. The metal was sounder than much plain wrought iron, however, because the elements that made it up had been worked to such a great degree by the hammer, thereby driving out impurities.

Little seems to be known about the introduction of damascus into Europe, though several possibilities exist. Northern attacks by the Ottoman Empire had carried damascus-barreled pieces into Austria in the seventeenth century; the siege of Vienna in 1683 saw some 200,000 Turkish soldiers in arms there, and no doubt after the Ottomans were repulsed, many damascus-barreled pieces remained behind. It seems apparent that many such barrels were used to make up new long guns and pistols after that, particularly in Austria, but it is also evident that European merchants began purchasing and even ordering damascus barrels in Turkey and Persia soon afterward. Damascus rifle barrels were in use in central Europe by the end of the seventeenth century; dated pieces may be found that will pinpoint the use of the metal for rifles, but an exact date can't be assigned here. Whether the first damascus barrels used for rifles were made in the Near East or in Europe is a moot point, but most of those encountered have only European marks on them. It seems probable, then, that damascus rifle barrels were being made in European centers at least by the first quarter of the eighteenth century, and most of them were of twisted skelps. English barrelmakers took up the art by the mid-eighteenth century, though the English preferred the plainer. barrels resulting from the use of untwisted skelps, and this taste prevailed largely until the end of the percussion era. Also, while Europeans preferred to finish damascus by etching the surface to raise the pattern as the Turks and Persians had done, English gunmakers used a "flush" finish that was more difficult to bring off, especially since their patterns were not so dramatic.

Damascus was brought to its highest development in Liege, Belgium, and the nearby Vesdre Valley by the end of the nineteenth century. Some of the patterns produced were incredibly complex, the result of preparing skelps from as many as a thousand elements welded together, twisted, welded again, and then welded up in a spiral pattern. Damascus persisted on fine sporting guns until after World War Two, but the introduction of fluid-steel barrels on shotguns had sounded the death knell of the art by the 1880s. Incidentally, I'd like to put away one notion that has plagued us for many years, and that is the strength characteristics of damascus. Many writers have solemnly advised us that the metal



Robert Griffith forged this damascus barrel, of both twisted and untwisted piles. Twisted piles show as "watered" patterns on the etched and browned barrel. C.R. and D.E. Getz finish-profiled and bored it to .54 for a wheellock rifle recently stocked by John.



Piles to be twisted are taken to heat and then twisted with a wrench (left). Above are three twisted piles welded together to form a barrel skelp. Note alternating directions of twists.

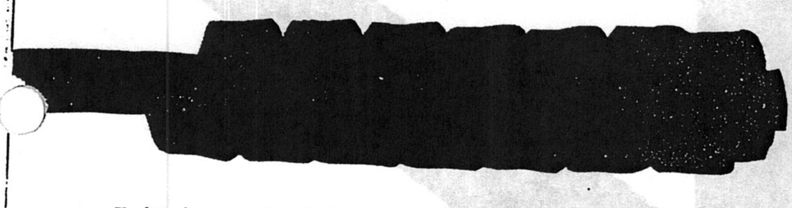
"eats itself up" from within, finally bursting like a rotten melon. That simply isn't true. Damascus has all of the strength of wrought iron, and perhaps a little more if the welds are perfect, though the spiral welding was no addition to strength in spite of what the old boys believed. Wrought iron has long fibers, and a plain iron barrel opens like a banana peel when it bursts, while damascus lets fly at the edges of the spirally wound skelp when it fails. Both wrought iron and damascus have adequate tensile strength for any conceivable charge of *black powder* if they were well made. The thing that has given damascus such a bad name is that too many idiots have tried to use modern progressively burning powders in damascus tubes. Since smokeless has an entirely different pressure-time curve than black powder, with pressure peaks *farther* up the bore, damascus shotguns occasionally blow just forward of the chambers where the barrels begin to thin. *Good* damascus is safe with black powder.

Bob Griffith, who is a fine blacksmith in Montrose, Pennsylvania, is the smith shown making what is probably the first damascus rifle barrel made in America. Bob became interested in the process while enrolled in the ironworking program at Southern Illinois University in 1974; there he met Daryl Meier, who had been making welded damascus blades before he became involved in the same program. After working with Daryl on various aspects of forging damascus, Bob became interested in the production of gunbarrels, and the result is shown here in the photographic sequence. The barrel shown was made of untwisted skelps, but during the process, we'll cover the methods used for making twisted-skelp barrels as well.

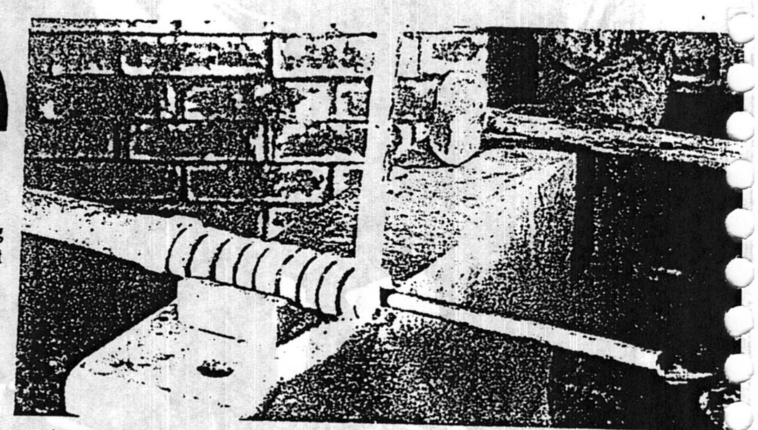
Preparing the billet or "pile," as the Europeans called it, is the first step in making damascus. The pile was made of alternating layers of iron and steel; for those used to make the barrel in progress here, Griff made up the pile with the outside layers of iron; since iron can take more heat than steel, it serves as an insulating "blanket." The iron he used was old wagon tires. English barrelmakers in the eighteenth century liked to make up iron for the piles from old horseshoe-nail stubs — hence the term *stub twist* — because the nails had been worked down to such an extent at the forge and were freer from impurities. Iron is problematical today, since it is no longer produced in this country, though foreign iron can be purchased in a few places. The steel used here was a low-carbon variety with 0.2 percent carbon and 0.39 percent manganese. This may represent a practical upper limit for carbon content in steel for making damascus barrels, since steels with higher carbon contents can create serious problems of differentials in welding temperatures. The welding temperature of wrought iron is higher than even mild steel, and high-carbon steel is easily burned in the fire when the heat is taken too high.

Griff's five-piece billet, for ease of handling, normally is left with one plate long to use as a handle. Early barrelmakers simply wired the billet together with iron wire and handled the thing with tongs. The billet is set *on edge* in the fire so that all of the elements come to heat at the same time; when it reaches orange heat, he fluxes the ends of the pile with 20 Mule Team Borax and slowly brings the mass up to welding heat. Griff looks for a milky-white, glossy surface on the metal, and at that point it has reached the same incandescence as the fire. The billet is quickly pulled out and taken to the anvil, where light, rapid blows of the hammer are given to the center of the billet, using heavier blows working toward the ends. The first blows are directed to the center so that flux and scale squirt out the sides and are not trapped inside. No more than ten seconds' working time is available before the pile begins to lose welding heat and must be returned to the fire.

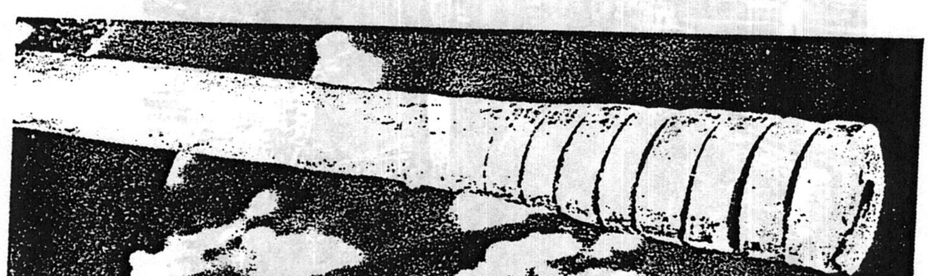
When it is completely welded, the billet is then drawn out from its original six inches to a full foot, with the metal worked at yellow heat. The billet is then cut exactly in half on the hardy of the anvil, and the halves piled one atop the other and welded once again, resulting now in nine laminates. There are actually *ten* layers, but since the outside laminates are of iron, two iron layers are welded together, causing, in effect, the loss of one layer. If a greater number of smaller laminates were required, the billet could then be drawn to twelve inches again, cut, and stacked back on itself once again. For the barrel in progress here, Bob welded another billet to the first one; both had been drawn, cut, restacked, and drawn to eight inches long. The new pile thus yielded seventeen laminates and represented a complete billet ready to be forged to proper skelp size. The skelp pieces are worked down into squares from these completed billets. The length of each section of skelp varies according to the thickness of it, but none used here was much more than twelve to fourteen inches, meaning that a thirty-two-inch barrel can be made up from as many as fifteen pieces of skelp. Of course, skelp pieces can be made longer. The barrel in progress here would have had a skelp sixteen feet long if it had been one piece; it's more convenient to keep the pieces short for ease of handling.

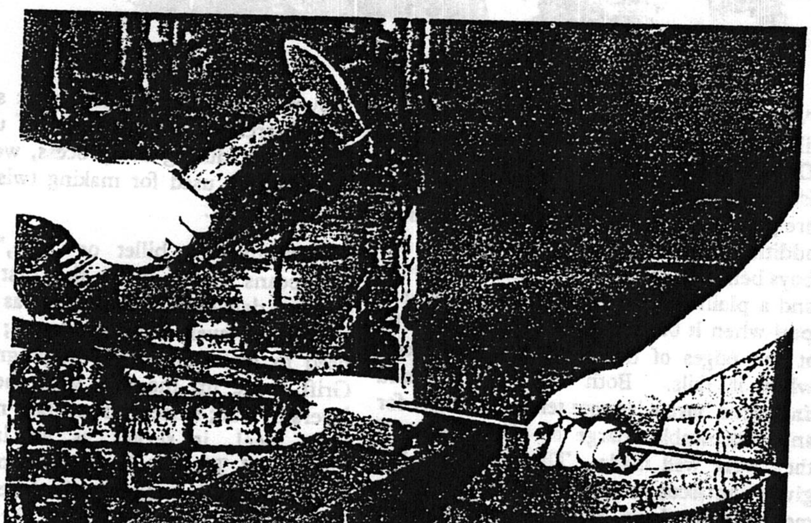


Twisted or untwisted, skelp is wound tightly around mandrel. Welding begins with "jumping up" – driving the white-hot section of barrel straight down on its end, against the face of the anvil.



After the first section of barrel is welded, a new section of skelp is scarf-welded to the end, and another section of wrap is begun.





With a bottom fuller in the hardy hole, the weld is consolidated. This barrel is being formed around a mandrel; the finished barrel shown on a preceding page was forged solid, then given a hot twist full-length.

If a barrel is to have a twisted skelp, then a different technique is used after the billet is welded and drawn out to eight to ten inches long. Rather than being halved and restacked, the billet is instead taken to red heat, one end clamped in a vise, and the entire billet twisted with a wrench from one end to the other. The degree of heat used is critical to avoid having iron elements shear. Before twisting, the corners of the billet are lightly flattened with the hammer to avoid causing stress points later. After twisting, a half inch is cut off each end of the billet, since that much of the billet had remained untwisted, being held by the vise and wrench. The amount of twisting varies according to the job, though eight to ten twists per inch produce a pattern consistent with European barrels of the eighteenth century. Actually, the billet must be twisted a bit tighter than needed, since all forging processes after twisting tend to unwind the billet. The number of twists per inch doesn't make the laminates finer in the finished pattern, but it does make the pattern itself finer. Really delicate lines in the pattern are a function of drawing out the billet to greater length, thereby making the laminates thinner before twisting; eighteenth-century patterns, particularly on rifle barrels, were relatively heavy. In fact, only on thin smoothbore tubes is it possible to bring the pattern down to its most delicate appearance.

After twisting and cutting off the ends on the hardy, the billet is then resquared on the anvil to prepare it for welding to other billets; this is done to avoid welding round sections together and possibly leaving voids as the result. The number of twisted billets to be welded together depends upon the nature of the pattern desired. In the photos, Bob is joining three billets to make a fairly coarse pattern. The twisted billets are then welded together; little more than one inch per welding heat can be completely brought together and still ensure a perfect weld with no voids. After welding together, the three-strand billet is then drawn into skelp sizes just as I described the untwisted skelps being prepared above.

Whether untwisted or twisted skelps have been prepared, the next step is to begin the wrap. Though a little unusual, the combination of both twisted and untwisted billets into one skelp was at times used, at least in the eighteenth century; the wheellock barrel shown was made up this way, showing the candy-stripe pattern of the untwisted elements alternating with the more complex pattern of twisted piles that had been welded to them.

The first piece of skelp is clamped in the vise at one end, with the mandrel clamped next to it, and the skelp is wound around the mandrel at heat and using the hammer, with an assistant holding the mandrel in place. More efficient methods of doing this were used in the old days; the Belgians, for example, did the wrapping in a bottom swage or swage block with a device for holding the skelp to the mandrel. The wrap must be kept as tight on the mandrel as possible, and the coils close to each other, which is no mean task. The section of wrapped skelp is now fluxed and brought to welding heat for two or three inches of its length and "jumped-up" on the anvil by driving the end of the section of barrel straight down on the anvil face; when the barrel is longer, the skelps are jumped on a steel plate on the floor. Jumping-up welds only the innermost corners of the skelp, since during the wrapping stage, the skelp has become trapezoidal in section, with the narrow face on the outside. One three-inch section of barrel is taken to three separate heats to close the coils as much as possible,

(Continued on page 58)

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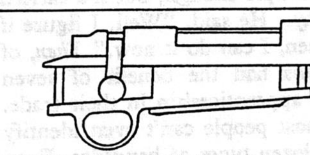
American Gunmakers

(Continued from page 11)

requires equipment that the average stockmaker wouldn't exactly have in the back room. For this process, Phil sends his stocks to Permagrain Products, Inc.; Box 115; Karlhaus, Pennsylvania 16845, and suggests that our readers contact Pete Henise, who is Permagrain's assistant manager. Phil indicates that "the process should be done at a stage when the stock is close to being completely shaped and inletted, although the inletting will require some additional work afterwards." The plastic causes the stock wood to become "virtually a new material, one that is very dense, has great strength, and is completely unaffected by water — along with retaining the natural beauty of the wood." However, the methacalate system is not entirely without drawbacks, as Phil notes. It adds eight to thirteen ounces to the stock's weight, which Phil offsets by routing out the buttstock and fore-end. Phil further notes that the plastic "makes the wood decidedly more difficult to work and the checkering operation becomes somewhat laborious," though the stock can be finished on the surface with whatever finish system the stockmaker prefers. Phil confines the use of the methacalate penetrant to jobs that will see the harshest use and considers it an "ace in the hole" for such applications.

Phil believes that the custom gunmaking trade is a good one to enter "only if the individual has the *natural* artistic aptitude and enough self-discipline to be productive enough." Phil certainly has no problem with that himself, admitting to finishing an average of thirty jobs a year, charging five hundred dollars for stocking a bolt-action rifle, including recoil pad, grip cap, and swivels. Wood, checkering, and metalwork are quoted separately. The address of Phil's new shop is Box 251; Story, Wyoming 82842.



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Forge-Welded Barrel

(Continued from page 23)

fluxing each time, and brushing off scale with a wire brush before returning the piece of barrel to the fire. This jumping-up is done with the mandrel in place, in this case a three-eighths-inch steel rod. Since the length of welded seam in a damascus barrel is so long, extreme care must be taken to ensure that the work is kept clean throughout welding.

Some fifty to sixty percent of the seam between the coils is closed after the third jumping-up; the remainder of the seam is then closed at welding heat with the hammer, with the barrel resting in the swage block. The gap remaining is difficult to close, and three inches of length may take from five to ten heats to close the spiral seam. To avoid sticking, the mandrel is occasionally given a light coat of oil so that it creates its own gaseous envelope, thereby avoiding any possible fusion. After the first section of skelp is completely welded, a second section is started. To accommodate the new wrap, a short piece of the skelp making up the first section of barrel must be left unwelded so that the end of it can be scarfed (chamfered) to receive the similarly scarfed end of the next section of skelp. After the end of the second piece of skelp is welded to the first section of barrel, the skelp is wrapped and jumped-up, and welding proceeds as it is described above. Now, however, there is an additional problem of bringing the unwelded section to proper welding heat without burning, especially when working the welds near the completed section of barrel, since the unwelded coil comes to heat much faster than the welded section. The workpiece must be constantly shifted from side to side in the fire to bring up the consolidated section of barrel without burning the freshly wrapped and unwelded section.

Wrapping and welding continues in this fashion, and when the skelp that will form the muzzle end is attached, the end of it is scarfed so that the muzzle of the blank can be finished-off square and won't have to be cut off. Joints between the skelps are visible as a line to the experienced eye, though most wouldn't see them.

When the barrel has been completely welded, it is forged octagon, annealed, and finished using the same processes used in making a standard U-skelp barrel. If open welds are revealed while boring, more often than not, they can be reconsolidated by forge welding, and in fact Greener mentions that this was a common practice with Birmingham makers.

There are other means of making a damascus barrel, some of which are more practical to use today. One source illustrates what is probably a Turkish or Persian barrel that has a slow spiral to the pattern that actually *reverses* itself — something of a shock to the eye until one understands what was done. In that example, the barrelmaker, rather than spirally wrapping the barrel skelp around a mandrel, had simply forged out the piles, twisting some of them, and then welded the piles together to form a long flat skelp. The barrel was then welded up just in the same manner a plain-skelp barrel would be done. After welding, the smith brought the tube to heat, chucked it in the vise, and gave it a hot twist, alternating the twist direction from one section of barrel to another.

Carrying this idea a bit further, Griff determined that it would be possible to weld a solid damascus bar that could be deep-hole drilled, thereby saving considerable labor and cost. To do this, Griff prepared four long pieces of skelp, each piece composed of one untwisted and two twisted piles to provide an alternating pattern. The four pieces of skelp were bundled and welded together, and the weighty blank was then forged into an octagon full-length. The blank was then taken to heat and given a hot-twist just in the same fashion a pile would be twisted. To ensure solid welds, Griff then worked the twisted blank end-to-end at welding heat, finishing with a heavy round blank. This was the method used for producing the wheellock barrel illustrated here.

Drilling, reaming, rifling, and profiling the blank fell the lot of Dick and Don Getz in Beavertown, Pennsylvania — fine barrelmakers whom we covered in *Rifle* 58. Griff brought the blank down to Beavertown, and I drove up. We spent the next day and a half hovering over that blank like a pair of mother hens, grinning foolishly as lathe or mill cuts revealed each section of figure to the eye, clucking and chortling as the finish reamer left a brilliant, flawless bore finish. The good brothers Getz were more than a little apprehensive that something would go awry, spoiling a piece of work that had an ungodly amount of time in the making, but there was never a bobble. They finally relaxed after we proofed the barrel twice with a hundred and fifty grains of FFg and two patched .535 balls, the mike showing no swelling anywhere.

God only knows what that first successful barrel cost if all the hours of research, trial and error, telephone calls, and the scrabbling about for good coal and iron were all totted up. But it worked, and now if the muzzleloading gunmaker wants something *really* unusual — and has a flush customer — he can contact Bob Griffith at Box 6; Montrose, Pennsylvania 18801, for a true damascus barrel. Griff hasn't set firm prices at this writing, but I feel sure that a finished barrel of a size appropriate for a "jager" or London-style percussion rifle will likely swallow up an honest eight hundred dollars in short order. For less fanciful longrifles, Griff can supply plain-skelp forge-welded barrels for considerably less. He's not likely to be exactly flooded with orders for such special things, nor does he want to be, since there are many other areas of blacksmithing that hold his interest; his ornamental work, in fact, is prize-winning.

Years ago, I asked Wallace Gusler how in the devil he'd perfected so many "lost" techniques working on his own. What he told me was simple enough, but it's carried me a long way. He said, "Well, I figure if they did it then, I can do it now." *Then*, of course, artisans had the benefit of seven years' formal apprenticeship in their trade. Nowadays, most people can't even identify above a half-dozen types of handfiles. Even so, well motivated fellows like Gusler, Brumfield, Laubach, and Griffith have provided us lazier types with the sure knowledge that fine, traditional handwork still represents the innermost core of craftmanship, and will persist. Such things should give us a better perception of the proper uses of modern technology in the trade.

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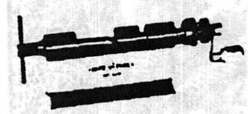

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