Making Chisels from S-1 Tool Steel by Armand Bussell

from a Class -- European Traditions in America by George Dixon (photos by the author)

From The Appalachian Area Chapter Blacksmiths

George Dixon was head blacksmith at the Samuel Yellin studio when it closed in 1991. He was the instructor at a class last February at J. C. Campbell Folk School, Brasstown, N.C., that I attended with the aid of a scholarship from the Appalachian Area Chapter blacksmith group. George is a very accomplished artist blacksmith and a good instructor who believes in sharing his knowledge in the art of blacksmithing. He is a former editor of **"Hammer's Blow"** and started the on-line forum **"theforge"** for ABANA.

Today he writes, illustrates, and edits a quarterly publication called the "Traditional Metalsmith" (www.traditionalmetalsmith.com), which is an excellent how-to 14-16 page quarterly publication detailing reposse' (to work or push from behind), chasing (working front side of plate steel), slitting, texturing, and other traditional metalworking techniques.

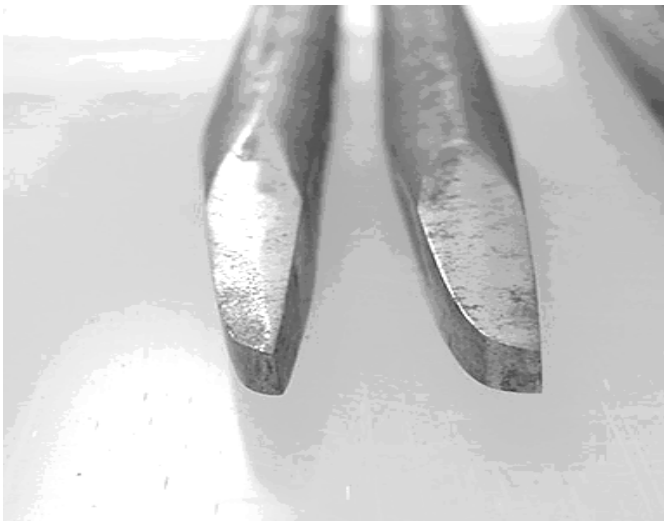
Some of the techniques George touched on in the class were; texturing sheet or plate steel with scale, forging decorative rivets or small knobs, and making hot and cold forming chisels from his favorite tool steel, S-1. Here are some of the rivets we made using his tools and methods.

George went into detail on how to forge, heat treat, grind and use the various chisels we made from S-1. In this article I will give a summary of making chisels from S-1, which, by the way, is an excellent shock resistant tool steel used in the making of striking tools. This was the first time I had worked with S-1 and found it a good material for these striking tools. George supplied the S-1 used in this class. At the end of this article you will find a listing of firms selling tool steels if you want to try out some S-1.

George likes to make chisels from 3.5 to 4 inches long so one can use them under a treadle hammer, which he used almost exclusively for reposse' and chasing.

To start let's make a pair of butchers from S-1 tool steel. Butchers are a blunt, sloped edge tool, justified to one side for working out lines and radii to raise a subject and give a 3-D effect.

Butchers are generally made in pairs with the



edge being 1/8 to 3/16 inch in width. The sharper one, on the left in the picture above, is used to establish a line and then the more blunt one is used to push more material away from the line to give more

relief to the subject – thus more 3-D effect.

To make these in S-1 start with some half inch dia. material. S-1 is a chromium-tungsten tool steel that provides excellent service in both hot and cold work shock applications. This steel exhibits both good wear resistance and hot hardness value. It is made with 1.0 to 1.8 percent chrome and 1.5 to3.0 percent tungsten along with up to 1.2 percent silicon, 0.5 percent moly and up to 0.3 percent vanadium. The actual values will depend on the proprietary mix of the supplier but all should work well for our chisels. One limitation of S-1 is short forging temperature range.

You don't want to forge above 2000 F – (light yellow), and want to stop forging at 1600 F - (dark orange). If you go above the light yellow into the white range the material will break up on you, called going "hot short" and below the dark orange you are simply beating yourself to death on a material with high hot hardness.

Start by heating the 1/2 inch round stock slowly in the forge. If a crack develops lengthwise it is because you heated it too fast. Bring it up to the light yellow heat and forge quickly into the desired shape. Use as few heats as possible. I believe one should do all the detail possible in the forging process and only finish grind for touch up. This may be left up to the individual smith since as you increase forging ability you will forge more and grind less.

After completing the forging process you should anneal the piece before doing the heat treatment. This removes stresses left in the tool from the forging and decreases problems with cracking during heat treatment. Heat the tool to about 1400 F – (bright cherry) and then cool very slowly by placing in vermiculite, or lime, or wood ashes or laying the piece beside the fire in the forge.

Now we are ready to heat treat but for this we need a brine solution for a quench. This same type of quench also works well for W-1 type of tool steel.

Why use a brine quench? It does two things, it helps prevent scaling of the surface of the tool and helps prevent the formation of a stable steam layer at the surface that acts as a good insulator and prevents a rapid even quench.

To make your quench solution add two cardboard cans (26 oz.) of table salt to 5 gallons of water. That is about 3 - 1/4 pounds of salt to 5 gallons. You can use rock salt too, and have it right if not all of the salt dissolves. Keep your mix in a closed 5-gallon container and stir before each use.

To do the heat treat -- heat slowly to a little above the non-magnetic point – for S-1 we want to get in the range of 1725 F (orange but not yet lemon). Heat your tool with the point out of the fire so as to not over heat the tip. Now quench in the brine water solution. Hold your piece vertical as you enter the brine water solution and move it rapidly up and down and around in the brine. Quench the whole shank of the tool if to be used under treadle hammer or with a striker.

Now grind and polish after final heat treat. Try tools without tempering or temper as desired. A low tempering temperature of 300 to 350 F will work well for cold use only – or if like most of us you want to use the tool for both hot and cold work you will draw the temper to at least this range the first time you use the tool on hot material.

We also made some schneckers; the word is from the Czech for claw or fingernail. Schneckers have a blade justified to one side with a slight hollow or radius for outlining radius cuts. You can never have too many of these if you want to handle a wide range of radius. Some that we made are shown in the following picture.

We also made slitters for slitting holes and these are basically a chisel with rounded corner for slitting and / or enlarging holes. Here are some of the slitters I made.

Note the rounded corners with the slitting edge continued around the corner. This means that you

cut not just on the bottom of the chisel but with the side too. It also makes it much easier to start your cut since all of the force is directed over a smaller area at the center of the tool.

There are many other tool shapes you can make and as with the chisels and schneckers shown above you

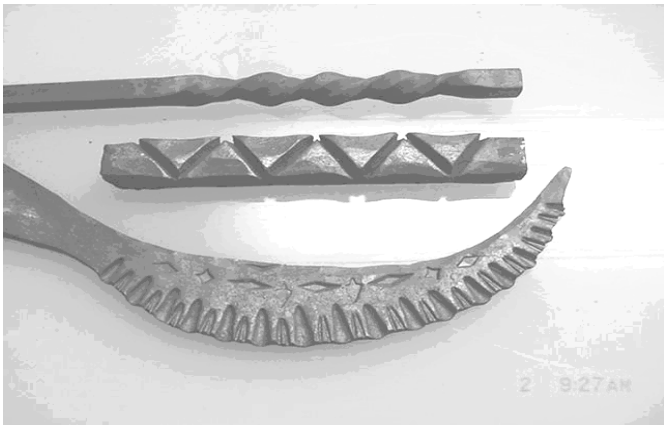
can forge them in a range of graduated sizes. Here is another view of the slitters with some of the other shapes I made.

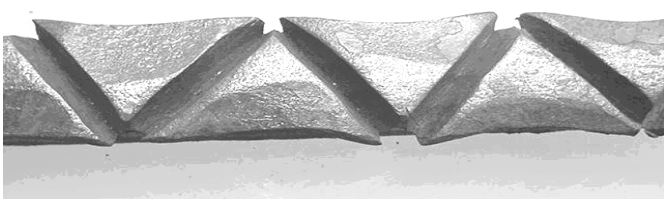
Another thing George showed us was how to texture sheet steel – 1/16 to 1/4 inch thick using scale. Slowly heat up the steel on top of the fire until scale has formed on the top-side. To get pronounced texture, lightly hammer in the scale. The scale is harder than the hot metal and will emboss from the scale. Repeat this step 2 or 3 times to get the texture you desire. Texture before cutting or working the material.

Here is a small sample of some of the effects I got using the S-1 tooling we made.

I would like to thank the Appalachian Area Blacksmith organization for providing scholarships to interested individuals for the advancement of education in the area of blacksmithing, without which some of us may not be able to expand our knowledge and education in this field.

Also, a big THANKS to all the hard working people who make this organization work.





I will be glad to answer any questions (or attempt to), about the subject material covered in this class, and I can be reached at 931-526-2101 or cell phone at 931-260-4433.

Tool Steel Suppliers

The following listing of tool steel suppliers is form ABANA's web site suppliers list put together by Dr. Mark Williams. Expect to pay $4 to $5 per pound for tools steel plus shipping costs. You could also make the tools shown in Armand's article form W-1 (water hardening drill rod) and 5160 spring steel. With the W-1 you should also use brine water solution for quenching. (*DaveSchrader*, editor)

Burgon Tool Steel Co. - Hampton, New Hampshire- Burgon Tool Steel Co. Tide Mill Road Box 1510 Hampton, NH 03842 800-582-7223 (in NH) 800-258-7106 (elsewhere) 603-926-5704 fax 603-926-4994 A good source for small quantities of tool steel. They usually have the material and size you need in stock. Unusual orders are normally processed within 10 days. Contact Art Putnam. The sales people are quite knowledgeable about all the metals they handle. They have metallurgists that can be consulted in difficult problems. Burgon has produced a nice little book entitled "Burgon Tool and Die Manual" (FREE). It's probably one of the best practical guides for selecting tool steels and heat-treating them.

Crucible - Camillus, New York Crucible 5639 West Genesse Street P.O. Box 991 Camillus, NY 13031-0991 800-365-1185 315-487-4028 fax 315-487-0800 outside North America http://www.crucibleservice.com/ crucible@crucibleservice.com Complete listing tool steels. Service centers located worldwide.

Latrobe Steel Company - Latrobe, Pennsylvania Latrobe Steel Company Latrobe, PA 15650 412-537-7711 Make a variety of tool steels. Especially of interest to smiths is their type MGR (AISI A8) shock resisting die steel. The hardness vs. temperature tempering curve is dead flat at 57Rc from 600F through 900F, and is above 55Rc at 1000F. It is a very nice hot working steel.

Linquist Steels, Inc. Linquist Steels, Inc. Stratford, CT800-243-9637S. Plainfield, NJ 800-526-7589 W. Columbia, SC 800-845-7052 Knoxville, TN 800-543-6258 Tool Steel Specialists. Very knowledgeable and willing to give advice. The service is efficient and personal. They go out of their way to please.

MBM Sales - Wisconsin MBM Sales Wisconsin 608-657-0721 Tool steels at good prices. They will ship UPS. Ask for Dale Steger.

Metal Supermarkets - Chicago and Atlanta Locations Metal Supermarkets Chicago location: 1675 Tonne Road Elk Grove, IL 60007 1-888-metal01 Atlanta location: 184 Selig Drive Atlanta, GA 30336 1-888-metalnu Metal suppliers with no minimum. They have many shapes of aluminum, stainless, brass, copper, carbon steel, tool steel, bearing bronze, alloy bar. Their prices are very good.
Supplier of many metals, both ferrous and non-ferrous, including carbon, alloy, & tool steels, stainless steel, copper, brass & bronze, nickel & cobalt alloys, aluminum, titanium, and magnesium alloys in a variety of forms. Also is an on-line source for information about metals.

Teledyne Allvac - Monroe, NC Teledyne Allvac P.O. Box 5030 Monroe, NC 22810 800-537-5551 Complete listing tool steels.

Foundations!

A Resource for Beginners.
by Bud Oggier
the Anvil's Ring/ Summer 1988 Part 10

"Hi, Jean, glad to have you back. Today I'd like to teach you how to weld in the forge. It's a very useful skill and is quite important to a blacksmith.

Jean, in order to weld successfully you must have two things: clean pieces to weld, and the proper temperature. If you have these elements your welding should be successful, regardless of what steels you want to weld.

In order to have clean pieces you must have a clean deep fire. This means no clinker and a good deep supply of coke. The fire needs to be deep and of good body in order to bring the pieces to heat rapidly and not produce excessive scale. In order to remove what scale is formed out of the weld, we'll use a flux. It does two things: coats the piece with a ceramic coating that keeps oxygen from reaching the weld area (thus reducing scale formation), and reduces the melting point of the scale that is formed so it can flow out as the weld is made. There are many fluxes that can be used, certain sands, borax, and several commercial compounds.

I normally use borax, the kind you buy in the laundry section of the supermarket, but you must be sure it is only borax and contains no detergent. Some smiths like anhydrous borax, which is the same thing as regular borax with the moisture removed and the price increased ten times. If you feel you must have anhydrous borax, take some laundry borax, melt it in a ladle, pour it out on a thin sheet, and when it is cool, break it up and grind it to powder in a mortar and pestle. The only difference I've noticed between the two is that laundry borax foams up when it gets hot and the moisture boils off before it melts and covers the piece, but it works fine for me.

I have never been very successful using sand, maybe because I don't know how to recognize the ones that work well. Commercial fluxes all work well, but are more expensive.

In order to provide enough stock so that the weld can be finished down to the original size, the pieces generally need to be upset some. If you don't provide this "additional" stock the weld will end up being thinner than the original pieces. Usually one other thing that will need to be done is to scarf the ends of each piece where they will join.

Well, Jean, let's begin. We'll weld two pieces of 1/2' square using the most common type of weld. In this type of weld, two similar sized pieces are joined together to form one continuous piece. Done properly, the weld will not show in the finished piece.

First we'll need to prepare the ends of the pieces for scarfing by upsetting them. Still remember how to do that? I'll start by upsetting the ends of my pieces for a distance of about 5/8". OK, here we go get a short heat and upset. I'm trying to keep the upset in the last inch of my piece. There one more heat should do it. While my piece is cooling, why don't you upset one of yours? That looks pretty good, Jean, just keep the upset short don't let yours get too long. Now do the other piece the same way. Good, Jean. Normally I would have put the scarf on as soon as the upset was made. However, if we were making a ring and went ahead and scarfed one end, we couldn't then upset the other end easily without destroying the first scarf.

Now to make the scarf itself. From the side the scarf looks something like an "S" and is not as long as the upset. To do this, put about 3/8" —1/2" of the piece on the edge of the anvil where the radius is. Then hit the piece with your hammer, hitting half on and half off the anvil. This will drive the edge of the anvil into the piece and produce a step. When the step is about 3/16"—1/ 4" from the top surface of the stock, drop your left hand down (for those who are right-handed) and taper the end to a thin edge. Then dress up the sides back to the upset size and taper the end so it is a little narrower. OK, here we go. I place the piece on the anvil about 3/8" from the edge,

hit the piece with the hammer, half on and half off the anvil, and drive it down. There, that's far enough; now drop my left hand and forge the end to a fine taper, dress the sides and it's done.

Now your turn good, Jean. If you had left a thick end or lip it would show in your finished weld; this way it will virtually disappear. Now we'll do the same to the other piece — OK, let's take a look. If the scarfs are made properly they will mate together. See, they do; that's good or we would have had to adjust them.

Well, I guess we're ready to weld. We'll heat the pieces to a good red heat and put on the flux. While they are heating, notice that the fire is deep, no hollow and no green coal, all good coke. I keep my borax in this wooden box; I'll put it on the edge of the forge now, bring out the first piece and sprinkle on some flux. Cover all four sides with flux, putting it on a little at a time until the piece looks wet all over. Did you notice the borax foamed up before it melted? Now it looks ready; do the same to the other piece, then bring both up to a welding heat.

When the pieces get hot enough the next several steps will happen rapidly. I'll hold one piece in my left hand with the scarf down, the other in my right with the scarf up, and tap them together to knock off any coke or loose dirt. Then I'll go to the anvil, lay the piece in my right hand down on the anvil, reach around and put the piece in my left hand on the edge of the anvil bringing it down so it matches the other scarf, and hold it in place.

Notice my hammer is sitting on the stump next to the anvil where it is handy. I'll pick up the hammer and hit both pieces in the middle of the weld; the second blow should be directly above the bottom lip, and the third on the top lip. This sequence is quite important. The first blow sticks them together, the second welds the bottom lip that is rapidly losing heat to the anvil, the third welds the top tightly. After these three blows, the sequence of the following ones doesn't matter much.

Now, how do we know when the pieces are hot enough to weld? The best trick I know for someone trying to learn to weld is to take a piece of 1/4" round rod and forge one end out into a very sharp taper, getting it as thin as you can. While the pieces are heating up, push the tapered end of the rod firmly against one of the pieces. Do this several times and when it finally sticks, the pieces are ready to weld. If you pay attention to the color of the pieces when you bring them out of the fire, you'll soon be able to tell by looking when you have reached a welding heat. While heating your pieces, don't blow the fire too hard give the heat a chance to soak all the way through. Adding a little extra blast at the end of the heat will help.

Here, Jean, take this weld feeler and test these pieces that are heating. Does it stick? No? OK, needs more heat. Is it sticking now? OK, here we go, pieces on the anvil, hit in the middle, then over the bottom lip, then the top. Now to forge it down to size. Work all sides a little at a time. For this size stock, heavy blows are not needed. Just be sure you hit hard enough to make the pieces conform to one another.

Before I finish this to size I want to take a look and be sure the weld is closed all over. See this place right here? There is a small gap, so I'll flux again. Note where the gap is? I'll take another welding heat and close it up. There, this time everything looks fine. There's nothing wrong with taking a second heat to insure a good sound weld.

OK, Jean, your turn. Any questions about what to do when your piece comes out of the fire? Good, it takes a lot more time to tell about than it does to do it.

You'd better take the weld feeler and cold forge its end flat again. The reason it works is that the end is so thin it assumes the temperature of the piece almost immediately. Is your piece ready yet? Not quite? OK, a little more. Remember, right hand scarf up,left hand scarf down. OK? Go, that's good, now hit the middle, now the bottom lip, now the top. OK, forge it down some. Fine, let's take a look. Well, Jean, it looks to me like you've made your first weld. Congratulations!

Some smiths make a big deal of this the phase of moon has to be just right, the wind in the right direction, weather not too cloudy, etc. But it's not a reli-

gious experience, just a very useful technique for the smith. Just remember, a clean piece and correct temperature, and all goes well.

One more thing as the carbon content in a steel goes up, the melting temperature goes down, and consequently, the welding temperature. So if we were welding two files, the proper welding temperature would be quite a bit less than with this mild steel. Sometimes you will have to weld a high carbon piece to a mild steel piece. In this case, the mild steel will be at the low side of its welding range, and the high carbon on the high side. You have to make the best compromise you can. You may want to weld a high carbon piece to a mild piece in projects such as a tomahawk blade or plane iron.

OK, Jean, now let's make a welded ring out of the same size stock. To determine how much stock it takes to make a ring of a given size, add one thickness of the metal to the desired inside round of the finished ring, then multiply that figure by 3.14. If the ring is to be welded, multiply the thickness of your stock by 2 and add this to the last figure. This will then be the finished length. So, let's make a 4" ID ring out of 1/2" square stock. Four inches plus 1/2" equals 4 1/2", times 3.14 equals 14 1/8', plus two thicknesses for the weld, equals 15 1/8".

Let's cut the stock and see how we make out. First, we have to scarf and upset. I'll start, then your turn. Upset the same as before, one end then the other. Next scarf one end, then the other—the scarfs must be on opposite sides of the stock so when the ring is formed they will mate together.

OK, here we go. I'll upset this end to about 5/8" square and 1" long, then I'll do the same to the other end. Now to make the first scarf, then the other one —one up, one down. There, that looks OK. Your turn. Keep your heats short, Jean (about 1") or you'll just have a lot more forging to do. Looks good; now the other end. Don't be afraid to get the steel to a good yellow for the upset the added heat won't hurt this mild steel, and it upsets much faster. Now for the scarfs. Be sure they will mate. OK, good.

Now to form the ring. To do this, form each end into a little less than half a circle, and be sure the bend starts from the very end or you'll have trouble matching the scarfs.

Here I go — I want to make the bends so that the weld will be made on the flat sides, not the rounded sides, because for me it is easier to finish up. Estimate the spot where the anvil horn is about 4" thick, and bend the piece around there. OK, that end looks fine, now for the other end. There, see, the bend starts right at the end, so the scarfs ought to match up well.

Now your turn. It's going well, Jean, just a little more bend and you're there. Good, now to finish the ring. Heat up the center portion, hold it there with these tongs, stand it on end, and gently tap the two sides towards one another. Stop a minute to make sure the scarfs will pass each other on the right side, then close it up. Now that the scarfs match, put the ring on the horn and make the tips of the scarfs conform to the ring. There, that looks pretty good. Now go ahead and do yours.

Well, looks like we're ready to weld, but first want to check and be sure there is no clinker in the bottom of the fire. See, Jean, I fished up a small clinker. The reason it is important to get the clinker out is that in a fire that will produce a welding heat, it will tend to melt the clinker and the blast will carry it up into the heart of the fire. If it gets on the surfaces you are trying to weld, you'll have trouble.

OK, we'll weld the same as the last time, but we'll have to finish up the inside and the outside over the horn. I'll put the piece in the fire vertically with the scarfs at the bottom. While it's heating I'll forge out the edge of the weld feeler. The piece is a good red now so I'll coat all four sides with the flux. Always try to get some in between the scarfs and pay particular attention to getting flux under the lips.

There, it looks nice and wet, so back it goes into the fire for a welding heat. Now to feel the piece — ah, the feeler sticks, so onto the anvil, hitting first the middle, then over the bottom lip, now the top lip,

now over the horn, and closing up the seam between the two scarfs. Now I'll forge the weld area back to its original size, some on the horn and the flats on the anvil face. There, that looks pretty good.

Your turn. Good, Jean, I think you have a good weld. OK, just be careful when you forge down not to get below the original size. Don't be too concerned if your ring gets knocked out of round, we'll straighten it out after it is back to the desired thickness.

Now to round it up. It can be done either on the horn, or more easily over my cone mandrel. Let's use the cone. In order to round up the ring we have to get it hot all over, so, into the fire. I'll have to turn it around as it heats to get the heat evenly distributed through the piece.

When I use the cone I use a hammer in each hand and hit the ring on opposite sides with both hammers at once. It doesn't take very hard blows this way. When it looks quite round, tap it down on the cone just a little before taking it off. OK, in preparation I'll put a hammer on the floor on each side of the cone. There, the ring is hot enough, so onto the cone, drop the tongs, pick up the hammers and hit wherever there is space between the cone and the ring. Now, tap it lightly on the top side, not hard enough to stretch it, just enough to round it up completely. There, that looks OK.

Try yours, Jean. Say, you're doing great, you didn't distort yours as much as I did. OK, heat it up, and round it up, and we'll take a good look at it. Now that it's cool, I'll wire brush it on the power wheel and we can take a good look.

This looks great, Jean. Maybe it's time for me to take lessons from you!

See you next time!

This article was reprinted courtesy of the author Ed Oggier, The Anvil's Ring and ABANA. It was originally published in the Summer Issue of the Anvil's Ring 1988, Volume 16 Issue 1. Reprinting of this article must be cleared through the ABANA publishing committee

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Northeast Blacksmiths holds its meets twice a year at the Ashokan Field Campus in New York State.

The Ashokan campus is located in Olivebridge, N.Y., several miles west of Kingston, N.Y. The meets are held the first weekend in May and in the first weekend in October every year. The main demonstration is in the blacksmith shop and there is a "Hands On" workshop for beginners. A main demonstrator is brought in for each meet, food and bunk-house style lodging are provided as part of the cost of the weekend long meet.

Contact : Tim Neu
to register for hammer-ins
or subscribe to the newsletter;
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For more information check out the web site; <http://nba.abana-chapter.com/>

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