

# Richard's Bullet Swaging Handbook

- **Chapter One: Bits & Pieces**

Before going any further there are a couple of things to clear up. First when I speak about bullets I will not be talking about loaded ammunition, empty cases found at the range, an old Steve McQueen movie, or those funny dots people put before items on a list. A bullet is the projectile that leaves the firearm, travels downrange, and hopefully hits its intended target.

Second, swaging is pronounced like aging. It is not swagging or swedging.

Bullet swaging is a simple process where a piece of metal is held in a die and pressure is applied to the metal by means of one or two punches until the metal deforms to fit the die. No heat is used, only pressure. The amount of pressure needed to swage the part can vary from a couple of tons to many tons. It depends on the ductility of metal (formability), its hardness, the shape of the part, the size of the part, and so on.

One question that often comes up is how hard can the part be and still be swaged. This is important because it is possible to break the swaging die if the part is too hard but at the same time extremely hard metal can be swaged if the correct tooling and press are used. One thing that isn't often considered is the ductility of the part. It is quite common to have two metals that have nearly the same hardness but one can be swaged while the other cannot.

This is because one metal has greater ductility or formability than the other even though the hardness is the same. Hardness alone does not determine if the metal can be swaged. Hardness is only one factor. Consideration must also be given to ductility, the shape and size of the part, and how readily the material will work harden.

We know that a material that is more ductile than another will swage more easily but the shape of the part to be swaged is also important. A bullet such as a Keith style that has sharp corners will be harder to swage than one that has well radiused corners. The sharp corners retard the flow of metal in the die and increase the pressure needed to form the part.

Another factor is how much the part will work harden as it is swaged. Copper and copper alloys will work harden quickly so that it may be necessary to partially form the bullet, anneal it, and then finish forming it.

So how hard of a part can be swaged becomes a little difficult to give a simple answer to but this will be addressed in greater depth in later chapters.

Another common question is what it will cost to swage bullets. As a general sort of thing if your main concern is cost, swaging probably isn't for you. The big advantage to swaging is the precision and accuracy of the bullets you'll make. It would be very difficult to make a swaged bullet as cheaply as you can cast a bullet. Today there are mass produced bullets that have the jacket plated onto the lead core and these bullets are usually pretty inexpensive. So the cost of the bullet will not be as important to a bullet swager as will how good of a bullet can be made or how well the bullet can be made to fit the design requirements.

Custom swaged bullets almost always have better concentricity than cast or mass produced bullets, they have a high degree of uniformity and density, and the process allows for very good repeatability. Being able to make the same bullet time after time is very important and swaging excels at this.

The common ingredients in a swaged bullet are the lead core and the jacket, if a jacket is used. Lead wire is usually used to make the cores but it is also common to cast the cores. Casting the cores can save money if scrap lead is available but lead wire is more convenient to use and often makes a better bullet. When the core of a bullet is one-quarter of an inch or less it usually is better to use lead wire rather than trying to cast the cores. It is more difficult to cast a good core in the smaller diameters and the cost savings isn't as significant unless you can get free lead.

The bullet jacket is probably the most expensive part of the bullet and the cost of the jacket will vary considerably depending on the length, diameter, and wall thickness of the jacket. Jacket prices and availability vary quite a bit so it's difficult to quote accurately the cost for a bullet jacket but usually the jacket will be about half to three-quarters of the total cost of the bullet.

A jacketed swaged bullet will often be about one-half the cost of a factory bullet. Sometimes the swaged bullet will be more than factory bullets and sometimes considerably less. Factory premium bullets can be duplicated for much less cost and very high quality; specialty bullets can be swaged that far out perform factory bullets but sometimes at a greater cost.

Accuracy of the swaged bullet is generally quite good because you can select the materials that go into the bullet, you have total control over the process, and you can match the bullet to the firearm. It's possible to simply duplicate a well designed bullet and for many that is plenty good enough. But swaging also lets you match the bullet to the gun for even better results. If a .309" diameter bullet shoots better in your .308 Winchester you can make that diameter. If you favor a .486" diameter bullet in your .488" caliber rifle to reduce pressure during the heat of an African hunting trip you can do that.

Need a bullet with an extreme ogive and tiny meplat for target work or a bullet with a blunt ogive and big tip opening for hunting in brushy conditions? Or maybe a long, heavier than normal bullet for a magnum blaster? A frangible bullet for the .50 BMG to reduce the danger of ricochets? Paper patched bullets for your Sharps rifle? A heel base bullet for easier loading into your Remington Army revolver? All are easily done by swaging them.

So with swaging you can not only make accurate bullets but you can make bullets you can't get elsewhere. Swaging not only lets you get the best from your favorite gun but also lets you dust off your Peabody What-Cheer and enjoy using it.

While talking about cost we have to consider the cost of the equipment. I find that a swaging set-up including the Walnut Hill press, swaging dies, and accessories will set you back about the same as a good lead pot, bullet sizer/lubricator, quality bullet mould (s), and the other bits and pieces needed to cast good bullets. Certainly there is inexpensive casting equipment that will do for a time if plinking quality bullets are all that's wanted, but if really good bullets are the goal the cost will be comparable.

Casting may seem less expensive but often that's because a person can ease into it by buying lesser quality equipment and replacing it with better gear as time goes on. The real cost of casting isn't noticed as the expenses are spread out over a period of time. Swaging tends to be an all or nothing affair so the costs are more noticeable and are felt more.

The equipment for swaging bullets can be nothing more than a simple "hammer swage" or a powerful and sophisticated hydraulic swaging machine. The choice of machine and tools depends on what you need or want to do.

The hammer swage or pound die is a steel cylinder that is bored through and polished smooth. A punch is used to form the base of the bullet and a second punch forms the nose of the bullet. The swage is

placed on a base that has one punch mounted on it, a piece of lead is placed into the swage, and the second punch is placed into the die. The second punch is struck one or more blows with a heavy hammer and the bullet is swaged. The die is removed from the base and the bullet is knocked out of the die. Usually the hammer swage has no way to bleed off excess lead so the lead core must be trimmed to weight before swaging it. This type of swage is very inferior to a modern swaging press and dies, is slow to use, and doesn't produce the best quality bullets. It is an interesting tool but mostly useful for giving a cased rifle a complete look.

Over the years many die makers have produced swaging dies for use in reloading presses. Most of these dies have been rather simple but some are better designs and occasionally the reloading press is rebuilt into something like a swaging press. Reloading press swages have a number of problems that make them less than satisfactory for serious bullet making.

The biggest problem and one that cannot easily be remedied is the press itself. An O frame loading press has a frame that is usually sturdy enough for swaging but reloading presses have a stroke length of around three and one-half inches to four inches. This is nearly double the stroke length of a typical swaging press. A mechanical press must compromise between having enough stroke length to do a job or having enough power to do the job. As the stroke length increases, the leverage or power of the press rapidly decreases. If the stroke length is shortened, the power increases but there may not be enough ram travel (stroke length) to do the work. Loading presses are designed with a stroke length that is suitable for resizing and loading standard or magnum cartridges. Leverage is given up to have the ram travel needed but this isn't a problem when loading most cartridges.

But a loading press doesn't have the power to do bullet swaging, or even some bullet and jacket resizing very easily. The special swaging press with its much shorter stroke has far greater power and can do swaging tasks that are nearly impossible with the loading press. Of course ram travel is given up to achieve the increase in power thus making many swaging presses unsuitable for reloading. Some swaging presses have a dual stroke feature that allows the press to be used for both purposes but this greatly complicates the design of the press and adds to its cost.

Another problem with reloading presses is that even if the frame is strong enough to handle the forces generated during swaging, the rest of the press may be too light for the task. The pins, link arms, and toggle may not be stout enough to handle the load. The ram in most loading presses is soft, which isn't a problem if the press is used as it is intended, but the shellholder slot in the ram will soon crush down from the pressure on it when swaging bullets and it won't be possible to put shellholders in the ram.

Reloading press swage dies are usually not strong enough for swaging larger bullets, they may not have the capacity for making long rifle bullets, and there is usually no automatic ejection system to push the bullet out of the die. A swaging press will have an automatic "soft" eject system that will ease the finished bullet out of the die. A reloading press swage normally has a rod sticking out the top of the die that must be whacked with a mallet to eject the bullet from the die. The sudden blow to the ejection rod in the loading press swage die will often damage the tip of the bullet or drive the ejection pin into the bullet and just doesn't lend itself to making a quality bullet.

It is possible to make an ejector frame for the press but the system remains underpowered and cumbersome. The reloading press swage is OK for making a few plinking bullets but is hardly a useful system for serious and accurate work.

The Walnut Hill swaging press is designed for bullet making and can also be used for reloading. It has a dual stroke feature so that a long stroke length or the short swaging stroke can be selected by simply moving one pin. The swaging die is placed in the press ram along with a punch called the internal punch.

It is called an internal punch because it remains inside the die. Another punch is held in a special punch holder in the top of the press. This punch is called the external punch because it is external to the die.

Early swage die makers used the terms top punch and bottom punch because the punches formed the bottom (base) and nose or ogive (top) of the bullet. This is misleading and inaccurate today because either punch can be used to form the nose or base of the bullet. If you are making a double ended wadcutter bullet, both punches form the bullet's nose and so both punches are the top punch. If you make a Webley Manstopper bullet, both punches form a deep hollow cavity in the bullet so that, in effect, both punches are bottom punches. This makes no sense when you try to describe which punch you might need so the terms external and internal punches are better.

To swage a bullet the die and punches are placed in the press. The press ram is raised up a little and a lead core or lead core and jacket are placed in the die. The press ram is raised to the end of its travel and the bullet is formed. The punch holder in the top of the press will need to be adjusted up or down to control how much pressure is put on the bullet and this is done by simply moving the press ram up and down and raising or lowering the external punch and holder until the bullet can be formed near the end of the ram travel. With all mechanical presses the greatest power will be developed near the end of the ram travel so the punch holder should be adjusted to take advantage of that condition. Adjust the punch holder correctly and let the press do the work for you.

Then the press ram is lowered and the bullet is automatically ejected from the die. The swaging work goes as fast as you can run the ram up and down, load and remove bullets, and not pinch a finger.

For some bullets such as the big .50 BMG or the 14.5mm Russian machine gun bullet no hand operated press will be adequate. The big bullets will require a considerable amount of ram travel and will need a good deal of pressure part way into the stroke. A hydraulic press is the only real solution to the problem. Big hand presses have been made for this job and other large caliber bullets but the fact is that a mechanical press can have lots of leverage (power) or a long stroke, but not both. No matter how large and bulky the big hand press is, it is still limited by the laws of physics.

For many bullet makers the hand operated press will be too slow or will not be able to easily make the bullets desired. The hydraulic press is once again the best choice. There are other types of powered presses but all have problems that make them too costly, too hard to use, too large, or much too power hungry.

The hydraulic press can have a reasonable production rate, can fit into a small space, doesn't need a heavy commercial power source, and while not cheap is much more affordable than other powered presses.

For most work the MultiSwage will be a good choice and is relatively low in cost. It uses the same dies as the Walnut Hill hand press but special dies allow the press to swage bullets as large as .700" diameter up to 2.0" in length. The press can also be used for reloading or extruding lead wire. It is a fast, easy to use machine, and takes up little more space than a good reloading press.

For heavy duty, all out swaging the BenchMaster is a better choice. This machine can reload ammo, extrude lead wire, and swage just about any bullet ever wanted. Solid copper bullets can be swaged and complex bullet designs can be made. The BenchMaster is the commercial bullet maker's first choice.

The HydraSwage II hydraulic press is intended for commercial use in production and prototype work. It is a free standing, cabinet model that has much more sophisticated controls than the BenchMaster, making the HydraSwage II a better choice for long production runs or for developing unusual bullets.

In addition to a swaging press and dies there are a few other tools and supplies that will be needed. This will include swaging lubricant, jackets for metal jacketed bullets, paper and lube for paper patched bullets, filler material such as plastic balls in various sizes, and lead for the cores.

Swaging lubricant is a special lube that is unlike anything else. Many substitutes such as Crisco, Vitalis, Cool Tool, case lube, and who knows what have been tried over the years but only swaging lube has the right combination of a high pressure film and good lubricity, no sulfur or chlorine, and ease of use plus a long shelf life. As a bonus Bullet Maker's Lube also serves as a moderate anti-rust compound.

Lead or a lead alloy will be used to make all lead bullets or jacketed bullets. The lead that will be swaged into a bullet, either the all lead bullet or the jacketed bullet, is called the core. This term comes mainly from the making of jacketed bullets but it's a good word to use to describe the cast or cut lead slug that will become a bullet. It might be more correct to say, "the rough cast or cut cylindrical piece of lead that will be used to make a bullet", but even though an all lead bullet doesn't have a core, it just seems easier to say, "cut or cast some cores". So lead cores will be the starting point for all bullets.

The question is whether to cut lead wire for cores or to cast them. I much prefer to use lead wire whenever I can. It's always ready to be used, no melting pot to have to heat up, no fumes, no chance of burns or fire, and I think that cores made from wire are better than those that are cast. Lead wire is held to tight tolerances and generally has a good surface finish. The fewer wrinkles and surface defects, the easier it is to swage a good bullet.

But casting has its place as well. When making bullets that use a core dimension of one-quarter inch or less, lead wire is really very economical. Casting small cores can be a real pain and the number of reject cores will be considerably higher than with large cores. There is no question that wire is the first choice in this case. As the core diameter becomes larger casting the cores becomes easier and the cost savings is greater if a source of good lead can be found. If salvaged lead is used be sure to try to get pure lead. Roofing lead or X-ray room shielding are usually quite pure but lead pipe and other lead products may have undesirable alloying elements.

Casting also lets the bullet maker make up lead alloy cores such as a lead/tin mix to aid in getting a good bond when making bonded core bullets or if a lead/antimony mix is wanted. But harder alloy lead wire is also available, such as a 6% antimony 2% tin alloy, if hard bullets or hardened cores are needed. The alloy lead wire is more expensive but then it has more "stuff" in it than pure lead.

Wheelweights are great for casting cheap handgun bullets but not especially desirable for making high quality bullets. Wheelweights are a mish-mash of many things and uniformity isn't especially important so long as they weigh correctly. The wheelweight alloy can vary greatly from lot to lot and from maker to maker which introduces a variable into bullet swaging that the user has little or no control over. Hardly the best thing if a person wants a dependable, repeatable, precision bullet. Wheelweights can be swaged but the alloy is designed not to deform in use. It is a relatively hard alloy and has poor ductility. Great for sticking on a car wheel but not so great for swaging.

Lead wire can be purchased in amounts from five pounds up to as much as three hundred pound rolls. I stock twenty-five pound spools as that amount helps to keep the cost per pound lower and will also save on shipping costs per pound since the cost to ship two ten pound spools is more than one twenty-five pounder. Twenty-five pound spools are also easier to handle than a three-hundred pound spool!

If lead wire is used it will have to be cut into suitable lengths. To do this a core cutter is used. Core cutters can be very simple devices that have a block to hold the wire, a cutter blade, and some sort of length gauge or they can be extremely complex and expensive machines. The cutter that I make has six holes of

various sizes that the lead wire is fed into. One bar is mounted to the workbench or held in a vise while a second bar is moved back and forth under the first bar. There is an adjustable stop that will set the length (weight) of the core. The lead wire is pushed through a pair of holes in the two bars until the wire is stopped by the adjustment screw. The long handle is pulled back and forth to cut the core. When the core is cut the wire is pushed into the cutter again and another core is cut.

The cut cores are always heavier than the bullet weight wanted. This can be only a few grains or considerably more. The cores will have rather rough looking ends but this is unimportant as the cores will be made uniform when they are swaged. Lead is a rather soft, plastic material. As the cutting begins the lead is first sheared cleanly. But as the cutting continues the lead will begin to stretch and pull or tear apart. No matter how the core cutter is made this action will take place and the cut core will have an angled end. There really is no such thing as a precision core cutter but so long as the cores are within a few grains of each other that's good enough. A large variation from core to core is undesirable as the weight variation will show up in the swaged core except to a lesser degree. Sometimes double swaging cores will be necessary to get the very least error but usually this is not needed.

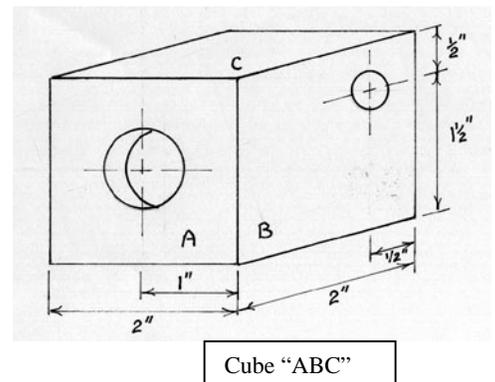
Since swaging bullets was first done bullet makers have been stuffing odd things into the bullets as a way to improve accuracy, penetration, and expansion. Frangible bullets are intended to break up on impact, bonded core bullets are intended to hold together on impact. Plastic, lead, steel, or balls of other material are used in bullets to make the bullet lighter, feed better in autoloaders, or just look really cool. Hardened penetrators are used in military and police bullets. Aluminum or other soft metal can be swaged into a tip and inserted into a bullet to improve its ballistic coefficient (BC) or to improve expansion. Tungsten cores can be used to make heavier than normal bullets, granulated plastic can be used to make lighter than normal bullets. Solid copper bullets were being swaged in small shops long before the bullets became a commercial success.

Home or small business bullet swagers have long been on the cutting edge of bullet technology, making improvements and developing bullet designs that were later copied by the big name companies.

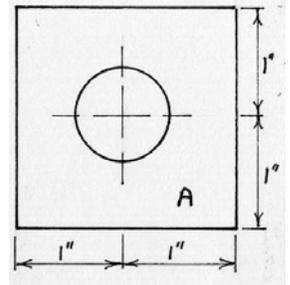
In the coming chapters all these things will be discussed, techniques and tools needed to do them will be covered. The next chapter will discuss various all lead bullets. This will cover different bullet types, how to make them, and the tools needed. Chapter three will discuss in some detail paper patch bullets. Other chapters will cover metal jacketed bullets, shotgun slugs, and unusual or even just plain, strange bullet designs.

Throughout the chapters of the book drawings of dies, jackets, and bullets will be used to illustrate what is being discussed in the text. The drawings will sometimes be sectioned so as to better show the construction of the jacket, die, or bullet. For those of you who are not familiar with mechanical drawings the following is a brief explanation of the markings on the drawings.

To the right there is a drawing of a steel cube, cube ABC. If we were to pick the cube up and look at it we could see three sides of it. Side A appears to have a shallow hole in it, side B has a hole but we don't know much about the hole, and side C is flat. We can tell the locations of the holes and the size of the cube from the dimensions placed by the sides of the cube. We know the cube is 2" on all sides. It has a large hole in side A but we don't know how deep the hole is and we know next to nothing about the hole in side B.

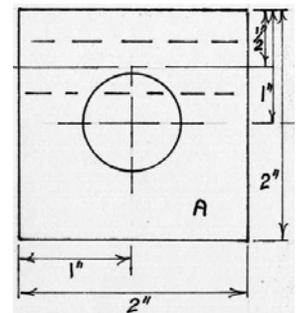


If we pick the cube up and look straight at side A so that the other sides can't be seen, it would look like the drawing Cube A. This drawing doesn't tell us much about the cube except the size of the cube and the location of the hole in side A. The type of dimensioning shown in drawing Cube A is called "Incremental" or sometimes "Chain" dimensioning. Each dimension starts at the edge of the cube and goes to some point on the cube, in this case the center of the hole, and then stops. The next dimension begins at the center of the hole and goes to the next point, in this case the far edge of side A.



Cube A

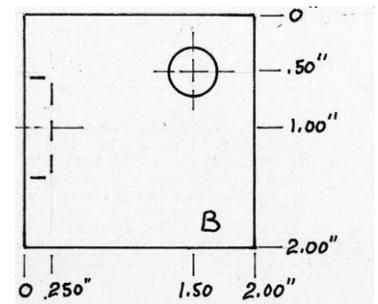
A much better way to draw side A is shown in drawing Cube A1. This drawing is the same as drawing Cube A but there are dashed lines across the top of the cube. Looking back at Cube ABC we can see that there is a hole in side B. The dashed lines in drawing Cube A1 are called "Hidden Lines" and show that there is something in the cube that can't be seen by looking at side A. If we didn't have drawing, Cube ABC, we wouldn't be able to tell what was in the cube or exactly where it is but we'd know something was there. We would know that the center of whatever is there in the cube is one-half inch down from the top of side A. The thin line that alternates between a long line and a short line is a center line and tells us the exact center in one dimension on the cube. Whatever it is could be a hole, a notch, a tab sticking out. All we know is that it is there.



Cube A1

The dimensions on the cube are the same values as in drawing Cube A but this time all the dimensions are taken from one of two sides. This type of dimensioning is known as "Absolute" or "Parallel" dimensioning.

One more drawing will give us the information that we need to understand the cube. This is the drawing of side B. Drawing Cube B gives us the location of the hole through the cube and the depth of the hole in side A. Drawings Cube A1 and Cube B tell us that the hole in side A is centered in side A and from drawing Cube B we know that the hole is .250" deep. Drawing Cube A1 tells us that the hole in side B goes completely through the cube while drawing Cube B gives us the location of the hole. With this information we could proceed to make another cube. The size of the two holes has been left off of the drawings to make them easier to read but a working drawing would have that information on it. There would also be information regarding the finish of the holes and what tolerances are allowed.



Cube B

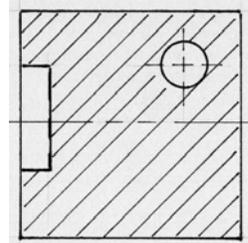
The dimensioning of Cube B is also "Absolute" but it is shown differently than in drawing Cube A1. The dimensions in all of the drawings are "unidirectional" in that they are all read from the same direction. Older drawings would have the dimensions on the side turned ninety degrees but that makes them harder to read so drawings today are usually unidirectional.

Sometimes it is helpful to section a drawing so that more detail of the part can be shown. This is done by drawing a line through the part that needs to be better understood. The line will have an arrow on each end and the direction the arrows point indicates which piece of the part will be shown. When a part is sectioned the sectioned piece will have lines drawn across it.

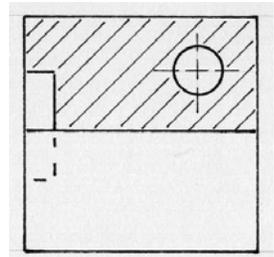
The lines may be solid, dashed, a dot-dash pattern, two lines close together and then a space and two lines again. Different arrangements of the lines are used partly to differentiate different pieces of the part and the lines can be used to indicate what the material is. Concrete would use different section lines than wood, lines for steel are different than for bronze, and so on. But I pretty much use a thin solid line for my section lines. I don't make dies out of bronze or cement so it isn't necessary for my use to worry about the complexities of section lines.

Drawing "Section 1" shows side B of the cube cut completely in half. While the cube is pretty simple the section drawing does show the hole in side A more clearly. The thin diagonal lines indicate that this is a sectioned drawing. In many cases it isn't necessary to cut the part completely in half and often leaving a portion of the part intact will better show the insides of the part relative to the outside.

Drawing "Section 2" has only a quarter of the cube cut away. This shows the hole in side A clearly while still showing the outside of the cube.

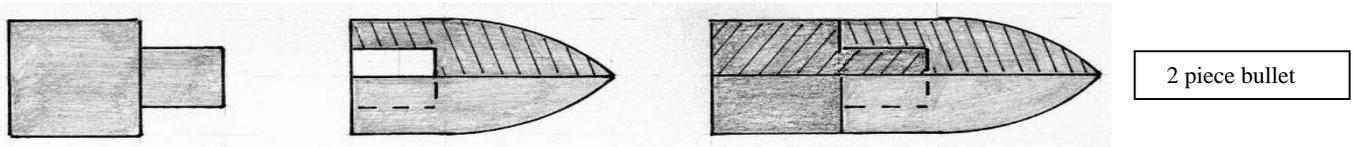


Section 1



Section 2

Both completely sectioned parts and partially sectioned parts or drawings will be used to illustrate ideas, bullets, and tools. Hopefully this will help to explain how the tools work and how the bullets are made.



The drawing above of the two piece bullet shows a solid base piece at the far left. In the middle is a nose piece that has been partially sectioned, note the hollow cavity in the back end of the nose piece. The drawing on the far right is the assembled bullet. The bullet is partly sectioned with the section lines on the base piece running the opposite direction than those on the nose piece. The dashed hidden lines on the nose piece and on the assembled bullet indicate the hidden cavity in the nose piece and the hidden tang of the base piece that has been pressed into the nose piece when the bullet is assembled.