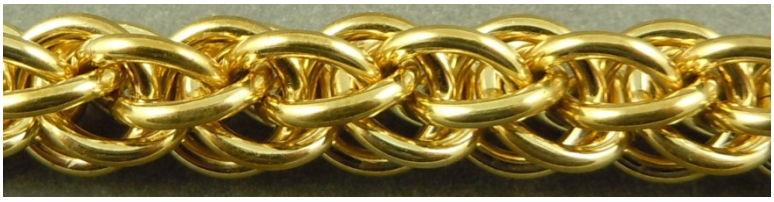


Chain Making Workshop

John Fetvedt

www.bijoux-de-terre.com

Table of Contents

Terms and Definitions

Aspect Ratio – The aspect ratio is the ratio of the inside diameter of the jump ring to the diameter of the wire (not the gauge, but the measured diameter). In some publications this is sometimes also called the key number, etc., and for most chains it will probably vary from 3 to 6 (or higher).

Burnishing – Burnishing is a way to remove very shallow tool marks and polish the chain, by tumbling it in a small tumbler with stainless steel shot, ceramic bits, or some other smooth media, and a burnishing compound. The rubbing of the media on the metal jewelry will polish it.

Gauge – Gauge is an artificial standard used to describe the thickness of a wire or sheet of metal. In the USA the Brown and Sharp gauge (or the American Wire Gauge) is used to identify the thickness if precious metal wire and sheets. It is an inverse scale; as the wire gets smaller the gauge gets larger. For example, a 22 gauge wire has a smaller diameter than a 20 gauge wire. The gauges you are most likely to be using in class are:

B&S Wire Gauge (AWG)	Size in mm	Size in Inches
22	0.64	0.0254
21	0.723	0.028
20	0.81	0.0320
19	0.912	0.036
18	1.02	0.0402
16	1.29	0.0508
14	1.63	0.0642

Spring Back – Spring back is the term used to describe the property of metal that makes the wire return slightly to its original shape after being bent, or deformed. A hard wire has more spring back than a dead soft wire. For example, if you wind a hard wire around a 1 inch mandrel and let it relax, the resulting jump rings may be an inch and a half in diameter. Whereas doing the same process using dead soft wire might result in jump rings that are an inch and a quarter in diameter.

Work hardening – Work hardening is the hardening of a metal caused by bending, twisting, hammering, burnishing, etc. Any of these actions disturb the alignment of the molecules and makes the metal harder. This may eventually result in cracks or breaking. Bending a wire back and forth until it breaks is an example of over hardening.

Chain Making Tools

Optivisor

Chain making requires the full time use of both hands, and depending on the chain you are assembling the jump rings can be very small. The most common optical enhancement device is probably the Optivisor. For making chains I generally use a #3 lens, but for working with some very small chain mail I use a #5 lens.

Pliers

Bent nose

I use the back side (the outside of the "C" shape) in my right hand for holding jump rings. I can hold all sizes of jump rings with this tool depending on how big a bite I take of the jump ring.

Flat nose

I use a flat nose pliers in my left hand for closing larger jump rings (4-5mm and larger). Closing rings with a flat nose pliers is less likely to distort the ring than using a chain nose pliers.

Chain nose

I use a chain nose pliers in my left hand to close small rings. There is not enough space on a small ring to use a flat nose pliers.

Jump ring opener

I use a jump ring opener on the little finger on my left hand and open the jump rings one at a time as needed.

Pick

A pick is a very handy tool for opening the correct path for the next jump ring through the chain being assembled. Use this tool when you run into trouble figuring out where to place the next ring. Note: this is a different tool than the "soldering pick" you will be using in the advanced chain class for soldering.

Working with Jump Rings

To open a jump ring, hold it gently (to avoid scratching the metal) but firmly just to one side of the cut with a pliers. I use the back side of a bent chain nose pliers. A flat nose or a chain nose pliers may be used if you prefer.

Prepare to open the jump ring by grasping the ring, just to the other side of the cut, with a second pliers or a jump ring opener. I use a jump ring opener on the little finger of my left hand. Jump ring openers are available from most jewelry suppliers.

Open the jump ring by twisting the ends gently to the side, away from each other. Do **NOT** open a jump ring by pulling the ends apart; this will distort the shape of the ring. Open the jump ring only as far as necessary. The amount, and direction, to open the jump ring will vary between chain patterns.

Insert the jump ring into the chain while holding it with the pliers. Rotate the jump ring so the opening is on the top, so the other rings will not fall out.

Close a jump ring, using two pliers, by gently twisting it back together from the sides while applying gentle pressure to the outside of the ring to bring the ends together. I like to twist the ends just past each other and then back again to line them up.

If the ends of the jump ring do not line up with each other when looking at the edge of the ring, gently twist them back and forth until they are properly aligned.

If the ends of the jump ring do not line up with each other when looking at the side of the ring, the shape of the jump ring has been distorted and the ring should be removed and discarded, and a new ring should be used.

Chain Making Tips

Names don't mean much – While there are fairly well agreed on names for several of the chain patterns e.g., Byzantine Chain, you will find that many sources use different names for the same chain pattern, and also that different sources sometimes use the same name to refer to totally different chain patterns.

Check the gauge – When you are looking at a new project, check which gauge standard is being used to describe the materials. Some books and articles have been published using the European wire gauge standard. However, more and more books and articles are now also including the actual measurements in the materials description, or in a table in an Appendix, so you can check which gauge standard is being used.

Pictures can be deceiving – Remember that most pictures are specifically designed to show off the chain. In real life many fancy designs do not show up as well as they did in the picture.

Starting a chain - The hardest part in assembling a chain is usually getting the pattern started correctly. With some chain patterns if you are not careful to keep the initial rings positioned exactly as described in the directions until you have completed at least two repetitions of the pattern (for example if you drop them) you may as well take the rings apart and start over.

Asymmetric links – When assembling chain patterns with asymmetric links, e.g. flower chain, wiggly chain, etc., consider making all links spiral in either the same direction, or perhaps alternate directions.

Asymetric earrings – When making earrings that do are not symmetric be sure that the two earrings are mirror images of each other. Otherwise the earrings will not hang right

Check for mistakes - Be sure to inspect your chain often for mistakes. You can often fix mistakes in mid-chain if you are careful, but in some chains it is easier to remove all the rings back to the mistake and then continue with the assembly.

Making Jump Rings

There are several reasons to make your own jump rings. I believe the best reason is that when trying a new pattern you can just go to your studio and make the proper size jump rings, without having to wait several days if you have to order them. Making your own rings also allows you to experiment with different patterns using copper, or other base metals, before using precious metals. And last but not least, after you have paid for the required tools, it reduces the cost of the jump rings.

The tools need to make jump rings are:

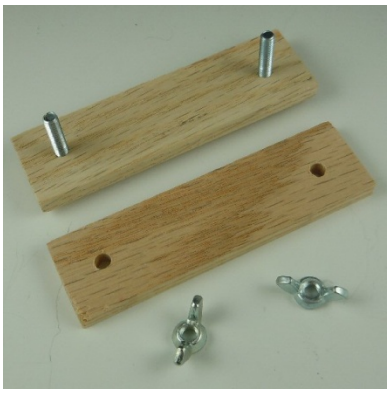
- **Mandrels -** Mandrels are rods used to form the coil of wire to be cut to make the jump rings. They are usually metal, but other materials will work. Mandrels usually come in a set in either metric or English sizes. I prefer to use English sizes because the increment between sizes is smaller than the 0.5mm increment usually found in metric sizes. Some sources for mandrels include: Kevin Potter at www.potterusa.com, Harbor Freight sells a 28 Pc. Transfer Punch Set (item 3577-2VGA) with 28 - 4-7/8" punches from 3/32" to 1/2", Rio Grande, and many other jewelry suppliers.
- **Winder** - A winder is basically a drill chuck mounted with a handle that holds the mandrel and allows you to turn it to make the coil of wire. Some sources for winders include: Kevin Potter, Rio Grande, and many other jewelry suppliers.
- **Coil Holder and Cutter** – A coil holder is a box like thing that holds the coil of wire with a slot in the cover for the saw blade. The cutter attaches to a rotary tool and the saw blade is housed inside a guide that just fits over the coil holder and keeps the saw blade aligned with the slot in the cover of the coil holder cut the jump rings. I highly recommend the Koil Kutter that is available from Kevin Potter at www.potterusa.com. I use the Koil Kutter on a Dremel Model 4000 running at about 20,000 RPM.

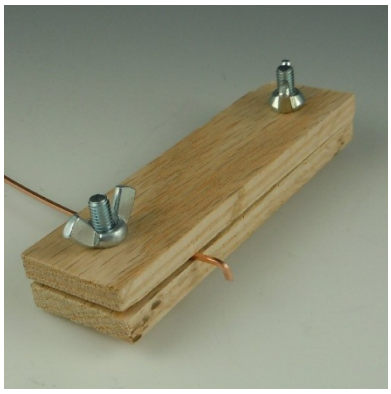
The steps for making jump rings are:

- Wind the wire around a mandrel into a nice even, tight coil.
- Place the coil in the coil holder, cover it with a strip of drafting tape, rub a little Bur Life on the tape, and secure the cover of the coil holder.
- Place the cutter on the right end of the coil holder, turn it on, smoothly slide it to the left end of the coil holder, lift it off the holder, and turn it off. Because of the direction of rotation of the saw blade the cutter must be moved from the right to the left. The first question I ask of someone who is having trouble cutting jump rings is “Are you left handed?” The answer is almost always “yes” and they were trying to cut in the wrong direction.

Holding Non-Round Wire to Make Jump Rings

It is almost impossible to keep non-round wire from twisting by holding it in your fingers while winding a coil without using some sort of a jig. I use two small pieces of wood held together by two bolts with wing nuts.





Place the wire between the wood strips and tighten the wing nuts until the wire is held very snugly. Bend the end of the wire down and slip it into the hole in the mandrel. Keep the edge of the board in contact with the mandrel as the coil is being wound.

My jig is constructed using two 1" x 4" x ¼" strips of oak, and two 1" long 10 x 32 machine head bolts with wing nuts.

Basic Fusing and Soldering Techniques for Jump Rings

Fusing is a technique of joining metal together without solder. Fine silver and Argentium™ sterling silver may be fused; other sterling silvers will generally not fuse. Fusing is best done on a flat soldering pad. I fuse rings that I am not going to deform or hammer. If I am going to deform or hammer the rings I generally solder them.

Soldering is a technique of joining metal together using flux and solder. Argentium™ sterling silver wilts, or slumps, when it gets near fusing temperature. If you need to hold the jump ring in a third hand to keep it away from other rings, it might be best to solder the rings.

Equipment Needed

Torch – A butane "cream brulee" torch is all that is needed for fusing or soldering jump rings. These run from about $10.00 and up at your local hardware store, but you will probably have to pay at least $40.00 to get a good one. I have tried 5 or 6 different torches and I prefer the Blazer GB2001 or the Solder-It PT-220. They are easy to light, do not require you to hold the trigger depressed, and have an adjustable flame.

Butane – You will also need to get a can of butane to fuel the torch. These are also available at most local hardware stores.

Soldering pad – This is a fireproof pad to place the jump rings on while you are fusing or soldering them. These are available from jewelry supply stores. I use a ceramic

soldering pad from EuroTools. The pad will get hot, so put something between the pad and any table surface you want to keep from burning.

Solder – I find paste solder the easiest to use for jump rings. Solder comes in several grades, i.e. easy, medium, hard, etc. Easy solder is the grade you want for soldering jump rings. Past solder contains the flux in the paste, so you do not need extra flux.

Pickle – Pickle used to remove any oxides that form during the heating of the jump rings. Citric acid makes a good pickle, and the powder is commonly available at food stores or wine and beer making supply stores. Dissolve a couple of ounces of the citric acid powder in hot water. Pickle works best when it is warm. If you plan to fuse or solder regularly you might want to invest in a small crock pot to keep the pickle warm. Information on using citric acid as a pickle may be found on the web at www.pajed.co.uk/fsofiles/CitricAcidPickle.pdf.

Fusing a Jump Ring

1. Close the jump ring making sure that the ends are firmly touching. The joint will not fuse if the ends are not in good contact with each other.
2. Place the closed jump ring on the soldering pad with the joint towards you.
3. Heat the ring carefully with the torch until the two ends of the jump ring fuse together. Argentium™ sterling silver is not as good a conductor of heat as fine silver, so you can keep the tip of the light blue flame directly on the joint.
4. As you heat Argentium™ sterling silver it will first get "cloudy" and then it will become very shiny. At this point you will see the joint partially disappear. It will probably not disappear completely, but you are only a nanosecond or two away from melting the jump ring into nice shiny ball, so take the torch away from the ring.
5. Pickle the jump ring.

Soldering a Jump Ring

There are at least three methods that I commonly use to solder a jump ring. They are:

- flat on a fire brick on top of a pillion of solder
- paste solder while on a fire brick or in a third hand
- the "pick" method while on a fire brick or in a third hand

Flat on a fire brick on top of a pillion of solder

1. Close the jump ring. Make sure there is no gap between the butted ends. Silver solder will not bridge gaps.
2. Place a very small pillion of solder on your fire brick or other soldering surface.

3. Place the closed jump ring flat on the fire brick with the butted joint resting exactly on the pillion of solder and facing you.
4. Place a drop of flux on the joint in the ring and the solder below it.
5. Light the torch and gently heat the entire jump ring by passing the torch in a small circle over the ring.
6. When the ring is almost to the soldering temperature pause the torch briefly over the joint.
7. Immediately remove the torch when you see the ring drop and the solder flow upward into the joint.

Paste solder while on a fire brick or in a third hand

1. Close the jump ring. Make sure there is no gap between the butted ends. Silver solder will not bridge gaps.
2. Place the jump ring on your fire brick or other soldering surface, or in a third hand with the joint either at the top, or on the bottom, depending on what else is attached to the ring.
3. Place a small dab of paste solder on the top of the joint.
4. Light the torch and gently heat the entire jump ring by passing the torch in a small circle around the ring.
5. When the ring is almost to the soldering temperature pause the torch briefly over the joint.
6. Immediately remove the torch when you see the solder flow into the joint.

The "pick" method while on a fire brick or in a third hand

1. Close the jump ring. Make sure there is no gap between the butted ends. Silver solder will not bridge gaps.
2. Place the jump ring on your fire brick or other soldering surface, or in a third hand with the joint either at the top, or on the bottom, depending on what else is attached to the ring.
3. Place a drop of flux on the joint in the ring.
4. Place a small pillion of solder on a fire brick or other soldering surface.
5. Light the torch and gently heat the entire jump ring by passing the torch in a small circle around the ring.
6. Heat the solder pillion with the torch until it melts into a ball and pick the ball up by touching the tip of a solder pick to it.
7. Keeping the solder ball on the pick hot move the pick to very near the joint in the ring so that you are also heating the ring.
8. When the ring is almost to the soldering temperature touch the ball of solder on the pick to the joint. The solder should flow from the tip of the pick to the joint.

9. Immediately remove the torch when you see the solder flow into the joint.

Polishing Chains

Do not attempt to polish chains with a polishing wheel or any other rotary device.

The best way to polish a chain is to burnish it in a small tumbler with stainless steel shot and a burnishing liquid. I have found that 30 minutes is usually adequate for sterling silver, gold filled, copper, and brass. I usually tumble niobium for only 10-15 minutes.

I use a Lortone Model 3-1.5B tumbler in my studio and a small tumble from Harbor Freight (manufactured by Chicago Electric Power Tools) in some of my classes and workshops.

I use the barrel from the Lortone tumbler (it is a little smaller than the Chicago Electric barrel), and 2 pounds of the Stainless Steel Mixed Shot (Rio Grande #339-097) with Super Sunsheen Burnishing Compound (Rio Grande #339-394). Make sure you get stainless steel shot or you will spend all your time trying to keep it clean. I rinse the barrel and shot in water and add 5cc of Super Sunsheen for each run. I leave the shot in the barrel, covered with water and Super Sunsheen, between tumbling runs.

I have heard people say that they have had trouble with "black gunk" appearing in their tumbler and on their finished pieces. This is usually due to dirt from running the tumbler too long without changing the liquid, and not due to the rubber of the barrel. I have not had this problem since I started changing the burnishing liquid before every use.

I have had students ask about household products they can use instead of Super Sunsheen. I have tried several products recommended by others, but I have not found anything that will give me the results that I get from Super Sunsheen. Super SunSheen is diluted 45 to 1 for use. A 1 quart bottle will lasts me for over 200 tumbler runs, and only cost about 3-4 cents per run. I just don't think it is worthwhile spending the time or money to try anything else.

I use Goddard's Silver Polish liquid (#707184), or Goddard's Silver Polishing Cloth (#707684), to put the final shine on my finished pieces.

Playing by the Numbers

Don't Panic. We are going to go over this lightly for those of you that really want to understand "the math" of chain making. First, I need to clarify a couple of points:

1. We will be primarily using inches and feet, rather than metric measurements. The reason for this is that using drill rod (to make the mandrels) in units of 64ths of an inch provides a smaller increment between ring sizes than the 0.5mm increment available with metric sizes. We will however be using 3mm and 5mm sized mandrels to fill a couple of gaps in the smooth increase of the smaller jump rings. Remember, inches may be converted to millimeters, and visa-versa, quite easily with a calculator. Simply multiply inches by 25.4 to get millimeters, or divide millimeters by 25.4 to get inches.
2. We will be using the terms mandrel size and inside diameter of the jump rings interchangeably. This is almost true for the smaller size jump rings, and not quite so true for larger sizes because of the "spring back" of the coil when tension is released. This is generally not a problem because for most chain patterns the exact size of the large jump rings is not as critical as that of the smaller jump rings.

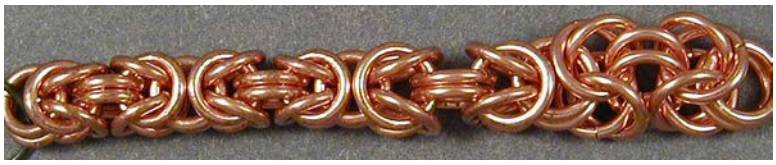
Aspect Ratio

The aspect ratio (AR) is the ratio of the inside diameter (ID) of the jump ring to the diameter of the wire (DW), not the gauge, but the actual diameter. In some references it is called the key number, or other names, and for many chains will probably vary from 3 to 6 (or higher). Knowing the aspect ratio for a chain pattern allows you to determine what size jump rings to use to build that same chain pattern using any gauge wire.

$$AR = ID / DW$$

Every chain pattern has a minimum aspect ratio. It is generally impossible to construct the pattern using rings with a lower aspect ratio, or if possible the chain will be very stiff.

Some chain patterns have a very narrow range of aspect ratios. For example, the Byzantine chain in the following picture was constructed using rings with the recommended aspect ratio of 3.5 on the left half, and rings with a larger aspect ratio (4.3) on the right half.



Tables of aspect ratios for all three wire gauges are available on our web site at www.bijoux-de-terre.com. Click on "For Our Students" on the left, and scroll down to "Reference Sheets".

Number of Jump Rings per Foot of Wire

To estimate the number of jump rings that can be cut from a foot of wire you simply divide 12 by the length of wire needed for 1 jump ring. The length of wire needed for

one jump ring is the inside diameter (ID) of the jump ring plus the diameter of the wire (DW) (again not the gauge, but the actual diameter) times pi.

$$Rings\_per\_foot = 12 / (ID + DW) * 3.14$$

Length of Wire Needed to Make X Jump Rings

To estimate the length of wire needed to make a specific number of jump rings you simply multiply the length of wire needed for 1 jump ring times the number of jump rings needed (X). The length of wire needed for one jump ring is the inside diameter (ID) of the jump ring plus the diameter of the wire (DW) (again not the gauge, but the actual diameter) times pi.

$$Length\_of\_wire = (ID + DW) * 3.14 * X$$

Determining the Correct Jump Ring Size to Use for a Chain

Use the table "Jump Ring Aspect Ratios – Round Wire – AWG" below for the following two examples.

The correct sized jump rings for constructing a Byzantine chain (suggested aspect ratio of 3.5) using 18 gauge wire are determined by following the green example. Scan right across the top of the table until you arrive at the column headed "18 gauge". Now scan down the "18 gauge" column to the row with the aspect ratio closest to the 3.5 needed, and follow that row to the left to identify that a 0.141" jump ring should be used. If you are using metric jump rings, a 3.5mm jump rings could also be used.

Changing the Wire Gauge

To change the wire size to 14 gauge for a chain pattern specifying 16 gauge 0.250" jump rings, determine the current aspect ratio by finding the intersection of the column headed "16 Gauge" and the row labeled "0.250" (yellow example) to see that the aspect ratio of the 16 gauge rings is 4.9. Now scan right across the top of the table until you arrive at the column headed "14 gauge" (blue example), and scan down the "14 gauge" column to the row with the aspect ratio closest to the 4.9 needed (4.9 in this case), and follow that row to the left to identify that a 0.313" jump ring should be used. If you are using metric jump rings, an 8.0mm jump rings could also be used.

Jump Ring Aspect Ratios - Round Wire - AWG						
ID inches	ID inches	ID mm	18 gauge	16 gauge	14 gauge	
1/8	0.125	3.2	3.1	2.5	2.0	
	0.138	3.5	3.4	2.7	2.2	
9/64	0.141	3.6	3.5	2.8	2.2	
5/32	0.156	4.0	3.9	3.1	2.4	
	0.164	4.2	4.1	3.2	2.6	
11/64	0.172	4.4	4.3	3.4	2.7	
	0.177	4.5	4.4	3.5	2.8	
3/16	0.188	4.8	4.7	3.7	2.9	
	0.197	5.0	4.9	3.9	3.1	
13/64	0.203	5.2	5.1	4.0	3.2	
	0.217	5.5	5.4	4.2	3.4	
7/32	0.219	5.6	5.5	4.3	3.4	
15/64	0.234	6.0	5.9	4.6	3.7	
1/4	0.250	6.4	6.3	4.9	3.9	
	0.256	6.5	6.4	5.0	4.0	
	0.276	7.0	6.9	5.4	4.3	
9/32	0.281	7.1	7.0	5.5	4.4	
	0.295	7.5	7.4	5.8	4.6	
5/16	0.313	7.9	7.8	6.1	4.9	
	0.315	8.0	7.9	6.2	4.9	
	0.335	8.5	8.4	6.6	5.2	

Wire Gauge Reference Sheet

B&S – Brown and Sharpe Wire Gauge – also known as American Wire Gauge (**AWG**) – used in the United States and other countries for round, solid, nonferrous wire

SWG - British standard wire gauge – used in Great Britain and many other countries

W&M – US Steel Wire Gauge - used in the United States and other countries for ferrous wire

Size in mm	Size in Inches	B&S	SWG	W&M
0.64	0.0254	22		
0.660	0.0258			23
0.711	0.0280		22	
0.723	0.028	21		
0.71112	0.0286			22
0.810	0.03175			21
0.813	0.0320	20	21	
0.8839	0.0348			20

Size in mm	Size in Inches	B&S	SWG	W&M
0.914	0.0360		20	
0.912	0.036	19		
1.016	0.0400		19	
1.02	0.0402	18		
1.04	0.0410			19
1.15	0.0450	17		
1.2065	0.0475			18
1.219	0.0480		18	
1.29	0.0508	16		
1.382	0.054			17
1.422	0.0560		17	
1.45	0.0571	15		
1.59	0.0625			16
1.626	0.0640		16	
1.63	0.0642	14		
1.83	0.0720	13	15	15
2.032	0.0800		14	14
2.05	0.0807	12		
2.30	0.0907	11		
2.324	0.0915			13
2.59	0.102	10		
2.68	0.1055			12

Thank you for attending my workshop.

I hope you enjoyed the workshop and get many years of enjoyment making chains.

There is a wealth of information available on chain making on our Web site at www.bijoux-de-terre.com. Just click on “For Our Students” on the left. If you have any questions, please email me at john@bijoux-de-terre.com.

Kits, for almost all the chain and chain maille jewelry I make, are available on our Web site at www.bijoux-de-terre.com.