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keyword or stock#

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Return to List
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Springmaking Without Tears
By: Steve Ostrem

Everyone who has worked on guns for a long time knows the awful truth. Sooner or later, a customer is going to bring in an unusual firearm for which spare parts, especially springs, are nonexistent. Or, maybe itâ€™s an interesting antique that you got a deal on at the last gun show or at a farm auction and would like to shoot if only the mainspring(s) werenâ€™t broken. Dozens of phone calls get you nowhere. Your usual reliable sources for parts have never heard of the thing and have no idea where to direct you. At this point desperation sets in. Doubling or tripling the price will deter all but the most determined customers. But we all know there is always at least one person out there that wants his one of a kind blunderbuss made to work again no matter what the cost. Their reasons are usually tied to a strong sentimental attachment to the thing. â€œ My (grandfather, great uncle, wifeâ€™s sisterâ€™s niece, etc.), carried this in the (Civil War, Mexican Revolution, Bay of Pigs Invasion, etc.) and gave it to my (father, brother, etc.) who in turn lost it in a poker game to me. Itâ€™s been in the family 1500 years so Iâ€™d like to see it work again.â€• The guy has his mind made up and a team of Clydesdales could not budge him an inch. That pretty much backs you into a corner. Worse still is when the project is self-inflicted. If you brought the thing home with the lofty goal of bringing it back to life it becomes a point of honor to see the project through to the bitter endâ€¦even if it means making a spring. No problem, youâ€™re a gunsmith; right? Youâ€™re supposed to know how to do these things. You might as well face up to it. You can run but you canâ€™t hide.

Believe it or not, making a spring is no more difficult than the many other tasks that we gunsmiths do every day. Granted, it requires a little specialized knowledge and attention to detail, but so do many of the jobs we do on a daily basis. Making a good spring is not an exotic specialty involving black magic or sophisticated equipment. The average gunsmith can crank out a typical flat lever action mainspring in an hour or so from start to finish. With a belt sander to do the rough stock removal it goes even faster. A v-type shotgun spring looks much more difficult but only takes about twice as long, once you get the hang of it.

This summer I attended an NRA class at Murray State College in Oklahoma to learn about English and European double shotguns. Jack Rowe, the instructor, grew up working in Birmingham, England in the gun trade many years ago. I watched him make a top lever V spring with a stud at on end in less than 45 minutes from start to finish using only a torch, a good vise, a file, a hammer, good spring stock, and quenching oil. Granted, heâ€™s made a few thousand more of the things than most of us and is able to make it look easy. Still, the process is a straightforward one and well within reach of the average â€˜smith. Aside from the basic tools and materials, the only other things you really need are average dexterity with a file, an understanding of hardening and tempering steel, and a little patience. Surely the flintlock that your customerâ€™s grandmother used at the Battle of Antietam is worth the effort!

The first thing you need when setting out to make a spring is a piece of good steel suited to the purpose. I have found that the **No. 149 Spring Steel Kit (#025-149-000)** that we sell here at Brownells has a very useful assortment is sizes that will allow you to copy most springs that you will come across. The 1075 type steel in this kit is ideal for making springs because it comes fully annealed and is very easy to cut and file to shape. It also hardens and tempers in a very predictable manner making it easier to get consistent results provided the person working with it knows what they are doing. If you try to substitute another type of steel you had better know your metallurgy. Many alloys cannot be made into good springs due the amount of carbon present or other physical properties that go well beyond my knowledge. Sure, some people are

successful at annealing old car leaf springs, cutting them up, and using them to make gun springs. Thatâ€™s great if you donâ€™t mind the extra work. For me, however, the Brownells kit is so cheap for what you get that I would never consider anything else unless I needed an unusual size that we donâ€™t carry.

The next big thing you are going to need is a good heat source. The standard propane torch is great for small springs and for forming bends in the larger ones as long as they are not too thick. However, it is generally not satisfactory for heating the larger springs up to red-hot for the hardening phase. For that you really need Mapp gas or, better yet, an oxy-acetylene torch to produce enough heat to get the job done. Of course, a heat treat furnace would be the ultimate appliance for hardening and especially for annealing springs because of the control it gives over the temperature. Fortunately for us, a furnace is not necessary to make a first quality spring, as most shops, (including mine), cannot afford such a luxury for the small number of springs that need to be made. Anything that can heat the entire piece red hot in a short time will work. Once you have the steel and fire, you are ready to begin.

A lever action mainspring is a good one to start on. The one weâ€™re going to make is nothing more than a tapered strip of metal with a long, gentle bow it that has a hole in one end and a sharp bend in the other. At the base there is a thick section that screws down to the lower receiver tang. Then there is a small step and from there the spring tapers gradually toward the front both in width and thickness.

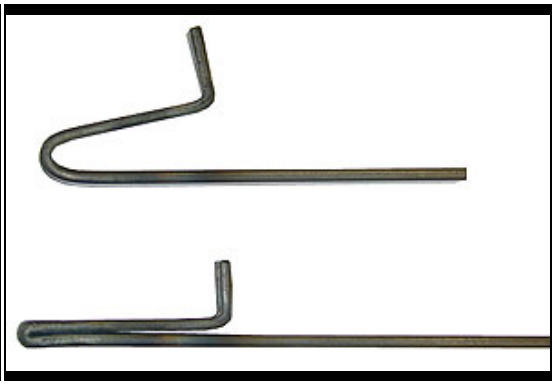
Original mainspring is used as a pattern.

The original spring has bends that are easily duplicated.

As you can see the original is used as a pattern by tracing its shape onto the spring stock with a scribe. The blue Dykem layout fluid really helps you see the lines while you file or grind the steel to shape. I used a center punch and a portable drill to put the 3/16â€• hole in the base. Then the piece was put into the vise and filed to the proper shape. The sides were left parallel until the last to make it easier to hold in the vise while filing everything to the correct thickness. No matter how you use your file or grinder to shape the basic form, remember to remove all file marks, scratches, or creases that run at right angles to the length of the spring. These are places where the spring is likely to break when flexed. It is important to always finish tapering or shaping a flat spring by filing the long way and then polishing the surface to expose any remaining flaws that could be potential weak points. With that done, it was time to put the bend into it. We can do this while the metal is cold because we are only bending it a small amount over the entire length. I put slightly more bow into this spring than the original as the old on has taken a set and become weak. After that the sides were tapered and the little bend in the front was put in and filed to shape. This is the point that bears on the hammer so the shape and location are fairly critical. Now that it looks like it ought to, weâ€™ll set it aside and go onto the next one.

The V springs found in double shotguns are a little trickier to form to shape because of the sharp bends required in the material. If we were to bend the metal while cold it would certainly conform to the correct shape, but the stress of the bending would leave that portion of the spring prone to breakage after hardening. We need to heat any area we want to bend a great deal just as a blacksmith heats iron to forge it into a horseshoe. The steel becomes quite pliable and easy to work with when red hot and can be bent at sharp angles without sacrificing any strength. Before starting the bend I polished the side of the stock that was going to end up on the inside of the V. Itâ€™s a whole lot easier to do it now than after the bend has been made! Next, the sharp V curve and the right angle curve on the ends of these springs were done after heating with the propane torch. The end was heated up and a right angle bend was started with pliers and then made into a nice sharp bend by placing it in a vise and pounding the metal into a right angle. The first stage was done hot but the second was done with the metal cool as only a small amount of actual bending was done. If you have a vise or chunk of steel with a good sharp corner to forge this part around without having to clamp it in the jaws you can do this operation with heat as well, but it really isnâ€™t necessary.

Finishing the right angle bend.

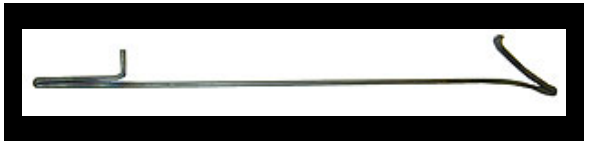


The V starts as a loop and is finished in the vise.

Try to match the original bend as closely as possible.

The V started out as a rather gentle loop made with pliers. After heating it back up it was quickly put into a smooth-jawed vise and squeezed to compress it down until the sides touched each other. The hard part for me is trying to get the length between the bends right. I usually put a small file mark on the part where I want to try to bend it, heat it up and use an old pair of pliers to make the bend. (*Donâ€™t forget to remove the file mark before hardening because it could create a stress point and cause your spring to break under pressure.)* Once you have the large loop made with the pliers you can control to some degree how that loop will compress in the vise by where you apply the heat. The red-hot section will move easier that the rest of the steel and affect the spot where the point of the V will end up in relation to the right angle bend at the other end. This length is usually critical because of the limitations of space allotted for the spring inside the action so you have to get it pretty close to the original.

Now, with the metal folded back upon itself, you can begin to spread the two legs away from each other until they are slightly farther apart than the original. This is to compensate for the initial set the spring will take when it is fully compressed for the first time.



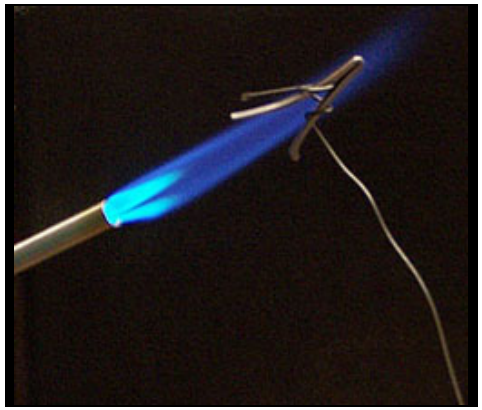
Making two at once can save time.

How far to allow for the set is something you will get a feel for as you go along, but it is essentially a guess. Once all the bends have been done correctly, all we have to do is file or grind the taper and shape close to those of the original like we did with the first spring. The final polish and touching up can be done after hardening and tempering. A properly tempered spring can be filed and shaped with a sharp file and can be polished without any problems, so you want to leave that for last. That way you don't have any more time invested than necessary before the spring can be proven by fully compressing it in a vise. Now that we have something that's starting to look like a spring, we'll turn up the heat and actually make it into a spring.

To harden the spring stock we need enough heat to bring the whole piece up to temperature at the same time. If your spring is not too large, a propane torch is all you need. For the larger and thicker springs something more may be needed. I used an acetylene torch with a slightly carburizing flame on the V springs and a propane torch for the lever action spring. A can of quenching oil was readied and put into position. Then the springs to be were fastened to a piece of thin wire to hold them while heating. One by one the springs were held in the flame and heated as slowly and as evenly as possible until they were red hot. Bright red or orange is hotter than needed for the steel I was using. Red hot is all you need. The glowing parts were plunged immediately into the quenching oil and agitated to cool them quickly. When the smoked cleared I had three blackened and extremely brittle pieces of steel. A trip to the buffing wheel cleaned them up and made them shiny as new dimes. Emery cloth worked well on the inside of the V springs where the buffer couldnâ€™t reach, and gave the pieces a very professional look. At this point we are almost home free. The really hard work is behind us and all that remains is to temper our springs. This step, however, is the most important of all and will determine if the springs will snap in half or collapse like a noodle when compressed in a vise. Be advised: this stage of the process does not take long at all and things tend to happen very quickly when bringing the pieces up to the proper temperature. It is easy to get the part too hot and therefore too soft. A little pre-planning here goes a long way toward achieving good results.

Tempering simply means heating the part to a specific temperature to draw out part of the hardness it has from being heated and quenched. The trick is to get the part to the temperature you desire. A heat-treat oven is ideal for this. You just set the dial to the temperature you want and put the part in. Luckily there are other ways to get the same results for those of us who cannot afford one. A lead bath with a good thermometer or a propane torch with a good eye for colors is all you need to make a good spring. Countless good springs have been made in this manner over the years. The trick is to know how much to heat the spring and when to stop.

Most people agree that right around 600 degrees is a good all-around goal to shoot for. Other sources recommend anywhere from 550 to 700 degrees. I personally like to go to 600 or a little higher when tempering to avoid any possibility of brittleness. With that in mind the first V spring was put on a piece of wire and dangled in the flame of my trusty propane torch. It is important to keep the piece moving to assure even heating. As you heat the part it will begin to turn a straw color. (Yellow to light brown). Get ready because things are going to happen rather quickly now. The color will grow darker and soon youâ€™ll have a bright â€œelectricâ€• blue forming. With just a little more heat the bright blue will turn to dark blue and we have arrived at our destination. Take the piece out of the flame immediately before it can go beyond this color and allow it to cool slowly. Let it rest while we do the next one.

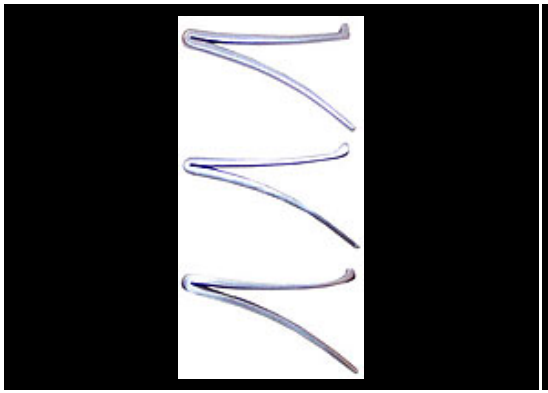


First spring being tempered.

The other V spring was done at a more leisurely pace. I fired up my lead pot for casting bullets and put a heat-treating thermometer into the molten metal. I decided to see what kind of spring I would get at the higher limits of the tempering range. When the lead reached 700 degrees the second V spring was wired up and submerged in the bath for a couple of minutes. Then I took it out and cleaned it all up again as I had done after hardening it. The other V spring was cleaned up and the two were taken over to the vise for the ultimate test. First one and then the other was put into the jaws and slowly compressed. Itâ€™s always a big relief not to hear a snap as the jaws compress, and an even bigger relief when the spring follows the jaws open again. Next I took a large pair of pliers to test the feel of both pieces. It definitely seemed to me that the spring tempered at 700 degrees felt spongier and softer than the one tempered closer to 600 degrees. Since it is no longer as hard as the first this makes perfect sense. However, after full compression in the vise

both took the same amount of set and stayed put after that. Looks like both of them will work. The lever action spring was done the same as the first V spring, except it was tempered to the lighter, â€œelectricâ€• blue. This spring has a smaller range of motion when it works so I decided to leave it a little harder. It is the same color you see on some 98 Mauser bolt stop springs and makes for a very snappy spring. Besides, I just love that color! On the other hand, this color leaves the part a little harder than I like to leave the more complicated springs or those that have to bend a great deal. For those Iâ€™ll stick to the higher temperatures and play it safe. Anywhere between 600 and 650 is fine. You can always anneal and re-harden a spring that is too soft, but putting one that is too brittle and breaks back in one piece is much more difficult!

After the vise test we can assume that the springs are good and things are pretty much under control. More polishing and minor filing can be done if needed, and your new springs can be installed in the gun. Thatâ€™s all there is to it! With hand tools, a torch and a little sweat we were able to do something most gun people consider a lost art or something so complicated that it should be done with sophisticated equipment. The â€˜awful truthâ€• about making springs is: itâ€™s not that hard!



Original spring on top with two copies ready for installation.

Old lever mainspring with newly-tempered replacement at left.

Springmaking is a skill most gunsmiths can use at one time or another. High dollar double shotguns, cowboy action guns, and many obsolete designs are all in need or new springs that need to be fabricated. This is where someone who knows what heâ€™s doing can make good money because he can do something many cannot. Good springs are the heart of any gun as they store the energy needed to fire the shot, eject the spent cases, and keep all of the parts of the mechanism in their proper relationship. Whenever I cock the hammer or work the action on a gun in which Iâ€™ve replaced the mainspring I canâ€™t help but think that it feels just a little bit smoother and crisper that it did with the old springs. That may just be my imagination but the feeling of satisfaction that goes with it is definitely real.

LIST OF MATERIALS

Brownells Spring Stock Kit #149	**#025-149-000**
Tough Quench Quenching Oil	**#083-027-032**
Heat-Treat Thermometer (For lead bath)	**#084-069-225**
Black Iron Wire (For holding parts)	**#038-018-003**
Gunsmith Kinks Book - *Lots of good springmaking info here.*	**#108-001-001**
Gloves and Protective Eyewear - *Always a good idea when playing with fire!*	

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