Richard Austin (1936-1990) was a metalsmith and author, with several hundred articles to his credit.

After his death I was given custody of an extensive collection of manuscript material-mostly on the technical issues of metalworking.

This text represents the first effort to organize the material-an attempt merely to group the files by topic. None of this is finished, and the text makes reference to illustrations that were never done-illustrations which were stored separately in any case, making it extremely difficult to bring the parts together.

It is unlikely that I will ever be able to spend the time to sort this all out. But it seemed a shame to let these articles languish unread by those who might benefit from them in some small way. So I have decided to release them in their roughly sorted form in the hopes that someone may find them useful.

This information is provided without warranty of any kind. No liability for its use will be assumed by the publisher. It is provided purely as an historic document.
The principle shortcomings of wax modeling relate directly to the inherent nature of the materials. Basically, there are two problems. First, it's difficult to hold close dimensional tolerances working in wax. The material is flexible and often softens with handling. Even when reasonable dimensional standards can be established at one point, the material may stretch or bend during subsequent work. Second, the material has relatively little structural strength. This means that certain kinds of thin sections are difficult to achieve. If you are producing traditional organic forms which are common to wax modeling, this presents relatively little problem. However, if you wish to produce precise crisp forms with thin cross sections, the problem becomes much more serious. Since most fine jewelry would utilize these crisp forms and thin sections (because of gold economics), it's important to find ways to use plastic materials to circumvent these inherent problems.

Although it's practical to make models completely out of plastic, this may require special materials, skills and processes. A hybrid model combining plastic and wax is much simpler and more practical. Since the thin sections and precise tolerances usually relate to stone seating, this is probably the best area for plastics application. Additionally, plastics can be added to some models to achieve
thin cross sections or deeply recessed areas. The best way to treat these is to examine some processes individually below:

**Bezels** - A cast bezel requires both good dimensional control and thin cross sections. This makes it an excellent candidate for modeling of plastic. The following material will outline one way of constructing a plastic bezel which can be cast separately or added to a wax model as required. Commercial acrylic sheet is probably the best material for this application since it is available in a wide range of thicknesses. Ultimately the thickness will correspond approximately to the bezel height. Begin by selecting an acrylic sheet of a thickness equivalent to the bezel height which you wish to achieve. You may wish to use a slightly thicker sheet and cut down the bezel after the model is formed. Also, many cabochons are not uniformly beveled, and you may wish to change the bezel height at different locations or curves. The first step is simply to cut a hole in the acrylic sheet which corresponds to the inside of the bezel. In most cases, begin by selecting an engineer's templet which most closely corresponds to the shape desired. Normally, you can find an oval quite close to the one you need. If the oval of your stone is truly unusual or the shape is other than oval, it may be necessary to mark the plastic in some other way. In any event, the basic shape is scribed on the plastic.
This can be done with a stylus or a hard, sharp pencil. Typically, I sand the plastic surface with 400 grit sandpaper and mark the bezel with a hard drafting pencil. You can keep the mark from rubbing off during handling by placing a piece of clear adhesive tape over the marks. Next, drill the hole through the plastic, inserting number two jeweler's saw, and saw out the basic form. This should generally be kept about one-half millimeter smaller than the size of the stone. At this point, some irregularity is tolerable. The next step is to use various rotary files to enlarge the hole to provide a good pit fit for the stone. I normally use a series of tungsten carbide rotary files for this operation. I work with care, insuring that the sides of the opening are as square as possible. Avoid unnecessary development of a radius. As you approach the final size for the opening, you can hold the stone over the hole and look into a bright light. This will disclose any contact points which should be relieved. As the final size is approached, I often use number four jeweler's files and/or 200 grit sandpaper for the final fitting.

Remember that a snap in place fit is not satisfactory. The plastic will yield somewhat more than the ultimate metal, so even though you can snap the stone into the plastic, it will fit tightly in the metal. There should be a free fit which will not bind the stone in any point.
The next step is to remove the basic bezel form from the sheet. Saw around the opening, leaving a wall thickness of roughly two millimeters. The outside of this cut can be relatively crude. The next step is to glue this oval form to a sheet of acrylic or polystyrene plastic. This will form the seat of the bezel. The material used for the seat can be in the range of one-half to one millimeter in thickness. The oval may be glued in place with instant cement or solvent cement. The next step is to saw the base sheet to match the outer side of the bezel. When the glue is fully dried, tungsten carbide tools are used to work the bezel wall thickness down to an appropriate dimension. This should be done with a very slight taper, leaving the top of the bezel slightly thinner than the bottom. Because of the natural radius of the plastic, you may find that the cross section which is developing at this point will be similar to that indicated in Figure 6. This can be corrected by flowing a bead of blue dental inlay wax into the depressed area next to the stone seat. After the wax is hardened, a small spatula can be used to form a radius. Normally, this radius will not interfere with a properly beveled cabochon. When the bezel wall section is properly developed, the inside of the seat can be removed, leaving a narrow shelf to accommodate the stone. The reason for leaving this operation until last is to provide
structural strength during the process of cutting down the bezel wall. At this point, you may wish to make the seat a little thinner by lapping on 220 grit wet or dry sandpaper. The height of the bezel wall may also be cut down at this point. If you're inexperienced in this technique, it may be best to begin with a bezel which is too deep since they tend to develop a knife-edge section until you have any good level of skill. This doesn't cause a problem if you have enough material to allow you to cut down the bezel at the end of the process.
WAX BUILDUP

Although I began by segmenting wax buildup and fabrication the
distinction is somewhat artificial. I seldom do a project which is
totally one or the other. If I don't sculpt the model I usually combine
fabrication and buildup. However, having made the distinction, a wax
buildup project is a good opportunity to illustrate several useful
techniques.

A totally built-up wax model requires some kind of a base. A
sheet of glass or polished metal is a good base for a flat project such
as a pin. A commercial ring mandrel is a good base for a ring. If
you are just starting to learn this technique you may not have a
commercial mandrel. In that case almost any cylindrical object of
the correct diameter will do. If you don't have a mandrel, roll a
paper tube from ordinary tablet paper and tape it together. Wrap the
tube with a smooth covering of aluminum foil and proceed.

Melted modeling wax sticks to metal to varying degrees so it's a
good idea to use a wax release on your mandrel. All kinds of materials
are recommended for wax release agents. These include cooking spray,
glycerine, oil, candle mold release, silicone grease and most of the
debubblers used in wax investment. Almost all of these materials
work to varying degrees on different surfaces. Many of the release
compounds which work best contain varying amounts of silicone fluids
or greases. All of the silicone fluids or greases are excellent
release materials. They are so excellent that they may cause problems
in other shop processes and they are almost impossible to remove com-
pletely without vigorous chemical action. If you coat a baroque stone
with silicone grease, and later try to epoxy the stone into a mounting, 
the chances of achieving a good epoxy bond are poor unless you go 
through all kinds of cleaning or grinding to prepare the surface of 
the stone. Most of the silicone compounds also interfere with paint 
bonding. If you use silicone type materials in your shop, you should 
make an effort to keep them completely separate from surfaces which 
will be later glued or painted. If you want to use silicones as re-
lease materials, I would suggest that you get a tube of silicone 
stopcock grease from a laboratory supply house. A tiny amount of this 
rubbed on a ring mandrel will provide good wax release. As a matter 
of fact, one tube of the silicone grease is probably a lifetime supply 
for the average hobbyist. If you can't find a lab supply house, most 
automotive departments carry spray cans of silicone lubricant. This 
material can be sprayed into a rag and rubbed on the surface where 
release is required. In cases where you don't wish to use silicone 
materials, light household oil is a good release agent. A film of 
oil will provide adequate release and it can be removed from most non-
porous surfaces. The best approach for removing oil is a hot, soapy 
ammonia solution followed by an acetone wipe.

No matter what release agent you use, you may have some problems 
with a wax model sticking to a mandrel or a stone that won't pop out 
of the master. The best approach here is to put the work in a deep-
freeze and let it chill. The differences in thermal expansion between 
metal and wax or stone and wax are generally enough to pop the material 
free. Be careful about the thermal shock on stones such as opal. 
Another thing that will help when you're waxing up around a stone is to 
provide a small hole in the back of the wax. A toothpick can be used to
apply a little pressure from the rear to help the stone out of the wax. This is much better than prying around the edge of the stone or trying to pop it out from the front surface.

**Water Soluble Wax** - I would like to take advantage of the topic of fabrication to introduce you to a curious material: water soluble wax. Since this material is generally used as a soluble base for wax buildup this seems a good time to include it in our discussion. Water soluble wax is available as white blocks or chunks. The material is fairly hard and brittle but it does melt and work like other hard waxes. The wax can be applied in any position where you would like to have support for your wax buildup but would like a hollow core in the final model. For example you could form a sphere of soluble wax, cover it with a fine network of wax, dissolve the core and end up with the model for a hollow filigre ball.

In this case the soluble wax will be used for two purposes. It will support the stone while wax buildup proceeds and it will provide the support to construct a wax bezel. Starting with an oval cabachon the whole top of the stone is encased in soluble wax. This can be done by placing the stone in the bottom of a small aluminum foil dish formed to size. Just pour melted wax over the stone and allow it to cool. File the wax away to the girdle of the stone as shown in the figure. If you wish to raise the stone carve a block of wax to form a core. This step is also illustrated in the figures. Assemble the parts on a mandrel by joining with sticky wax. Build up the wax model including the bezel area. Note that the wax at the edge of the bezel will tend to feather edge. This can be adjusted after the soluble wax
is removed. When the model is complete, slip it off the mandrel and place it in a bowl of room temperature water for a couple of hours. When the cores are gone, trim and touch up the model as required. The construction steps are illustrated in the photos. The model illustrated was built-up by applying heated wax with a spatula. For large flat areas try adding melted wax by painting it on with an artist's brush.

Wax Pen - So far we haven't talked about the use of commercial wax pens. I have one in my own shop and I've had the opportunity to try several brands. Frankly I find that I don't use mine very often. If I have a quick job I'm too impatient to wait for it to heat up and stabilize. The only time I work with the pen is when I've got a whole day to spend waxing or I'm after a special effect. However, if you are going to do a high volume of commercial work they can speed up the process considerably.

FABRICATION

Jewelry models can be fabricated from wax forms in much the same manner that jewelry can be fabricated from metal sheet and wire. Actually, wax is available in as many or more forms than metal. In addition to a full range of wax sheet, round and square wire, and bezel stock, wax is also available in a variety of unusual extruded shapes.

Many of the materials such as wax sheet are also available in various harnesses or grades. Most of the materials will be fairly soft or flexible at or slightly above room temperature. The materials are easy to form or bend. The shaping can be accomplished over a form or free-hand.
As is the case with buildup, construction by fabrication would often be combined with other techniques. However, a few examples of projects constructed by fabrication are illustrated here. The honeycomb pendant was fabricated by forming sheet wax around a hexagonal mandrel. Tubes of various length were joined with melted inlay wax. The nest like pearl ring was modeled with a shank of half round wax wire. The top was formed from straight lengths of 18 gauge round wire.

Another handy fabricating technique is one that I call pierce and blow. Begin with a sheet of soft wax. Pierce the wax with a heated awl and immediately blow on the melted wax. This method is a nice compromise between random or accidental design and control. The models for the texture tab and the wedding band illustrated were made using this technique.
MODEL PREPARATION

Preparing a seat in a wax model that is a good fit for a stone is always a challenge. This is particularly true in the case of faceted stones, baroques, cameos, or cabochons with domed backs. In commercial jewelry this problem is often solved by sticking to standard, calibrated stones, by reducing the material around the stone to four contact points for prong mounted rings, or by just hiding everything with a bezel. However, there are occasions when it is desireable to use a prong type mounting and still have a well fitting seat all around the stone. This may be dictated by the jewelry design and/or the mechanics of protecting a stone.

The process for preparing such a model is simple and straightforward. The outline of the stone is scribed on an appropriate block of hard carving wax. Using a small rotary file, a rough seat is cut into the block. No special care is used at this stage and a rough cavity is actually better than a smooth one. The carving proceeds till the stone will drop into the depression with it's girdle approximately level with the surface of the block. When this stage is reached a small hole (approximately 1/8") is drilled completely through the center of the model. This will allow you to push the stone out of the wax when the model is complete. Next, the stone is coated with oil or any commercial wax release and placed in the depression in the desired location. A small spatula is used to introduce melted dental inlay wax to the space between the carving wax and the stone. The wax is applied quite hot. This will produce a very low viscosity and carry the wax well into the space between the carving wax and the stone. No particular care is required and no harm is done if the wax covers a portion of the stone above the girdle. Next the wax is carved down to the girdle
of the stone.

At this point any attempt to remove the stone by force might damage the wax model. However, if the work is placed in a refrigerator freezing compartment for a few minutes the stone will either fall out or you can force it out using a toothpick through the hole in the bottom. These steps are illustrated in Figure 27. This approach is not recommended for stones which are heat sensitive (opal) or porous (turquoise). If you try and replace the stone in the seat you will find that the seat is slightly too small due to the wax shrinkage. Therefore, the next step is to polish the wax seat with eucalyptal or another solvent/polish to remove a small amount of the surface. Alternately you can use a small sharp tool to scrape away a few thousandths of an inch of the wax surface. The completed stone seat may then be incorporated in the jewelry model in any desired fashion.

This technique is very useful for preparing mountings for tumbled stones. Another variation of the method is to hand press soft sheet wax around the stone and form the stone seat. Most sheet waxes have more "tack" and may be difficult to remove.
WAX PRONGS

In the section under wax turning we discussed how to turn mountings for small round stones. However, if your stone is oval, rectangular or free-form this technique won't work. In these cases there are two basic ways you can develop a prong mounting. Prongs can be carved into place as you construct your model. Basically this means there are sculptured out of the small block of material that you use for the rest of your pattern. The second alternate is to apply the prongs after the model is basically complete. I prefer the second choice in almost all cases. Generally I will complete all of the detailing of the model before adding the prongs. This allows me to polish the wax or place texture around the stone with no difficulty.

The prongs will be much easier to apply if they are made of some material which is significantly higher in melting point than the base wax you are working with. Generally, I make my prongs out of polyethylene or polystyrene. In either case I generally prepare a long thin sliver of the material of rectangular section. The reason they add the extra length is it simply makes it easier to hold on to control until modeling is complete. I use sticky wax on one end of the prong and locate it on the model. Next I work with a very small sharp pointed spatula to fuse the prong in place. I generally build
up a little extra wax around the base of the prong with blue inlay wax. Styrene is particularly good for this application because if you get a little too much of the inlay wax around the base it is very easy to carve away the excess material with a small knife without digging into the basic prong. When all of the prongs are in place I use a very hot spatula to cut them off at a length twice what I expect to use in the final finished piece of jewelry. Normally it is much easier to file and adjust the prongs after casting. However, on occasions they can be cut precisely to size and no extensive finishing will be required.
PHYSICAL PROPERTIES

Both plastic and wax share a common property or characteristic which can complicate the model building process. Both materials are somewhat elastic. It's easy to build a model with tolerance that's so close that the stone will 'snap in'. Even though shrinkage occurs during casting the stone will not go into the unyielding mounting. The objective of the model building process is to create a well fitting bezel, which fits as uniformly as possible but allows the stone to fit with minimum finishing after casting. There is a reasonably good rule of thumb which will allow this to be completed successfully. When the model is inverted the stone should fall out of it's own weight. The only exception may be the case of diamonds (or other oleophylic gems) in wax mountings. In these cases, the bonding between the wax and the gem may obscure the actual character of the fit. Plastic models are unlikely to display this adhesive characteristic.
BEZELS

In about 50 percent of all my bezel mounted jewelry I apply the bezel by soldering it onto the casting. In many cases this is a quick, neat solution to the problem. However, in some cases I like to cast the bezel as an integral part of the model. The bezel can be carved from hard wax or formed from thin wax sheet. In the first case the carving is time consuming. In the second case it's harder than it looks to form a bezel with a nice joint. There are several other techniques you might try.

. Waxed Paper
. Plastic
. Soluable Wax

Waxed Paper - Begin with ordinary waxed paper and cut a long strip about 1/3" wide (just a little wider than the bezel). Wrap it three or four times around the stone. Cut off the extra paper and hold a heated spatula against the paper until the wax melts and fuses. When everything is cool remove the bezel and incorporate it into the model. This technique can be used to build up and reinforce any small sections as required in your model making.
SQUARE RING FORMS

Many references in the literature take note of the fact that fingers are not round. The best way to achieve a comfortable fit and insure that the ring stays upright is to slightly square the shank. This is not widely seen on commerical jewelry because it dramatically increases the finishing cost. It is not widely held to be a saleable enough feature to warrant the expense. However, in cases where customers are buying expensive, fine pieces of jewelry, I often prefer to use this style of shank. Some comments on designing and fitting these rings are in order.

If you are going to make these ring forms it's simpler if you work with a suitable commercial mandrel. The only one that I'm familiar with that's widely available is the mandrel manufactured by Jarvi. This is the one I use in my shop, and it has been quite satisfactory. The other problem is the fact that sizing the rings can be a little complicated. To the best of my knowledge, there are no ring gauges available which are manufactured to this shape or convention. For use in my own shop, I've developed a set of ring gauges, which I use to measure for the shanks. At the end of this chapter, I will include some comments about how to go about setting yourself up and making ring shanks or measurements to this square system.

As you work with the squared off ring, you will find that generally a smaller cross-sectional area of the opening will
go over a person's finger. If a given circular area is enclosed by a size five ring, a person can wear a squared ring with an opening with less area. I've achieved this rather directly. When I made my gauges. I made a series of small, flat rings which were adjusted to each of the standard ring sizes. This was done on a round mandrel. When they were complete, they were annealed, put on the Jarvis rectangular mandrel, and hammered with a soft plastic hammer until they conformed to the new shape. This was done with a minimum amount of stretching to reform the same circumference to the squared off cross-section. For my own use, I refer to these by the same standard sizes.

My size 5 square ring has the same circumference as a size 5 round ring, but it's smaller in sectional area. The photograph illustrates a finished ring gage. It should be noted that just as in round rings, the width of the shank influences the size required. Larger sizes are usually needed for wider rings. There is another factor which I've noted working with these shanks. They seem to be less sensitive to size. A person may find they need exactly a 5-3/4 round ring to fit comfortably. With the annual seasonal changes, they may complain that the ring is too loose in cold weather, and too tight in the summer. I'm not certain whether it's real or imagined, but people seem to have less of this difficulty with the squared-off shanks. I seldom measure any closer than the nearest half size
in the squared shanks. I find I have fewer size complaints with this system. This may be a good thing, because you'll discover it's fairly hard to stretch or cut down the squared rings, since you only cut down or stretch one quadrant at a time. It's very important in working with the squared shanks to measure very carefully, and cast very precisely. Again, the fact that people are not too sensitive to the size of their square shanked rings leaves you a little leeway.

As I stated in my construction instructions I do not allow any tolerance or extra for adjusting the size from the original pattern. If the original pattern is precisely measured and carefully made the small percentage of shrinkage (perhaps ½%) which you will encounter in a proper casting will just about equal the amount which you're going to polish away in finishing the inside of the ring. Care and precision in this area will save you a good deal of trouble.
MODEL BUILDING

RELEASE AGENTS

Some provision is required to keep wax from adhering to the mandrel or base during fabrication. Plastic film or aluminum foil may be wrapped around the mandrel before fabrication begins. Die lubricant, oil, glycerine or silicone grease may be applied to prevent adhesion. Silicone grease is the most potent release agent generally available. If you are having trouble removing the wax from the mandrel, a few minutes in the freezer may break the wax free. If you can't locate a supply of silicone grease from a jewelry supply house, purchase it from a laboratory supply firm. It will be sold as silicone stop cock grease.
Since every detail of the wax model will reappear in the final casting, it's important to achieve a good finish on the final wax model. Although in some situations the charm or character of the investment casting is obtained by texturing the wax, there are cases where the jewelry requires a highly polished final finish. In these cases a wax polish is very useful.
For many years, I used Eucalyptol in my own shop. This material seems to work for almost all kinds of the waxes used in jewelry modeling. However, it requires that you not apply it too liberally as it can actually damage or soften the surface of the waxes to a great depth. Generally Eucalyptol is applied with a soft cotton cloth which has been moistened but not saturated with the material. The softening action can be stopped by wiping the wax model with acetone after polishing is complete. There are also a number of commercial wax polishing compounds. I've tried several of these and they all seem to give a reasonably satisfactory results. In all cases you will find that the polishes have various effects on different waxes. That is, essentially some waxes seem to be more soluable than others.

Another good technique can be borrowed from the candle makers. Lightly buff the work with a women's nylon stocking. This can be used to bring the wax to a very high lustre. A plain cotton cloth can also be used to polish many waxes. If the material tends to soften and smear try doing the polishing under a flow of cold running water.
One problem is worth enumerating. If you wish to structure a surface which is going to be flat and highly polished, it's very difficult to build such a surface from wax. First of all, it's hard to bring the wax to a smooth surface, and if you do succeed in filing it or sanding it to a flat plane, the use of the wax polishing agents will tend to cause slight ripples or dulling of the edges. In cases where I'm trying to achieve a large smooth polished surface in a casting I generally go to a material such as acrylic or polystyrene. This can actually be buffed if you desire and it can be maintained in a very flat plane. The complete model can be made from plastic or plastic sheet may be used for the flat areas.
WAX POLISHING

There are a number of schemes for polishing wax. Very often individuals promote one or another as being particularly superior. In my own experience, I find that almost all of the techniques work in any particular circumstance. The problem is that different waxes behave differently with different polishing methods. This means that some methods might be very good for blue inlay wax, and much less satisfactory for hard carving wax.

The basic problem with most polishing schemes is the fact that normal abrasives are very quickly clogged with wax. For this reasons, sandpaper works rather poorly since it clogs up almost instantly. However, sandpaper can be used effectively for hard carving wax and plastic. However, you should note that it usually requires a somewhat finer grade of paper. A given creative abrasive cuts much more aggressively into wax than it does into metal. This means that the profile of the finish will be much rougher. When I am working in wax I found that a 400 grit water dry sandpaper is about as coarse as you can use effectively. There is far less clogging if the material is used wet.

For many materials fine steel wool offers an excellent polishing medium.
There are techniques available to test this hypothesis. One would be to use a device employed in the automotive industry called a profilometer. This device was developed to measure the surface profile of highly machine surfaces such as, engine cylinder bores. To the extent it's practical it should be possible to measure the profile of a highly finished mold and the equivalent profile of a casting. The nature of the profile might add some light to the issue of surface texture and quality.
MODEL BUILDING

CORES

The use of cores to produce hollow shell castings has a very long and respected history. Ancient Chinese, Indian, Greek Roman and American Indian metalsmiths all produced various objects based on cored casting and the process is still in use. In many cases, the core is removed after casting but this was not always done. In some situations the presence of the cores has caused significant deterioration in ancient pieces. REMoval of the core is certainly the preferred practice, but not an absolute requirement.

The use of cores is generally associated with more or less closed shell forms. However, this need not always be the case. M0dels for rings, pendants and bracelets can all be built up on investment bases to simplify the model construction. The technique can be particularly useful for modeling large thin sections or deep recesses. The process may also simplify the finishing inside deep recessed forms.
MODEL BUILDING

MANDRELS

Both wax fabrication and build up may require a mandrel to support the work in progress. A number of wax mandrels are available on the market. These can more or less be divided into three groups; straight taper mandrels, step mandrels and individual mandrels in specific sizes. The usefulness of the various commercial products relates mostly to their ability to position the work for convenience. For limited production, a conventional steel ring mandrel is satisfactory. You can construct a simple stand or place the mandrel in a gravers ball or vise.
DESIGN FOR CASTING

PRONG DEFECTS

Apparent brittleness or breakage is a common defect in the prongs on cast mountings. In most cases the defects seem to be ordinary shrinkage porosity. In a few cases, I have seen examples which look like the culprit might be excessive grain growth. This second possibility is certainly theoretically possible, but it's much harder to interpret in a finished piece of jewelry.

The problems of porosity in the prongs can usually be cured with the proper configuration. The difficulty seems to lie in two areas, the use of straight untappered prongs, which causes a poor cooling pattern, and the connection of a very fine prong to a much larger much solid mass. In my personal opinion, the key is to structure the prongs with a slightly tapped section. This will insure that chilling begins at the tip and proceeds smoothly toward the mass of the ring. Where possible I like to use a small radius at the base of the prongs, but this may not be practical if it makes the form too rigid or too difficult to clean up during the finishing operation. The ideal prong section is indicated in Figure 3. Although, this can vary somewhat it is a distinctly tapped section. Although, it need not be as finely faceted or blocky as the section shown here this works rather well in the finishing system, since either
automatic or hand finishing will tend to radius the sharp corners and reduce the prong to a more conventional section.
CASTING IN PLACE

I have never been a great fan of the cast in-place process. The stone is subjected to four kinds of abuse; high temperature, thermal shock, contraction pressures and polishing abrasives.

However, for those of you who want to try this technique, I would like to offer some suggestions. First I would suggest that you confine your first efforts to synthetic material, so that the risk if damaging the stone doesn't represent too much of a financial hazard. My candidate would be to use a faceted synthetic corundum. The corundums are hard enough to minimize damage to the stone during the polishing and finishing operations after casting. Also, the stones are reasonably resistant to thermal shock. If you are designing a piece of jewelry for casting in-place you would do well to consider a design which would be difficult or impossible by another technique. As long as you are going to go through all this work, the results should be one which can't be duplicated by other means. For example, if a faceted stone is to be held in place with two massive corner caps. This would be extremely difficult to close in a conventional stone setting operation. However, it is an absolute natural for the cast in place process. In designing such pieces it is important to remember that the stone must be anchored in place during the burn-out process. The design must allow the investment to hold the stone securely in place.
TO CAST A HOLE

Sooner or later you'll want to cast a part which is pierced by a hole. This means that there will be a small column of investment which will be totally surrounded by metal during the casting process. As you increase the length and decrease the diameter of the hole, the structural strength of this little column is diminished until at some point it will simply be swept away by the rush of the metal. There are several things you can do about this design problem. As a rule of thumb, you should probably limit such holes to a ratio of about 3 diameters long, that is the hole should not be more than three times as long as it is in diameter. This can be extended in a couple of ways. First, if you radius the edges at the end, this will thicken and reinforce the investment column and you can go to a longer hole. Various improved configuration are illustrated in Figure 27. Another alternate is to not extend the hole all the way through. In the model building process you can completely pierce the piece. Just before you finish the model you can fill in the center with wax and end up with a configuration similar to the one shown in the next figure. You simply drill out the web in the middle at the end of the casting process. Actually, this also illustrates a second problem that you'll encounter from time to time. That is, you may wish to drill a hole in the model which does not pierce it completely. In this case, the problem is even
more difficult because the column of investment is only attached at one end. Again, tapering the diameter will help considerably but an aspect ratio of about 2 to 1 is probably a good limit for this configuration.

There are a number of situations where this won't really allow you enough design flexibility. A good example would be a situation where you wish to cast a hinge. Obviously, you could fabricate on hinge parts from tubing. However, in the interest of a clean design you might wish to cast a solid hinge integral with the form. This can be done if a different core material is used for the hole. An ordinary graphite pencil lead can be used for the core.

Simply build up a wax model around a pencil lead allowing the lead to extend on both sides. The piece is cast with the pencil lead in place. Essentially, the pencil lead replaces the investment core in the hole but has considerably more strength and impact resistance. After the casting is complete, a small drill can be used to remove the carbon core and complete the work.

The process does not work with most colored pencil leads and some modern polymer boded lends. What you need is an old-fashioned clay bonded pencil lead.