How to Make
Vulcanized Rubber Molds

By John Donivan

Just what is vulcanization, anyway? Think of natural, uncured latex rubber, which comes from the rubber tree, as a pile of loose string similar to a plate of spaghetti. It is loose, stringy and has virtually no strength. In the mid 1800's, Charles Goodyear discovered that by adding sulfur, heat and pressure to the rubber, a process called vulcanization occurs. The sulfur bonds to the rubber molecules and "cross-links" them. In effect it bridges the gaps between the rubber molecules and pulls them into a cohesive "super molecule". To continue the analogy, our plate of spaghetti becomes more like a 3d fishnet – geometrically spaced, strong and resilient. All that is required to accomplish this is prepared rubber, which comes already mixed with the appropriate rubber and sulfur compounds, a mold frame, and a vulcanizer – essentially a hot press. The process we will use is identical to the process used to make tires and all sorts of other items, but in our case since we are making a rubber mold of an item, then of course we also need a model to be molded.

The Model One of the most important things to understand about making molds is that the part is going to shrink in the process. Most people think in terms of about 8% shrinkage, but it can vary from that to more like 10%-12%. This is to say that if you mold a part that is1mm thick, the waxes you get out of the mold will be .92mm thick, or about that. Also very important to understand is that the shrinkage is greatest in the direction of the pressure of the vulcanizer itself. Thus, since the platens (the hot plates of the machine) of the vulcanizer are pushing against the sides of the mold, the shrinkage is greatest in that direction. People often mold readymade jewelry with decent to good results, but if an original model is being made for production, this shrinkage must be accounted for. Tiny bits of wire, extremely thin sections and a wide variety of things can simply shrink away in the process, resulting in a useless mold. In addition, every scratch, every mark, every speck of dirt, any dings or irregularities in the model all will be molded and will be in each and every wax that's pulled from the mold. Plus there is a degradation of detail in molding that is usually acceptable for one mold. I once saw a series where they molded a mint coin, cast the result, molded the result, and did that about 10 times. After a few times it was obvious, but in the end what was a fresh, crisp coin had become an unrecognizable lump. The model should be crisp in its details. Fine sandpaper, emery or abrasive wheels are fine for a finish. Polishing isn't necessary and may in fact be detrimental due to the softening of details. Again, a model should in theory be "perfect" – every contour, every edge, every part should be in place and just so, lest you mold problems instead of a part. This may be impractical for some readers' skill set, but it should be a goal. And again, a true model should be around 8% larger in scale, to allow for shrinkage. Finally, the vulcanization process is at around 315 degrees F., so anything that goes into the mold frame must withstand that temperature plus considerable pressure. Sterling silver is the material of choice, but most higher melting metals will do. Anything like wax, wood, fabrics,

plastics, etc. simply will not survive the process and some, like plastics, may even release toxic gases.

Spruing After the mold is made and cut, the opening in the side will be pressed against a nozzle of a wax injector, which is a container full of pressurized, molten wax. After that it will be invested and cast, and the void left from the burned out wax will be filled with metal. How all of this is accomplished is through spruing. Sprues are essentially pipes, and the process of spruing is not really different from plumbing. Sprues are soldered onto the model in strategic places so that wax, and later on metal, can reach the part. In addition there is “internal spruing” which means that the model itself is designed in such a way as to permit the smooth flow of wax and metal. This article won’t try to address the whole subject because it is an art and it’s beyond the scope of this writing, but here are some concepts:

1. In general, the main sprue of the part should be on the heaviest, largest place, so the wax and metal flows from large to small.

2. Neither wax nor metal will flow backwards at any time. If your part goes outwards from the sprue and then switches back towards it, that portion will need another sprue.

3. Beware of what I call, “The Coke Bottle Effect”, which is what happens if you get a full soda bottle and suddenly turn it upside down. What happens is that it goes “glug, glug, glug”, as air bubbles go past the soda, trying to fill the bottle. This is because the neck of the bottle is small. In casting what this means is that if you try to cast an hourglass shape – two large parts with a narrow neck between them, and you sprue at the bottom of one shape expecting the other shape to fill through the neck, you will have the Coke bottle effect and a huge porosity problem if you even get the piece at all. Sprue each of the larger pieces separately to avoid that, and look out for that situation – trying to fill a large piece from a small orifice.

4. Most jewelry sized pieces can work with a single sprue rod, if they are well designed. Sometimes, as with earrings, two or more pieces are molded at once, and a sprue must be built to accomplish that. Again any metal will do, but generally brass rod of an appropriate size is used. I usually cut a basic sprue about ¾” long, which of course will vary with the model. It needs a certain length, though – don’t make them too short! Sometimes more sprues must be added to let the wax reach certain areas of the part, too. What needs to be avoided, though, is making cages of sprue rods, as they can be difficult if not impossible to cut out of the mold and get parts. Generally, spruing is best left on the horizontal plane of the model – the plane that the mold will be cut along.

Spruing IS an art and each model must be sprued according to its own needs. An understanding of the principles and just constantly thinking of the plumbing and how the wax and metal is going to flow through the model is really the important thing. That flow happens in an instant, and what you are looking for is a smooth, even flow with a minimum of turbulence, like water flowing around a piling in a river.

Packing the Mold Mold frames are machined out of a solid block of aluminum, as the pressures involved are fairly high. They come in a variety of sizes, and a size should be chosen that suits your model. The model should fit into the cavity of the frame with at the very least around one half inch all around it. See Photo #2. It must fit within about 2/3 of the height of the frame. That is, a typical frame is one inch high, or thick, and so it will accommodate a model that’s up to 5/8” wide or maybe ¾” at the most. You might get a mold from a thicker model, but the sides get so thin that it can create real problems getting waxes. If the model is too near the edge then wax can leak out or other problems. If you think of a well-framed portrait in a picture frame, that’s about the proportions you want, or less. There’s nothing wrong with molding a small earring in a standard frame, it’s when the frame is too small that problems arise. Next, measure the thickness of the frame. We have several frames that are one inch think, a couple of larger that are 1 ¼”, and one

that’s 5/8” thick. See the picture at the top of this article. You will use one layer of rubber per eighth inch of mold, plus one extra. So, a one inch mold will take eight strips (8/8=1”) plus one extra, for nine layers of rubber. It is most important to understand that you need to have pressure in the frame during the process, and it is that extra layer, plus what you do in the packing, that makes that pressure possible. The rubber actually liquefies from the heat, and even though eight layers may look like it’s above the edge when you pack it, when you apply heat and pressure the platens will simply clamp the frame itself and you’ll get no pressure and a bad mold. If you have a standard size that many call a “ring mold”, with a 3” x 1 7/8” opening, then you can use precut rubber that’s die struck to that size. If you are using strips or sheet then you shall have to cut your rubber. Leave the protective plastic on, and either draft the size of your opening with a ball point pen and ruler onto the sheet, or simply lay the mold on top and trace out the opening on the sheet, again using a ball point pen. Cut the rubber into rectangles with scissors, and then snip off the corners so the sheets will fit into the frame opening. If the frame is too large to be covered by the width of one sheet, then cut one sheet to length and then another strip to fill in the balance. The rubber needs to be a fair fit in the frame, but a bit of play is not going to ruin it. You want a good fit, not a precision fit. Rubber is not cheap – try to be efficient with your layout to preserve material.

For the actual packing process, first off you want the model to be in the center of the layers of rubber. That is, two layers above, two layers below, or whatever suits your model. The body of the mold is going to be, in the case of a 1” thick frame, eight layers deep – the ninth layer is needed but it’s going to be trimmed off in the end. Stack up eight layers of rubber and hold your model up to it, and gauge how it’s going to fit inside. If it’s a flat sheet, it will fit in the very center of the mold – four layers above and four layers below. A larger ring may have two layers above and below. With that knowledge in hand, start packing the mold. Lay the frame on one of your aluminum backing plates, peel off the protective sheets on both sides of the rubber, and carefully put it in the frame opening, with the smooth side up, making sure it lays down flat on the bottom. If we suppose for the moment that your model is a simple piece of sheet metal – the most basic kind of molding job – then you would do that with four sheets of rubber. Pull off the protective backing, and just lay them in. Then, also with that simple model, place the model in the center of the rubber, with the sprue rod touching the wall of the frame. Most frames have the sprue on the short side, but if you need it on the long side that’s ok, too. Make sure the model is in place, centered in the rubber, with the sprue touching the edge of the frame, and then lay another piece of rubber on top of it. I like to put that piece into the frame starting at the top of the model, and lay it down towards the sprue, so the pressure of it tends to push the sprue into the frame wall. Push down firmly on the rubber with your fingers, making sure that no air bubbles are included and that it is firmly down all around the edges of your model. When you’re done you should see an outline of the model raised in the rubber. Then lay the other four pieces of rubber on top of that, making nine layers all together, and you are ready to cook it.

If your model is more than just a sheet – a ring or most anything that’s thicker than one sheet of rubber, then you’ll need to make a place for it in the mold. Start out the same way, figure how many “blank” sheets will go on the bottom and top, and put the first sheets in the bottom of the frame. Then, without removing the backing on the rubber, lay your model on a sheet in the position it will be in and trace around it with a ball point pen (the tool of choice for drawing on rubber or the protective sheets).

See Photo #3. A crude tracing is fine – just put a rough line around it. If your model takes four sheets of thickness, then do the same on four sheets of rubber, always placing the model in the same position. Then with scissors cut out the center of the sheet along the lines you traced, including the sprue rod. A tip – if your model spans three sheets, say, leave the rubber for the sprue rod space on two of them, above and below, and cut it out for the center sheet and it will work perfectly. What you will have is a sheet of rubber with a whole punched out of the center in roughly the shape of your model. Lay your model in place in the frame, and then lay the pierced sheet in around it. See Photo #4. Use a spatula or some such tool to work the rubber in and around everything so it lies down on the underlying layer, but take great care not to scratch or

mark the model! Any damage you do will be molded, at this point. If there are any voids where you didn't cut so close or any spaces in the rest of the model, then snip off small bits of rubber and fill in those spaces. As you will see, it is sticky, and as long as you don't have air spaces then neatness is really not an issue. The goal is to fill every space with that layer of rubber, and extra rubber is better than less, because it just creates pressure later on. If it's a ring, then cut a circle out of the scrap you cut out, and put that into the center of the shank. Also if there are undercuts, as under the center of a ring that's hollow underneath, make sure those are filled as well. At the end of this article, I'm going to address some of the more challenging aspects of molding, such as small holes and such, but really you just want every part of the mold to be either model or rubber – no gaps or airspace, and it really doesn't need to be pretty, just pack it. See Photo #5. Then do the same for the next layer, and the next if needed, until the model is flush with the top layer of rubber, at which point you fill it with full sheets just like the last example, and then it's ready to cook. See Photo #6.

Cooking the Mold Now comes the easy part. What follows are the directions that come with my favored rubber, but you need to read the documentation that comes with your brand and follow it carefully. The vulcanizer should be set to 315 deg.F, and it must be preheated to that temperature. Just like a cake, 320 degrees is not going to destroy it, but 350 degrees will, and cooler means it likely will not vulcanize at all. So, great precision isn't necessary, but as close as possible (use a thermometer) is important. Put the other aluminum backing plate on top of your packed mold frame, put the whole assembly into the vulcanizer, and crank down the handle tight. The handle should be very tight, but it does not need to be "monster tight". Just turn it down until it stops when you exert a fair amount of strength, and that should do it. Be aware that too much pressure can deform a delicate model inside the mold itself, also. Some recommend tightening the handle after 5 minutes, too, but it usually isn't necessary. A good rule of thumb is that if you have to wrestle with the crank or put a tool on it or bang on it with a hammer when you remove the frame, then you are going too tight. A very firm, steady pressure is sufficient, and the heat. Cook the mold for five minutes per layer, plus 5 minutes warm up time. So a one inch frame has 9 layers of rubber. 5 minutes x 9 layers = 45 minutes, plus 5 minutes equals 50 minutes to cook the mold. After that time, unscrew the crank, turn off the heat unless you're doing another mold, and take out the frame, remembering that it's 315 degrees – use a potholder or similar. You can quench the mold in a quantity of water if you like, or just wait. Quenching it will do no harm whatsoever. After it's cool, take off the backing plates, grab some of the rubber that's protruding, pull and push on the mold, and out will pop a solid piece of vulcanized rubber with your model encased inside of it.

Cutting the Mold After the mold is cooked and cooled, trim the excess rubber from the edges with scissors, and it is ready to cut. There are two things needed for this. One is a clamp of some kind. There are several factory made clamps on the market. I use a pony clamp that's tied with a rope to hang at just a certain spot over my bench pin. See Photo #8. Whichever of the many options you choose, you need a clamp. Next you'll need a scalpel. Scalpel handles cost under $10, and the blades are cheap. You'll need a new blade for each mold you cut, so keep that in mind. They ARE scalpels – just the same as doctors use except they're not sterile. For many people they will be the sharpest tool they will ever use. You need to listen, pay attention and be very careful, as accidents can be severe. When changing blades, don't use your fingers, use tweezers to get the blade on and off. The rubber will cut easily with a scalpel, but anything less sharp, even a used scalpel, just won't do the job. When you cut the mold, you actually need to accomplish two things: you need to cut the model out of the mold in such a way that it will give clean waxes in use, and you need to cut keys in the mold body so that the mold will fit exactly back together every time the two halves are put together. First, the keys. I knew a mold maker who cut a zigzag line all the way around his molds, which worked very well though it was a lot of work. Most people cut raised square dimples in each corner, with the corresponding low spot to key into, which also works quite well. What doesn't work so well is low, rounded keys, cutting the surface into a wave surface, and leaving the back end of the mold uncut. The first two methods are simply not strong enough – the mold will squirm out of place easily. The last one seems like a good idea until you pull waxes, and that can

be a real pain when you can't pull the mold truly apart.

To cut a mold of a flat model with square keys, proceed like this: Find the sprue, and hold the mold with the top – the side that was up all along, up. Place the mold on your bench pin on its side, put the scalpel blade into the rubber around ¼" or so right next to the sprue rod, and pull the scalpel downwards, cutting a line into the edge about ¼" deep. When doing this, your other hand should be on top, holding the mold, and the scalpel should go downwards into airspace. Do not ever put your fingers in front of the scalpel, and especially not when it may "pop" out of a cut, as in this case. Then turn the mold onto the next edge, do the same, and all around until you get back to the sprue rod. This will create a line cut around the perimeter of the mold about ¼" deep. See Photos #10 & 11. PUT DOWN THE SCALPEL. With the clamp, grab one of the corners at the top edge, and pull the mold so that the line you cut opens up. Push the scalpel blade straight up into the rubber right at the corner, and cut downwards around ½" or so, and then go back to the same starting spot and cut along the other edge in the same way. It's difficult to explain, but see Photos #12-16 for cutting the keys. PUT DOWN THE SCALPEL. Move the clamp so that it grips the edge that you first cut, at the corner you just cut, and pull the mold open. Now cut across the cuts you made earlier, and then down to the center line on two sides, making a small, square "mesa" type shape. Again, see the photos; it's difficult to explain in words. PUT DOWN THE SCALPEL, and then do the same with the other three corners. At this point I will assume that readers understand to PUT DOWN THE SCALPEL anytime they're doing anything besides cutting. Trying to manipulate a clamp, a springy mold and a scalpel all at once is just plain foolish. Now that the corners are cut, move the clamp to the sprue rod end of the mold, and open it there. See Photo #17. I'll usually cut into the mold from the two corners to create enough of a flap of mold the get a good grip in the center of the mold. Cut inwards, keeping on the center line you began with the very first cut, following the sprue rod, and cutting the rubber at the centerline of the sprue rod, very carefully, until you get at or near your model. See Photo #19. It's best to cut down the centerline of the sprue, but the model is different. You want to have 100% of the rubber either up or down. When you pull waxes, often there will be a line where the two halves of the mold meet up, which is called the "parting line". If you cut the rubber down the center line of your model, you'll likely get a parting line down the center of your wax. If you cut along the bottom edge of the rubber, where the side meets the bottom, likely you'll have no line. So, where the sprue meets the model, cut downwards to the edge –where the side of the model meets the bottom of the model – the "lower corner". Generally you can see a line in the rubber that's a little paler color that is that edge. Very carefully cut from that line outwards, into the body of the mold, all the way around the model. See Photo #20. I generally cut the left side a bit from the sprue, go back and cut some on the right side,(PUT DOWN THE SCALPEL [;<}), move the clamp to get a better grip, and cut it all around. As soon as the model is released from the mold, it's to your advantage to remove it so you can see and cut better. See Photo #21. After that line is cut all around, then you can simply continue the cutting outwards until it meets up with the line you cut at the very first, and the mold will fall into two halves. If you used a sprue former, which I'll discuss below, then it's ready to go. Otherwise, cut two semicircles to fit into the wax nozzle in the end where the sprue comes out, and it's done. See Photo #22.

There are as many scenarios for mold cutting as there are models – very elaborate pieces with holes, piercings, undercuts, settings. Cutting a great mold is certainly an art, and getting good at it takes a great deal of practice. Some molds have removable cores, spiral parts that uncoil when they're removed, and more. Cutting a basic ring mold is not too different from cutting a flat model mold, though. If you cut exactly the same, though, you'll encounter a problem. If you just cut across the bottom edge for the inside and the outside part of the ring mold, when you pull the halves apart the ring will be buried in rubber. The larger the ring, the more difficult it's going to be to remove without damage. This can be dealt with by cutting the rubber on the outside of the ring on the bottom edge, and cutting the rubber on the inside of the ring along the top edge, so that when the mold is taken apart one half has the mold of the outside of the ring, and the other half has a core sticking up, which is the hole through the ring. It's also useful to cut a slight dome where the inside core goes into the mold body, so it will key into place. Any piercings should be

handled the same way – cut the rubber 100% up or 100% down. Small pieces of rubber likely will not meet up properly at the half way point, and you'll get weird, crooked shapes instead. If it's a ring, any piercings must be cut flush with the center core, so they pull away from the wax on the outside half. You'll never get that core out of the ring shank if it also has bits of rubber hanging off of it.

The End Sprue formers are conical pieces of brass that fit over the end of the sprue rod and leave a nice, neat space for the nozzle of the wax injector. I don't use them because they only fit one size of sprue, and simply cutting out the space works just fine almost always. If you want to use them then you just pack them in the mold like anything else. I have a sprue burner that's like a branding iron, if I need to neaten up the hole on a troublesome mold. And be aware that the mold can be worked on further after its cut, if necessary. Sometimes a model will have many tiny drill holes, which may either not fill with rubber, or even if they do those little bits will sway out of place when the wax blows through. I just snip them off to a short length, to be drilled out in metal. Extra spruing can be cut, if necessary, too. Small flaws like porosity, which will be bumps in the rubber, can be cut or melted away. Another thing that's quite useful – sometimes necessary – are what are called "burp lines". After the mold is cut, sometimes you'll cut lines into the mold at strategic places. These have the dual purpose of letting air vent out as the wax in injected – the burp, and also it makes the mold flexible. A large signet ring that's encased in rubber can be cut so that the rubber at the top of the ring and the two sides pull away in three separate parts, butterflying the mold, and then the wax will just pop out. Make sure you don't cut into the middle of an important element, of course.

It's easy to make a rubber mold, up to the cutting part. Cutting a rubber mold is a real skill, and not something to be learned overnight. But it's not so hard to cut basic or simple pieces with success.

2 Ready to Pack

3 Trace Shape & Cut

4 Model in its Space

5 Pack All Spaces

6 The Filled Frame

7 The Cooked Mold

8 Ready to Cut

9 A Good Workspace

10 Cut Around Edge

11 Cut All Around

12 Starting a Key

13 Cut the Corner

14 Corner is Started

15 Across Top and Down

16 And Down Again

17 Getting Into the Mold

18 Cut Along the Sprue

19 To The Model

20 Cut all around Model

21 Almost There

22 For the Injector Nozzle

23 Done

24 First Wax

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