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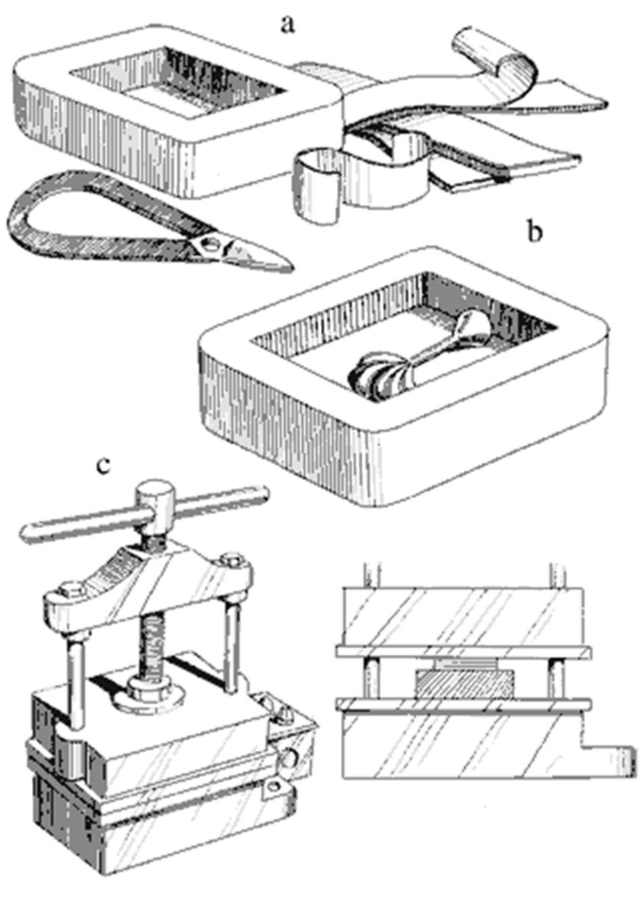
Rubber Molds For the purpose of reproducing a number of pieces from a single original model, rubber is the ideal material. The specially formulated rubber used in mold-making is able to hold an impression of even the most delicate detail work. It is also pliable, so that wax reproductions may easily be pulled from it. It is able to withstand the heat of the molten wax; and it is long lasting, so that many reproductions are possible from a single rubber mold.

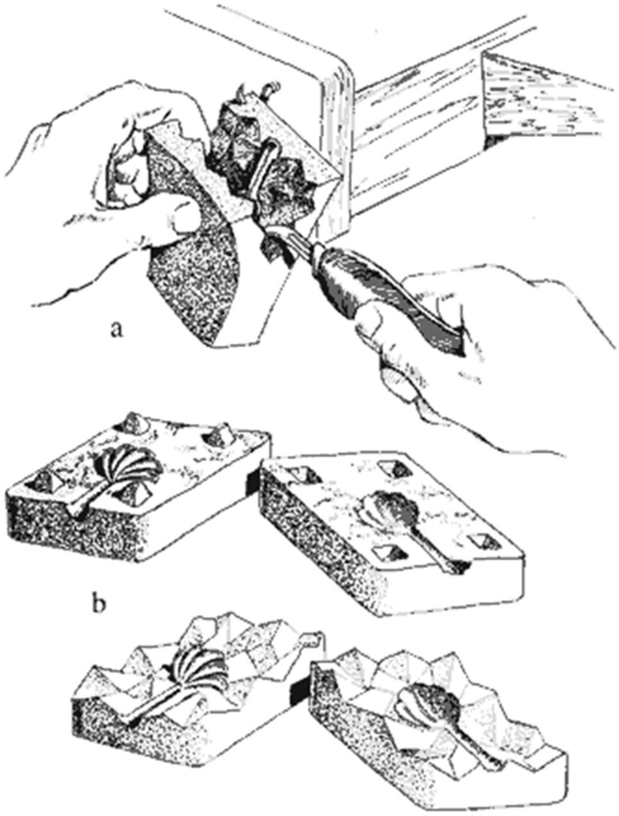
The rubber comes in strips, sheets, or rolls, and is individually cut to the correct size. It also comes in a variety of grades and in a sizable range of qualities. It is upon the grade and quality of the rubber that the shrinkage factor depends; the denser the rubber, the less it will contract after vulcanizing. But here too, discretion and economics must play a part. A grade-A quality rubber, which might be ideal for a highly detailed and precise model, would be a waste of money on a roughhewn silver bead, whereas a spongier rubber would never do justice to the finer model.



So first the piece must be appraised by the mold-maker, not only for the quality of the rubber it demands, but also for the approach he will eventually take to cut it from the vulcanized mold. After this has been done, the chosen rubber is cut to fit into an aluminum or zinc-magnesium frame, packed down in layers, until somewhat more than half the frame is completely filled with the rubber [Fig. 1.5a].

The model, to which a sprue that looks like a golf tee has been soldered, is placed in the frame on top of the rubber, with the end of the sprue touching the inner wall of the frame [Fig. 1.5b]. More sheets of rubber are then packed down tightly on top of the model, sandwiching it entirely, until an equal number of rubber sheets have been placed on top and bottom of the model. The rubber, which rises one or two layers higher than the level of the frame, is ready to be vulcanized.

Vulcanizing A vulcanizer is an electrically controlled device which resembles a cross between an etching press and something from the Spanish Inquisition [Fig. 1.5c]. The aluminum frame containing the rubber-packed model is placed between two aluminum plates (rubber, like wax, does not stick to aluminum), so that the top plate just barely comes into contact with the topmost layer of rubber. The machine is turned on and the plates begin to heat up, melting the rubber at around 300° F. As the rubber begins to flow, a crank is turned to bring the two plates closer together, causing the now-viscous rubber to become compressed completely around the model and to flow into all empty spaces and air pockets within the frame. This operation is repeated until the two aluminum plates come into complete contact with the aluminum frame and the rubber is compressed as much as possible between the plates. The mold is now done. After it has cooled, the now solid block of rubber containing the silver model within it — like an avocado formed around its pit — is popped out of its frame and given to the person who slices open the rubber, freeing the model and creating a mold from which thousands of pieces of jewelry may be cast.



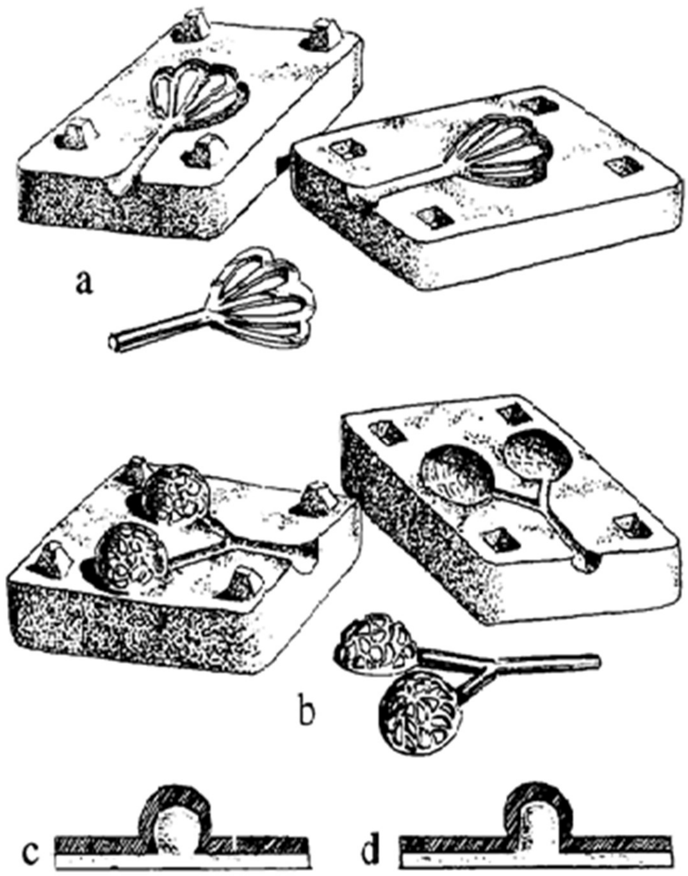
Mold Cutting Rubber-mold cutting, like every other operation we have discussed, is quite simple. The rubber-mold cutter, after having appraised his piece, hooks the vulcanized block of rubber to the side of his bench — usually with an ordinary beer-can opener or bent nail — and makes a few tentative cuts around the edges with a surgically sharp knife [Fig. 1.6a]. He must free the model in such a way that the rubber falls into two halves that can be fitted together again easily and exactly. So he begins by either cutting a male-female locking mechanism into the four corners of his mold or by slicing a saw-toothed pattern completely around the edge [Fig. I.6b].

Once this has been accomplished, he can turn his attention to the real work at hand: cutting the model out of the rubber. The model is completely embedded inside the mold; there is no way of being absolutely certain just exactly where it is. The best that the mold-cutter can do is rely on memory and bend the mold open as far as it can go, stretching the rubber so that eventually the contours of the model start to show. Once the form of the model becomes discernible through the rubber, the mold-cutter may pick and choose, within reason, the placement of the final cuts.

However, unlike casting and vulcanizing, where a successful product is more or less guaranteed if you are careful, a good rubber mold depends upon the individual skill and experience of the mold-cutter. Anyone can slash the rubber mold into two pieces and free the model; only a real professional can do the job so that no difficulties arise later, either in casting or in finishing.

There are many things that a rubber-mold cutter must keep in mind, the first of which is the ultimate objective — the pulling of a perfect wax from the rubber. If the wax, which is still highly flexible when it is taken out of the mold, can only be removed by twisting and turning, a distortion is bound to occur, a distortion that will be permanently documented in each reproduction. Therefore, ease of removal is a prime factor in determining how the mold-cutter will approach the task. A basically flat piece entails no problems; the mold-cutter simply slits along the edges so that the mold divides equally and the wax is just lifted out [Fig. I.7a]. A ring, on the other hand, especially one that boasts a highly domed hollow crown, demands much more sophisticated techniques so that the pulling of the wax may be effected without distortion. In fact, the more complex the piece, the more the ingenuity of the rubber mold-cutter will be tested.

However, there are some things that even the best rubber-mold cutter in the world cannot accomplish. It is the job of the designer/model-maker to understand what is possible and what is not possible in cutting a mold. A hollow filigree bead, for example, is absolutely impossible to produce in one piece from a rubber mold; there is no way to free the rubber inside the ball assuming that the melting rubber can even work its way inside the openings of the silver model. In order to produce a hollow bead, the model-maker must present it to the caster in two halves. The mold-cutter can then position his cut around the rim of each hollow hemisphere, and removal from the mold is an easy matter [Fig. 1.7b]. After polishing, the two halves are soldered together and the bead is done. This same principle applies to any hollow, fully formed three-dimensional object. It must be cast in two halves; the two halves reproduced in the rubber mold and, then, soldered together.

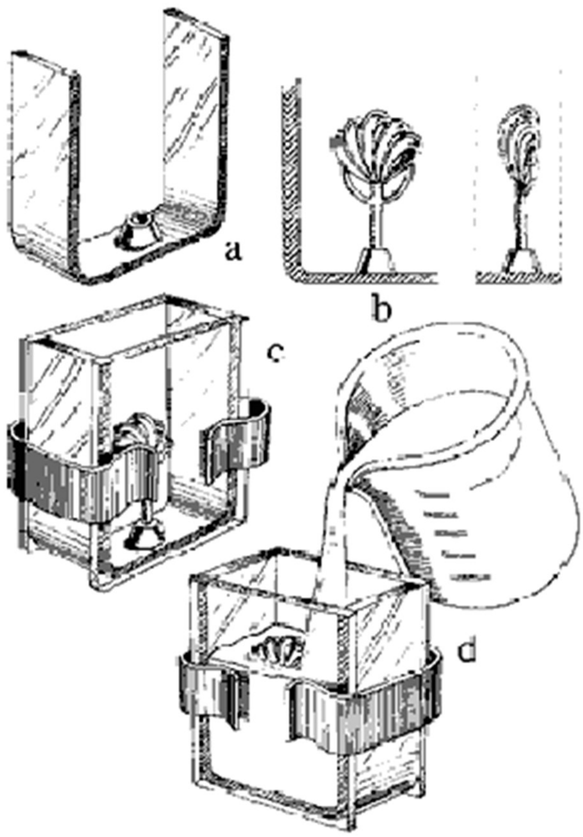


Similarly, objects having very severe undercuts cannot be pulled from a rubber mold without some distortion. Anything that comes to a bottleneck should he avoided. For example, a large hollow bead rising from a flat surface can be reproduced in the rubber — there will be a large enough opening for the rubber to flow inside the cavity and take on the impression of its exact contour — but that which is hollow in the model becomes solid in the mold and, after the wax has been formed, there will be no way possible to squeeze that solid rubber ball through the tiny opening in order to release the wax without distorting it [Fig. 1.7c]. One way of avoiding this is to make sure that wherever you have a deep core, the base of that core should not exceed the width of the opening — even though the outside contours might create the illusion of uniform thickness within [Fig. 1.7d]. In fact, very deep cores should be avoided altogether if possible, since the rubber will contract unevenly around long extended hollows, causing the wax to become excessively thin in spots. A simple understanding, on the part of the model-maker, of the basic principles of rubber mold making will ultimately produce a cleaner, better piece, as well as goodwill between the model-maker and the mold cutter: no mean accomplishment; he is a worthwhile ally.

The mold-cutter's job, however, is not finished after deciding how to split the mold to insure minimum distortion in the wax. He must seriously consider where the split should fall along the surface of the model. This is the hallmark of the fine rubber mold-cutter, because wherever this parting line, as it is called, runs, there will be a slightly raised line caused by the overflow of wax seeping through the unavoidable space between the halves. Quite often, the mold-cutter will have to make a trade-off between distorting the wax and laying his parting line across the most intricately carved section of the piece. A poorly placed parting line can cause the jeweler hours of unnecessary cleanup; it could even amount to re-engraving entire sections of the piece each time one is cast. I once did a model of an Art Nouveau piece, a lady with long, flowing hair. Numerous hours were spent on incising lines into the hair to accentuate the pattern of the tresses. Numerous hours more were spent accentuating those lines in the cast metal model so that they would be as sharp and as clean as possible, since detail does have a tendency to become less distinct in the rubber mold. When I got my first reproduction back, not only did the patting line run across the nose and check of the lady's face, it ran at a right angle to the direction of the hair. Each strand had to be filed and separated individually. Needless to say, I quickly had another rubber mold made — by another rubber mold-cutter.

In general, the mold-cutter, with an eye toward ease in cleanup, tries to run his parting line along the edge of a piece. This is the easiest sort of seam to remove: the jeweler simply files down the edge of the casting and all evidence of the parting line vanishes. Failing this, the mold-cutter will place his parting line across the broadest plain surface he can find, preferably one that is domed up, so that the jeweler will have no difficulty in filing or grinding the seam. If this method is inappropriate as well, the mold-cutter hides the parting line in the most obscured section of the piece, usually in the back, or where settings or another casting are intended to fit.

Once the parting line has been decided upon, the cut is made and the silver model is removed from the rubber. Then the mold-cutter has to manicure his product. Release lines - lines which are cut into the inner surface of the rubber to facilitate removal of the wax from the mold - are made. Incised imperfections, which might have escaped the model-maker's attention, and which now show in the rubber as raised ridges or nipples, are burned away with a hot tool. If necessary, additional sprue channels are cut directly into the rubber to augment the flow of wax through the main sprue. Most important though, sections that appear too thin are burned out slightly to allow more room for the wax to enter.



Shrinkage Unexpected thin spots are the great bane of the model-maker who is about to put his piece into production. And, in most cases, these thin areas should not really be totally "unexpected"; they are caused by inadequate compensation in the original wax model for the shrinkage that will occur afterward. The finished cast silver original is at least three percent smaller by volume than the original wax had been. Now, to that sum, must be added the shrinkage factor of the rubber.

A rubber mold, unlike the original mold in the investment, is not inert after it has set. As long as the silver model is still wedged firmly inside it, it will conform exactly to the dimensions of the model. However, once the model has been released, the rubber will expand to fill some of the space that had been taken up by the metal, much as a rubber ball held tightly in the hand will expand when the pressure is released. The result is that the mold impression is appreciably smaller than the model from which it was made. Depending upon the rubber, this shrinkage may be as little as three or four percent, for CASTALDO rubber; to as much as eight percent for the less expensive brands. So, the model-maker is dealing with a very major shrinkage factor, which can range from six percent overall at the very least, to as much as 12 percent and more. And there are yet three more operations to be performed, each one of which will further reduce the size of the finished piece.***Non-Shrink Molds*** As we have seen, shrinkage is a factor that the model-maker must confront every time he sits down to create a piece of jewelry. To give you an idea of how shrinkage determines the ultimate size of your model, I have found that, in order to make a ladies' ring the standard size six and a half, I must make my model size seven full (which actually gauges just a little less than seven and a quarter on the ring stick). Using calipers to determine dimensions, and scales to compute volume is generally of little use and, often, it is only by dint of experience that a model-maker is able to judge the amount of shrinkage a piece must undergo from model to finished casting — that is, until now. Now, through advanced technology, a model-maker who wants his ring to come out size six and a half can actually make his model size six and a half. Shrinkage is no longer a factor.

In the trade, this new approach to mold-making is given a variety of names: R.T.V's (room temperature vulcanized molds), cold molds, or silicon molds. However, not all cold molds are silicon-based, some are polyurethane, and not all silicon molds are cold molds. Therefore, for the sake of clarity, I prefer the term "non-shrink," which refers to the salient feature of all; when they are applied and cured, these molds, unlike vulcanized rubber molds, do not contract. Consequently, the impression left by the model retains the exact dimensions of your original. Non-shrink molds, whatever their composition, are available in two distinct types: those that are intended to be applied as a liquid and those that are formulated into a consistency similar to putty. The uses of this latter type are limited to the creation of molds from metal models or, at least, from models of a material far more durable than wax; they will be discussed in a later chapter. For your delicate wax model, however, only the liquid non-shrink mold is ever used.

Since the molding material will be poured, rather than laid down in sheets as we have been accustomed to doing, a special flask must he created. The usual procedure is to gauge the depth of your model and then to select a mold frame that is at least one-half inch greater. Mold frames are made of aluminum to facilitate removal of the finished mold; they arc U-shaped and come already equipped with a built-in sprue holder on the very bottom [Fig. 1.8a]. Into this, the mold-maker inserts the sprue of your model, making certain that the model is upright and that it does not exceed the width of the frame at any point: [Fig. 1.8b]. Then he sandwiches the frame between two sheets of either glass or Plexiglas, sprays a lubricant on all interior surfaces, and clamps the entire unit together, creating a leak-proof flask [Fig. 1.8c].

Now he must mix the molding solution, which comes to him packaged in two separate containers: one holding the solution itself, a viscous liquid the consistency of heavy cream; and one that contains the catalyst that will harden and cure the solution. Special care must be taken to mix the two together in the correct proportions. Too much hardener and the mold becomes brittle and difficult to cut. Too little hardener and it becomes too soft to take an accurate impression. Then, just as in investment casting, the flask is placed into a vacuum to remove the entrapped air bubbles, which can cling to the model and ruin the mold. Once this process has been completed to the mold-maker's satisfaction, the solution is simply poured into the flask until it completely covers the model [Fig. 1.8d]. Another few minutes in the vacuum, just to insure that the solution has been sucked into every tiny undercut of your model, and the flask is set aside. In twenty-four hours the solution will have set and be ready to be cut and used as a mold.

The advantages of such a mold should be obvious. First, of course, as we have already noted, every casting pulled from such a mold retains the exact dimensions of the original. Second, and perhaps even more important, is the fact that there is no chance of your model being lost in the burn-out — always a risk, although a slight one, whenever your original is cast into silver. Here, not only is your original safe, since it was never melted away, but also, if the mold-maker is careful and your model is not too fragile, your original wax can be returned to you for further additions and modifications.

Remember, though, as of this writing, the process is still a new one and there are many drawbacks to it. The mold is not as strong as rubber and it can tear much more readily. It takes longer to cure — a day as opposed to an hour — a problem in large-scale production. The mixing of the solution and catalyst must be totally accurate; otherwise the mold will be unusable and another entire day will have been wasted. The shelf-life, unlike a vulcanized rubber mold which can last for decades, is relatively brief. After two or three years, you might find that the mold has reverted to a semi-solid goo — a problem which is particularly troublesome in very hot climates.

—shrinkage and all. That is now. However, in the future, it does seem likely that yet more advanced technology will produce a non-shrink material that will be the equal of vulcanized rubber and may even be superior